

# designing a positive white cane.

*a future vision and design approach*



**student:** Thijs te Velde

**coach:** Rebecca Price

**chair:** Pieter Desmet

*I would like extend my special thanks to my chair Pieter Desmet and mentor Rebecca Price. Without your guidance and support, I would have never known I could pull this off. I would also like to thank Margot Scheltema for her generous advice and access to her private life. You were the big inspiration for this project and I thank you for that.*

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*“I put down my robe, picked up my diploma,  
Took hold of my sweetheart and away we did drive,  
Straight for the hills, the black hills of Dakota,  
Sure was glad to get out of there alive.”  
- Bob Dylan*

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# Chapter i

## executive summary.



### Context & case

You are reading the report for a master's graduation project conducted at Delft University of Technology. This project is chaired by prof. dr. ir. Pieter Desmet and coached by dr. Rebecca Price. The project was initiated by Margot Scheltema, an influential Dutch commissioner with multiple companies. She initiated this project because she is suffering from retinitis pigmentosa, a progressive eye disease, and will soon have to walk using a white guiding cane. However, she finds this cane too stigmatising and is looking for a more positive white cane.

### Research

In order to get insights into possible design directions for a positive white cane, extensive user research was conducted. This research was conducted in collaboration with Visio, an institution that helps the visually impaired that is based in Den Haag. With help from Visio, three auto-ethnographic studies were conducted, as well as one generative session and three observation studies. These observation studies were conducted by means of participant observation and gave insight into how cane walkers are trained, how the visually impaired interact with technology and how visually impaired people can be profoundly misunderstood by their environments. Independently, two observations of Margot Scheltema were conducted that gave insights into how the visually impaired are still able to live a rich life. Also, one generative session was conducted and two events were visited that include a trade fair and the Dutch retina day.

The research shows that the visually impaired face multiple problems on a daily basis. These problems include increased visibility due to (the effects of) visual impairment, loss of agency, difficulty communicating (the effects of) visual impairment and experiencing a negative self-image. Some attitudes towards assistive devices were also observed, and these are connecting the image of the assistive device to self-image, facing the reality of the situation, not letting the opinions of bystanders affect you and being concerned about the social effects of using specific assistive products. From these insights, four personas were created that can be places in certain situations in a journey map. These personas, combined with an extensive literature study and the journey map served as a basis to develop design proposals upon.

### Design proposal

After some failed attempts to reaching a meaningful design proposal, a tool was created that allows concepts to be developed while keeping research front and center. The final concept consists of a modular cane that used contemporary technology to give the visually impaired an edge in developing their unique skills and add their insights to the world. It leverages positive aspects about

being visually impaired and amplifies them, making them actionable. Three embodiments of this modular, open-ended design were developed and presented in scenarios. The aesthetics of the cane were designed in such a way that it shows the technological advances it makes use of, while still having a very striking and unique appearance. Combining the added benefits with this unique identity brings together multiple strategies that serve the purpose of de-stigmatising assistive products that were found in literature research.

### Validation

The concept was validated using a stigmaticity test and a generative session at Visio using visually impaired participants. The session at Visio gave insights into what kind of data the visually impaired imagined to be generating, with whom they would want to share that and which degree of privacy they would prefer to be associated with which kind of data. The stigmaticity tests shed some light into the effect of the aesthetics of the positive white cane. In these tests, the dyadic distance between participants and a research confederate were measured and the amount of looks the research confederate received were recorded. It was found that, in the female research confederate, dyadic distance was significantly closer when wielding the positive white cane. This means that people were more comfortable getting closer to her than when she was wielding the current white cane. This was also the cane with the male research confederate, but less significantly so.

### Conclusion

The results of this design project suggest that a positive white cane be made that combines advances in technology and a unique aesthetic that not only de-stigmatised the white cane but also brings meaningful new features to the visually impaired. These new features will allow them to become more connected, learn faster and contribute to society in a more direct manner. The data generated by this positive white cane would also serve researchers in their attempts to shape the world and make it more inclusive for everybody. Next steps that can be taken include the making of functional prototypes, holding joint workshops with both professionals working in the field of visual impairment, visually impaired users and government workers to explore the possibilities the positive white cane has to offer and many others. This project will exhibit at the Design United exhibition at Dutch Design week and I hope to make many connections there that could potentially allow me to develop this project further.



## Project goals.

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The master's graduation project is an interesting one because, next to delivering a good result to all relevant stakeholders and showing one's skill as a budding designer, it is also the last project in which the student is relatively free to set their own learning goals and work on them. Because of this, this section will be divided in two parts: project goals and learning goals.

The project goals are somewhat inherent in the project brief but have been elaborated on some more to also define the scope of the project. The first project goal is *to execute extensive user research*. Because of the empathic nature of this project, understanding the user and being able to empathise with them will be key to producing a satisfying result. This project goal can also be defined as a learning goal as I would like to do these kinds of projects in my professional life and have to grow in these design methods in order to have a chance at getting into that industry. The sub-goals for this goal can be defined as gaining empathy and understanding for the target group and building a strong network of stakeholders.

The second project goal is *to add to the body of research on assistive products and product stigma*. I would like this project to employ a research through design methodology (on which more can be read in section 1.1.4). This means that the outcome of this project will consist of research in the form of design artefacts. This has the implication that the resulting design concepts can be quite speculative, as long as the path towards them is clear and a discussing can be held about whether or not we want to go to a future that allows these products to exist. Whether this goal entails publishing a scientific article or not remains to be seen and is up to the project planning.

The third project goal is *to take the first steps towards developing an interaction genre for the visually impaired*. Interaction genres are already well-established in GUIs (graphical user interfaces, for more, see section 1.1.3). Interactive products for the visually impaired are, as of now, mere adaptations on products meant for sighted users and do not make use of their particular skillset. I aim to develop an interaction framework during this project that leverages the skills of the visually impaired and allows them to interact with the products in their environment in a deep and expressive manner.

The learning goals both result from the nature

of the graduation project as described above and emerge through reflection. The first of the learning goals is *to deliver a graduation project that shows my design process to future employers*. I believe that, in design, process is everything. Through showing the connection between result and process in the design process, one can show capacity for reflection as well as designerly skills. In this project, I want to show that I am skilled at executing a user-centred design approach that combines with academic skills to deliver a future product-service-system that is based on real knowledge. I believe the design field to be growing more and more to interactive systems of products and users, and want to show through this project that I am fit to participate in the shape of design to come.

The second learning goal is *to incorporate prototyping in the design process more*. I have always been a believer in the hands-on approach to designing and the notion of "thinking with the hands", but have so far failed to become skilled in it. In this project, I would like to involve different methods of prototyping during different phases and reflect on their use. I have previously been a very screen-based designer in that I did a lot of desk research, sketching and thinking but rarely went out into the field or thought using my hand. In this project, I would like to change that.

The third learning goal is *to build and leverage an extensive network of stakeholders*. This project has great opportunity for that since it is initiated by Margot Scheltema, an influential woman in the Dutch finances circles. This is my first opportunity to engage multiple parties in my project and I intend to fully grasp it.

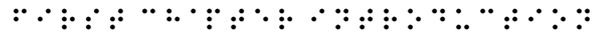
# section 1: research.





# Chapter 1.1

## literature review.



### 1.1.1 Literature review.

This literature review will present an academic framework on which this design project is built. It deals with multiple themes that all come together to form the context in which this project lives.

The first paragraph concerns assistive products and the stigma surrounding them. There exist many physical and mental disabilities in the world and just as many products to alleviate their effects. These assistive products can be used to help people live normal lives but also have many drawbacks. This causes there to be a low adoption rate (Scherer, 2015). There are, however ways to make assistive products appealing (De Barros, Duarte & Cruz, 2012). Stigma is a subject that is very much linked to assistive technology. The products we use have a definite effect on our perception of ourselves and others (Belk, 2002). Products can cause us to categorise others in certain groups or form expectations or certain attitudes. These attitudes towards users of certain products can be positive or negative. Consider for example your attitudes towards a person wearing an expensive Rolex wristwatch. Depending on one's predispositions towards these watches and the associations they carry, one could expect the wearer of this watch to be wealthy, cultured, appreciative of craftsmanship or annoyingly pompous. Assistive products like the white cane are mostly bearers of negative stigma (Vaes, 2014). This paragraph considers the causes of this negative stigma, how it can be assessed and how it can be changed through design.

The second paragraph describes specific deal considerations for the visually impaired. The visually impaired are a unique target group with unique needs that need to be taken into consideration when designing for them. Especially in the design of interactive connected products, which are as of now often screen-based (Van Campenhout et al., 2013). These screen-based devices mainly appeal to our cognitive skills and not our senses and motor skills (Djajadiningrat et al., 2004). This projects chooses the domain of tangible interaction as a valuable for visually impaired people because it "materialises the dematerialised" (Van Campenhout et al., 2013). This is especially important because this project deals a lot with connectivity. It also considers the principles of inclusive design to make the proposed design accessible for all kinds of visual impairment and skill.

The third paragraph talks about design research and ways to uncover latent user needs. It will outline various user research methods that have been employed during this project. Some of these methods draw from own experience (Ellis et al., 2011) while others try to get design insights straight from the users they will impact through observation and prototyping. Several methods that are made specifically for designing for and with visually impaired participants will also be discussed (Metatla et al., 2015).

The fourth paragraph deals with the technological and social trends that ultimately inform the future vision this project points toward.

## 1.1.2 Assistive products.

In *Possessions and the Extended Self* (Belk, 2002), Russel W. Belk tries to understand consumer behaviour by seeing our possessions as “part of ourselves”. Belk identifies four stages in the functions of possessions in human development. To us, the most relevant are the third and fourth stages in which adolescents and adults use possessions to help manage their identities and the elderly use possessions to achieve a sense of continuity and preparation for death, respectively. Belk posits that the extended self is not “(...) seen to be limited to external objects and personal possessions, but also included persons, places and group possessions as well as such possessions as body parts and vital organs”. It can be argued that Belk reasons from Cartesian body-mind dualism (a concept which will be relevant in the next section), but nevertheless shows how important possessions and products are to the construction of self. A especially interesting subset of products that have a particularly large impact on the construction of self-image are assistive products.

Assistive products are products that help disabled people - be it mentally or physically - cope with and in some instances even overcome their challenges. However, their use does not come without any drawbacks. In *Assistive Technology use and Stigma* (Scherer, 2015), Marcia Scherer focuses on the issue of stigma and its impact on assistive technology use. She identifies issues such as “family expectations of the AT (assistive technology), [and] viability resulting from use of AT in public settings (...)”. The article also posits that stigma in assistive technology is a complex issue that stems from multiple issues, including but not limited to product aesthetics, gender and age appropriateness, social factors such as ability to acquire assistive technology, culture around disability and general device features and design. As an example, it has been found that “adolescents with disabilities tend to be more concerned with their appearance and projected image than older adults” (Scherer, 2015).

It is clear that stigma can be solved differently for each and every target group. In a study on low acceptance rates in children, researchers found more factors that can contribute to users rejecting assistive technology (Gori et al., 2016). These factors were found by analysing existing products for the visually impaired and include (i) invasiveness, (ii) high cognitive load, (iii) need for substantial training, (iv) poor performance, (v) lack of action perception link and (vi) lack of multi-sensory integration.

The two reasons that people are most reluctant to use assistive products are aesthetics and stigma (Barros, Duarte & Cruz, 2012). One way to increase acceptance rate in assistive products is to present them as consumer products. This has to do with both the aesthetics of the assistive products and the way they are presented. Research has shown that designing and presenting assistive products as consumer products increases their adoption rate (Barros, Duarte & Cruz, 2012). One way to present assistive products as consumer products is to develop a solid design language. The way this is approached in this project is using a six-step process, in which the design language is constructed by doing research, along with isolating and embodying themes and principles (Rheinfrank et al., 1986). If the assistive product developed in this project is not only aesthetic in terms of interaction, but also in form and materials, it will produce a better emotional experience and even work better (Desmet & Hekkert, 2007; Norman, 2003).

### 1.1.3 Design considerations.

Around the globe, researchers and designers are working to make the world and the products we use more accessible for people with disabilities. Since the release of Viktor Papanek's seminal work *Design for the Real World*, designers have been directing their effort more and more to helping those groups in society who actually need it (Papanek & Fuller, 1972). A quote from Papanek's book nicely illustrates his "10 percent-rule".

*"Why this polemic? What is the answer? Not just for next year but for the future, and not just in one country but in the world. During the summer of 1968 I discovered a Finnish word dating back to medieval times. A word so obscure that many Finns have never even heard it. The word is kymmenykset. It means the same thing as the medieval church word tithe. A tithe was something one paid: the peasant would set aside 10 per cent of his crop for the poor, the rich man would give up 10 per cent of his income at the end of the year to feed those in need. Being designers, we don't have to pay money in the form of kymmenykset or a tithe. Being designers, we can pay by giving 10 per cent of our crop of ideas and talents to the 75 per cent of mankind in need."*

One look at the portfolios of globally influential design firms such as frog and IDEO shows that modern designers and design firms abide by this rule. Not only large design firms, but researchers are making an effort to make things easier for the per cent of mankind in need - among which are the visually impaired. In the next sections, we will consider some examples and try to learn from them. We will also outline some design considerations that can be taken into account to more meaningfully design for the visually impaired.

Researchers from the Italian National Research Council have developed a search engine interface for the blind (Leporini, Andronico & Buzzi, 2007). The reason they give for developing this specific application for the visually impaired is that "(...) the search and retrieval of information is important for everyone but it is crucial for people with disabilities, especially for the blind, who cannot access printed information." They present several limitations and downsides to the widespread use of screenreader and propose guidelines for better interface design, the most relevant of which is the use of sound cues. The rest of the guidelines concern the underlying structure and website architecture which affects the order in which certain items are read by the screenreader. A project done at the Department of Applied Computing at the University of Dundee, Scotland, offers a more interesting approach (Gregor, Newell & Zajicek, 2004). Using the principles of User Sensitive Inclusive Design (Newell & Gregor, 2000), they designed a web page that allows for dynamic diversity. This web page allowed for use by persons of various levels of visual impairment and computer skills. It was achieved by creating an adaptive webpage that can be configured to remedy the lack of representative user group and to accommodate for an incredibly diverse group of users. Voice support was added as well as the option to highlight and enlarge pieces of text. The researchers suggest that other aspects such as confidence and memory capacity should also be addressed by limiting the amount of available functionality, but allowing users to add additional facilities. Some more guidelines for User Sensitive Inclusive Design are to "(...) (1) determine common dimensions on which users can be mapped, (2) designing flexible interfaces, (3) present information most effectively to people with disabilities in various modalities and (4) design interfaces which do not require good memory and language capabilities" (Newell & Gregor, 2000).

In this project, user research attempted to follow the first guideline as laid out by Newell and Gregor. The second, third and fourth guidelines can be approached by using the principles of tangible interaction. Tangible interaction is an interaction framework that attempts to make the intangibility of digital and electronic devices tangible again. What started as an attempt to balance the rise of Virtual Reality by conceiving of computer-augmented environments (Wellner, Mackay & Gold, 1993), has become a full-blown research area, taking cues from fields such as ubiquitous computing and human-centred design (Ishii & Ullmer, 1997; Norman, 1988). Because one of the goals of this field is to return interaction design to a discipline that "... respect(s) all of man's skills: his cognitive, perceptual-motor and emotional skills" (Djajadiningrat et al., 2004), combined with the insight that simple daily life calls on a great deal of cognitive skill from visually impaired people, tangible interaction is deemed a promising framework in the design for the visually impaired. Some of the challenges embedded in this field, especially when talking about design for the visually impaired, is how to communicate the results of an action - in other words, how to present feedforward. In the design of tangible interactions during this project, the frogger framework by Wensveen, Djajadiningrat and Overbeeke will be used (Wensveen, Djajadiningrat & Overbeeke, 2014). This framework seems to be based on work by Gorbet, who presents a framework of design principles for physical-digital objects (Gorbet, 1998). In traditional GUIs (graphical user interfaces), a set of interaction genres have already been established. Genres are "... a set of design conventions anticipating particular usage contexts with their own conventions" (Bellotti et al., 2002). The authors give examples such as the flashing cursor indicating that text can be typed. There are no such genres in tangible interaction yet, but one of the goals in this project is to develop such genres for the visually impaired.

As of now, all controls in electronic products look and feel roughly the same (Norman, 2013). That is why these controls are currently explained by textual information on screens. Obviously, this is not of much use to the visually impaired. As observed in the research done for this project, this results in a disjointed and dissatisfying interaction with current electronic products (see section 1.2.2). Norman's natural mapping principle could offer a solution, in which the way controls are laid out spatially explain their purpose. It does however not apply to design problems where there is abstract data involved that has no physical counterpart (Djajadiningrat et al., 2004). One can also use a semantic approach, in which the product's appearance and controls become signs (Krippendorff & Butter, 1984). This is more of a metaphorical approach and depends on the user's experience and knowledge. In their paper *Tangible products: redressing the balance between appearance and action* Djajadiningrat et al. propose a more direct approach, one that uses "... the sensory richness and action-potential of physical objects as carriers of meaning and interaction" (Djajadiningrat et al., 2004). The authors see a certain aesthetics of interaction in it, they are, in their words "... interested in not only the structural but also the affective aspects of affordance." In their mind, there are four aspects to aesthetic interaction. The third aesthetic element to interaction is the aforementioned aspect of skill. Well-designed interactive electronic products allow users to grow and learn whilst using the product (Djajadiningrat, Matthews & Stienstra, 2007). A study in two-handed input done by William Buxton and Brad A. Myers shows that the introduction of skill in the control of electronic products not only increases efficiency in use, but satisfaction as well (Buxton & Myers, 1986). Another thing that can increase efficiency in the addition of haptic feedback. Haptic feedback is unique because it "... supports two-way communications between humans and interactive systems, enabling bidirectional interaction between humans and their surroundings" (Hale & Stanney, 2004). Making the interaction more aesthetic will allow this product for the visually impaired to still experience this product on an aesthetic level (Desmet & Hekkert, 2004).

## 1.1.4 Design research.

In an empathic design project like this, research is a vital tool towards unstinting unique user needs and producing value. Several qualitative research methods were used in this project. The first tool that was used towards understanding the visually impaired user group was autoethnography. Autoethnography is a research method that breaks with the traditional empirical methods and instead focuses on subjective experience. It is "... an approach to research and writing that seeks to describe and systematically analyse (graphy) personal experience (auto) in order to understand cultural experience (ethno)" (Ellis, Adams & Bochner, 2011). In order to get a more objective view, participant observation was used. For this, the book *Qualitative Research Methods: A Data Collector's Field Guide* was used (Mack et al., 2005).

In ideation, design research can be seen as a mix between thinking and doing, an approach that Christopher Frayling describes as research for design (Frayling, 1993). Frayling describes this practice of research as "... research where the end product is an artefact - where thinking is, so to speak, embodied in the artefact, where the goal is not primarily communicable knowledge in the sense of verbal communication, but in the sense of visual or iconic or imagistic communication". This approach treats the outcome of research, the design artefact, as the ultimate goal of the process. Another more applicable approach to research in design is research through design. This is a method that "... stressed design artefacts as outcomes that can transform the world from its current state to a preferred state. The artefacts produced in this type of research become design exemplars, providing an appropriate conduit for research findings to easily transfer to the HCI research and practice communities" (Zimmersman, Forlizzi & Evenson, 2007). In other words, a practice through which designers focus on making the right thing. In this process "... the final output of this activity is a concrete problem framing and articulation of the preferred state, and a series of artefacts - models, prototypes, products and documentation of the design process". Because of the nature of this project's ideation process (using a lot of empathy for a target group that has a profoundly different experience than

the designer), a technique called informance design was considered. In informance design, designers can, through "... the use of performance techniques such as improvisation [...] promotive multi-disciplinary, collaborative design work in ways that are as much visceral and experiential as intellectual and reflective" (Burns et al., 1994). A very nice example of how this can impact a design project for the better can be found in the paper *Cardboard Computers: Mocking-it-up or Hands-on the Future* (Ehn & Kyng, 1992). Another ideation tool that was used is called making for exploration (Frens & Hengeveld, 2013). This is a hands-on ideation approach that focuses on exploration and elaboration through actively engaging with materials. Through iterative prototyping, the designer generates insights during the design process. The prototypes that come out of this process are filters, consciously limited in scope to only research one aspect of the design (Lim, Stolterman & Tenenberg, 2008). In this stage, it is important that the designer engages with physical, preferably low-fidelity materials such as cardboard and foam. This is because the tools we use have the same fidelity as the insights that we need. As we move up in the design process, the fidelity of the problems we want to solve (such as an exact fillet of a product) increases, and so should our tools. A second reason for this low-fidelity, interactive prototyping is reflection. Time and time again, it has been found that physical making has a strong connection with cognition. As one team of researchers states it: "Successful product designs result from a series of "conversations with materials." Here, the "conversations" are interactions between the designers and the design medium - sketching on paper, shaping clay, building with foam core" (Hartmann et al., 2006). An inspiring application in the field of interaction design of this technique can be found in *Rich Interaction: Integrating Form, Interaction and Function* (Frens, 2006). Another reason is to train the creative body. With practice, designers can turn into craftsmen of designing interaction, becoming attuned to certain interaction qualities and moving certain parts of knowledge to their hands (Sennett, 2008).

*The pictures on the adjacent page show representations of design approaches that were deemed interesting in research: designing through making.*



## 1.1.5 Trends.

In Smart Cities in Europe, the researchers point to multiple characteristics of a smart city, six in total (Caragliu, Bo & Nijkamp, 2009). All are interesting, but three of these are especially important in the context of this project. First of all, the fact that smart cities are characterised by "... the utilisation of networked infrastructure to improve economic and political efficiency and enable social, cultural and urban development". This point places emphasis on connectivity and links it to growth. The second important point is "... a strong focus on the aim to achieve the social inclusion of various urban residents in public services." Connectivity and the use of connected products by groups on society that have been traditionally at a disadvantage could help them gain a comfortable role in society and still have a sense of belonging in it. This brings us to the third point, being "... profound attention to the role of social and relational capital in urban development. A smart city will be a city whose community has learned to learn, adapt and innovate". I see the visually impaired community as a good candidate for championing this role. Who else has learned to learn, adapt and innovate as well as them? A few key areas in which smart cities could be used have been described and identified (Zanella et al., 2014) but not much has been done yet in the field of using urban IoT and smart city technologies to improve accessibility and strengthen the role of the impaired in society. An interesting aspect in which smart city technologies and the visually impaired can link are in policy. As stated in one article, "... transformation from an ordinary (non-smart) city to a smart city also entails the interaction of technological components with political and institutional components" (Chourabi et al., 2012). The visually impaired community is a master of their own experience and could have direct impact on making cities accessible. This is also observed in observational research done during this project (see section 1.2.2). In order to help city planners design more accessible cities for the visually impaired, data is needed. In big data, three sources of data can be identified (Kitchin, 2014). These sources are directed, automated and volunteered. Directed data are gathered by surveillance and are already being collected on a large scale using for example CCTV or passport controls. Automated data consist all types of data that are generated by devices that are used - examples that can be given include payment history, internet search history and many more. Volunteered data is data that is voluntarily provided by the user of a product or system. Example of data are pictures that are uploaded to the internet or shared locations. One large critique on the development of smart cities is the risk of also creating a panoptic city (Kitchin, 2014), in which all aspects of citizens' lives are logged and processed. Some researchers propose that life-logging technologies forget the things they record (Doge & Kitchin, 2007).

There are difficulties in getting the visually impaired target group to participate in smart cities, however, and these lie in the digital divide. To cite Winberg and Bowers: "... the more widespread are innovations in computer interaction which require visual ability, the more visually impaired users are disenfranchised from leading edge technical developments" (Winberg & Bowers, 2004). As observed during observational studies of ICT-related training with the visually impaired, this group of people has to work very hard at gaining access to digital tools (see section 1.2.2). This is not a matter of Access Digital Divide (ADD), but of Social Digital Divide (SDD). This Social Digital Divide is explained by the skill levels people have when they use these digital tools (Hargittai, 2002). Kvasny even goes further and uses the words digital inequality to "... signify a shift and distinction in focus from access to use of information and technology" (Kvasny, 2002). Not being able to use the internet is problematic because of its widespread use in today's society. In the information age, the internet can be seen as a necessity for living. Letting some groups in society not utilise its benefits can set them back considerably, or in the words of Floridi: "... building an equitable information society for all is a historical opportunity we cannot afford to miss" (Floridi, 2001). Floridi offers a set of universal information ethics, which are based on the notion of allowing access to information for all and ensuring the quality and security of that information. A connected white cane that places itself within the network of the smart city will allow visually impaired users to interact with the Internet in ways that are more suited to their particular skills. To allow collaboration with sighted users within this system (using a tangible interface), several design rules have to be abided by (Winberg, 2004). In order to allow for collaboration with graphical interface users, these tangible interfaces have to (i) provide access to the same functionalities as are available in the graphical interface, (ii) allow for exploration and manipulation of the system - this gives both user groups the same level of control over the system and allows the visually impaired user to explore all functionalities (iii) be coherent with the graphical interface. The visually impaired participant should also be able to have a meaningful contribution to the system (Winberg, 2006).



## *Assistive products and product stigma.*

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### **Reasons for low adoption:**

1. invasiveness.
2. high cognitive load.
3. poor performance.
4. lack of perception-action link.
5. lack of multi-sensory integration.
6. aesthetics.
7. social stigma.

*(Schrerer, 2015; Gori et al., 2016;  
Barros, Duarte & Cruz, 2012)*

### **Possible solutions:**

1. reshape meaning of product.
  - advances in technology.
  - identify product with user.
  - strengthen product (brand) identity.
2. empowering users.
  - additional features.
  - boost social skills.
  - boost group identity.
3. reshape context.
  - present as consumer good.
  - educational campaign.
4. better fit between user and (interaction) design.

*(Vaes, 2014; Rheinfrank et al., 1986;  
Barros, Duarte & Cruz, 2012)*

### **Effects:**

1. improved aesthetic and emotional experience.
2. a better working product.
3. greater adoption rate.

*(Desmet & Hekkert, 2007; Norman, 2003;  
Barros, Duarte & Cruz, 2012)*

## *Design considerations.*

---

### **Dynamic diversity:**

1. modular design.
2. design for skill.
3. multimodality.

*(Newell & Norman, 1982;  
Matthews & Stienen, 2012)*

### **Multimodal interactions:**

1. using sound cues.
2. tangible interaction.
  - genres.
  - perceptual-motor skills.
3. haptics.

*(Leporini, Andronico & Buzzati, 2012;  
Wensveen, Djajadiningrat &  
Belotti, 2012)*

## *Social and technological trends.*

---

### **Smart cities:**

1. connectivity.
2. social inclusion.
3. social and relational capital.
4. interaction between technology and politics.

*(Caragliu, Bo & Nijkamp, 2009; Chourabi et al., 2012)*

### **Big data:**

1. multiple sources.
  - directed.
  - automated.
  - volunteered.
2. ethics of forgetting.

*(Kitchin, 2004; Doge & Kitchin, 2007)*

### **Digital divide:**

1. digital equality.
  - Access Digital Divide (ADD).
  - Social Digital Divide (SDD).
2. collaboration with sighted people.
  - access to same functionalities.
  - allow for exploration of system.
  - coherent with sighted GUI.

*(Winberg & Bowers, 2004; Hargittai, 2002; Floridi, 2001; Kvasny, 2002; Winberg, 2006)*

# Chapter 1.2

## user research.



### 1.2.1 User research.

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As presented in both the introduction and literature review, user research is vital to the execution of this project. User research will not only allow us to uncover latent knowledge in the group we are designing for, but also to empathise with them. User research is also vital in the ideation phase, as concrete observations can be used to kickstart ideation. Generative sessions can also be rich sources of inspiration for ideation. This part of the graduation report will be structured as a report in itself. First, methods will be considered and the research results will be presented. Afterwards, conclusions will be presented and main insights. The timeline of research activities can be found on the facing page.

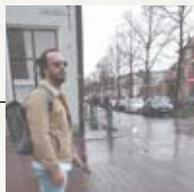
The research questions that were determined before starting research are the following:

- 1. What are the struggles visually impaired people face on a daily basis?**
- 2. What are their issues towards assistive devices?**

With these two specific research questions, it is hoped that a first steps towards a design can be taken. This design will both have a functional use for the visually impaired target group as well as be seen as favourable by them and the people surrounding them.



01-03-2019  
autoethnography  
at Visio



06-03-2019  
autoethnography  
in Delft



07-03-2019  
observation  
Margot Scheltema



20-03-2019  
autoethnography  
in Den Haag



19-03-2019  
autoethnography  
in Leiden



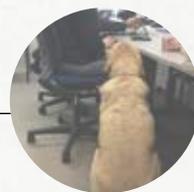
16-03-2019  
visit  
ZieZo fair



28-03-2019  
observation  
Margot Scheltema



02-04-2019  
observation  
cane training



02-04-2019  
observation  
ICT training



17-04-2019  
session  
at Visio



12-04-2019  
session  
at TU Delft



02-04-2019  
observation  
social worker



22-06-2019  
visit  
Retinadag

-  autoethnography
-  observation
-  miscellaneous

## 1.2.2 Methods.

In this section the data collection methods used over the course of the research are described. While designing the research strategy, the principle of triangulation was used (Berg, 2001). By using a combination of different data collection methods, research subjects and researchers, the aim was to capture more rich data, and to avoid a one sided narrative.

### Autoethnography

As Wall (2006) puts it, autoethnography “allows the author to write in a highly personalized style, drawing on his or her experience to extend understanding about a societal phenomenon”. As the subject of the study is highly personal and related to emotions and struggles, a similarly personal and sensitive method is needed, alongside the more traditional qualitative research technique of participant observation.

Autoethnography can take several different forms. In the course of this study autoethnographic texts were the product of the researchers reflections on fieldwork activities. In the creation of autoethnographic texts, researchers tell about their experiences in most cases using the first person. Aesthetic qualities of the text are also important to convey the experience to the readers (Ellis, Adams, & Bochner, 2011).

During this study, the two researchers experienced navigation with limited vision, and analysed this experience, thus creating their personal narratives. As the autoethnographies were created by two researchers, the differences between voices and narratives could be subjects of analysis as well. Using this kind of self-observation as a research tool had two main goals. Next to obtaining knowledge on the main research question, the secondary goal was to develop empathy towards the user group, which will aid the design phase and also the communication with users. Having this experience, and looking at it analytically can be a powerful tool in bridging the communication gap resulting from experiencing the world in a different way.

The two researchers took turns in wearing modified glasses. The glasses simulated retinitis pigmentosa, the same condition Margot Scheltema lives with. The second researcher observed the first researcher and also the reactions of the bystanders. The two participants in this study are Veronika Szabo and Thijs te Velde. They are both design researchers conducting their master’s graduation project at Delft University of Technology. Features that set them apart from the general populations are their knowledge of design research and their stake in the project. These two participants were selected to allow them to both gain experience in conducting autoethnographic research and participant observation as well as gain insights useful to the graduation projects.

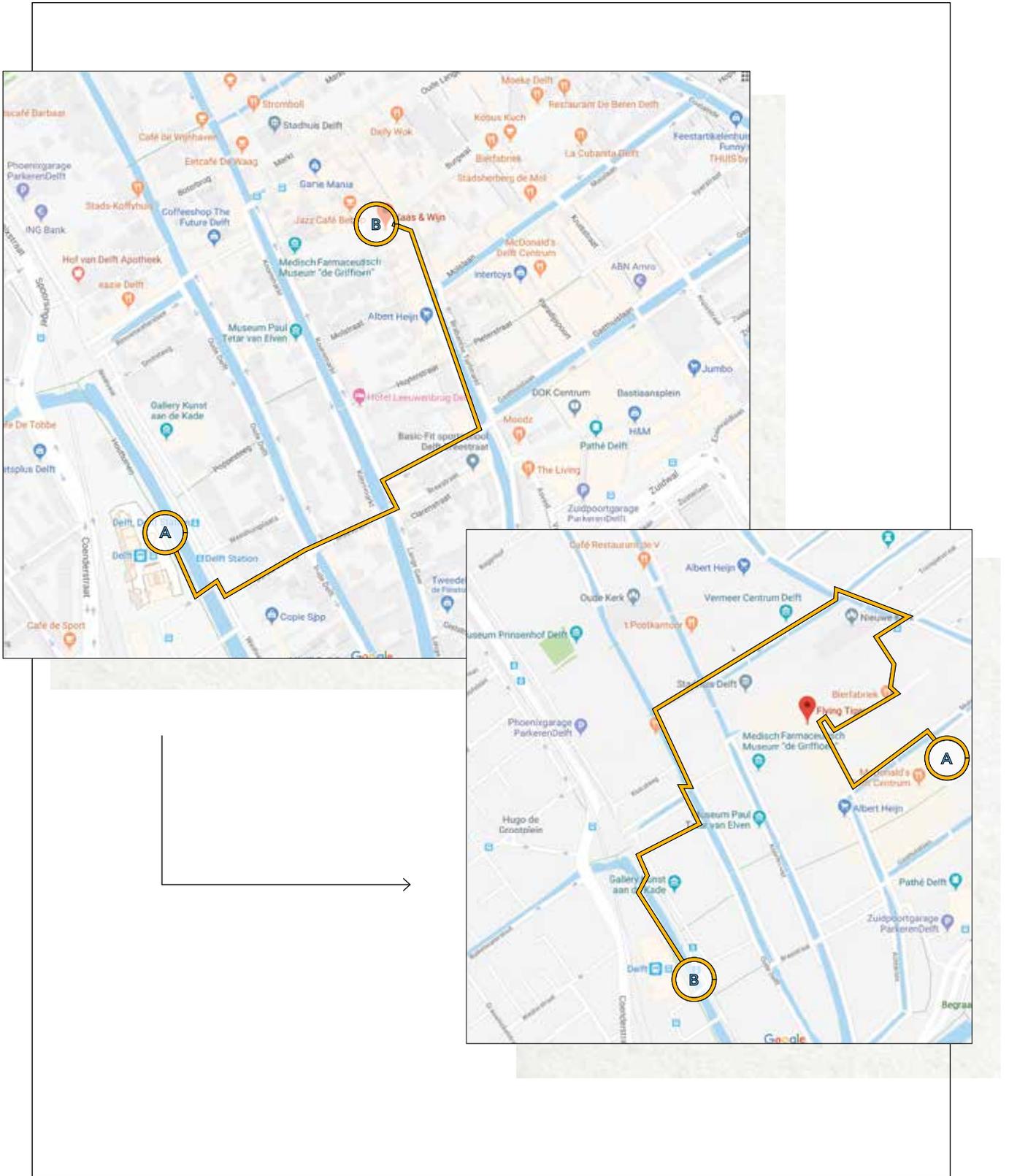
During the activity, audio recordings were taken and the researchers’ observations were stated out loud for further processing. After each session, the researchers took quick notes on their most important observations and impressions. After each research activity was completed, both researchers expanded their notes by the help of the audio recording, and also created a text containing their personal narrative of the activity.

This method was used in three sessions. To obtain diverse observations, a variety of locations, times and activities were used. This way the researchers could also compare the experiences between cities and times of day to see if there is a lot of difference between, for example, a familiar or unfamiliar neighbourhood or between rush hour and a quiet morning hour.

In total, the tools used to perform these autoethnographic studies are the following:

- **Glasses to simulate the effects of retinitis pigmentosa.** We took a pair of sunglasses and neatly cut out blinds out of thick black paper. We then used a pin to create two small holes in the middle of these blinds to see out of. This simulates the effects of retinitis pigmentosa. We chose to simulate this specific type of visual impairment because one of the main stakeholders in the project suffers from this condition.
- **Long cane.** The kind people at Visio allowed us to borrow a used long cane. This particular cane is quite worn as it has been used in many a training but still functions and serves our purposes perfectly.
- **Mobile phone for audio recording and taking pictures.** Because we won’t be able to record everything using writing when walking around town, we decided to use a mobile phone to record the majority of information.
- **Field notebook and pen.** We did, however, still carry around a notebook to note down particularly noteworthy observations.





### 1. Autoethnography in Delft (06-03-2019).

To get familiar with the methods of participant observation and autoethnography, a pilot study was conducted in the city centre of Delft. The secondary goal of this study was to uncover problems that can emerge during execution of the methods, and improvement possibilities of the equipment used. The third and last goal was to get insights into the reaction surrounding visually impaired people and to gain empathy for this target group.

A detailed plan of the session can be found in appendix A. The session consisted of two parts, with a short break in between to switch roles and note down observations and switch roles. The map of the route can be seen in the figures on the adjacent page.

The time schedule for this first autoethnographic study was as follows:

- **11:00: Start of first part of the study** (Veronika guided, Thijs was visually impaired). During this first part of the study, Thijs was getting used to walking around using the modified glasses and cane, and Veronika was probing how much guidance is needed. Veronika and Thijs were also getting used to stating their experiences out loud, and making notes whenever anything noteworthy occurs.
- **11:00: Start walk from Delft central station to Kaas & Wijn** (Brabantse Turfmarkt). During this main part of the first round of study, Thijs noted observations about the visually impaired experience while Veronika noted observations about the reaction of bystanders to the presence of behaviour of a visually impaired person.
- **11:20: Arrive at Kaas & Wijn, buy sandwiches.** During this forced interaction with a bystander, Thijs was making observations about how it feels to execute mundane activities as visually impaired persons, while Veronika was making observations about the behaviour of the people in the store.
- **11:30: End of first part of the study, start of reflection.** Writing notes for narratives. After this, both researchers noted down other key observations while they were still fresh in their memories.
- **12:00: Start of second part of the study** (Thijs guided, Veronika was VI). This is when we change roles. This time around, Veronika will have to get used to walking with the modified glasses and the cane, while Thijs will have to get used to guiding and making observations at the same time.
- **12:00: Start walking back to the station.** The second leg of the study begins. The approach remains the same, the roles are reversed.
- **12:20: Buy notebooks at Flying Tiger** (Phoenixstraat). Another forced interaction with the environment and possible bystanders allowed both researchers to gain empathy for visually impaired people and observe the reactions of the environment to the presence of one.
- **12:30: End of second part of the study, start of reflection.** Writing notes for narratives. After this, we wrapped up the second part of the study and noted down additional observations for use in our personal narratives while they were still fresh in our memories.

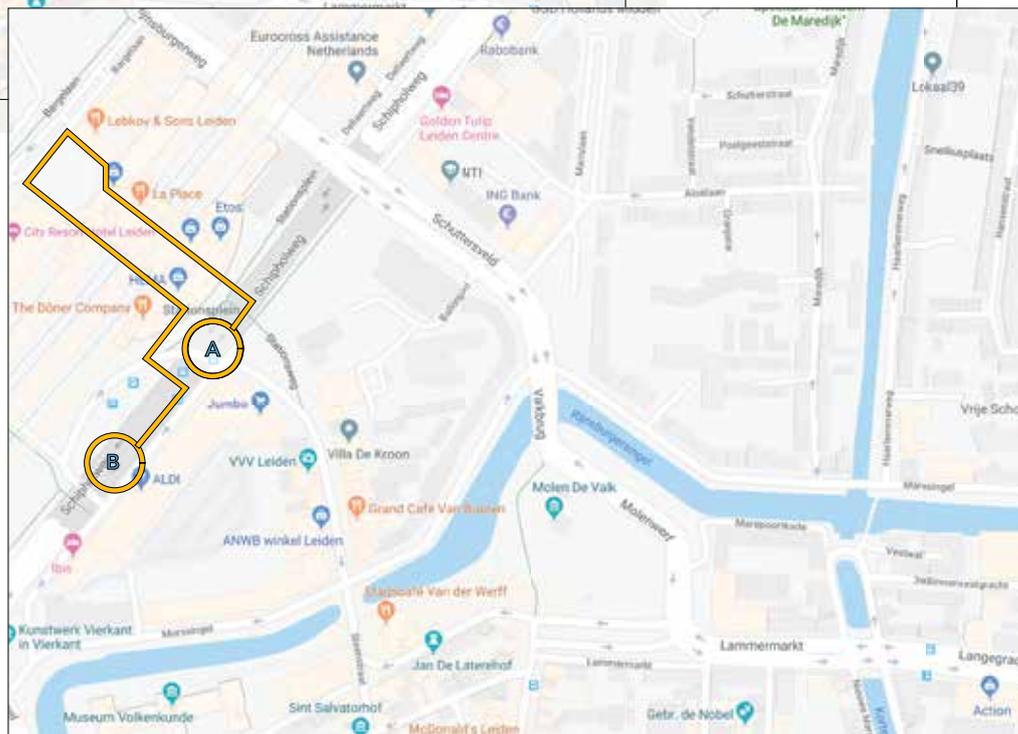
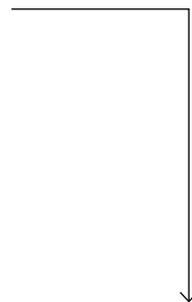
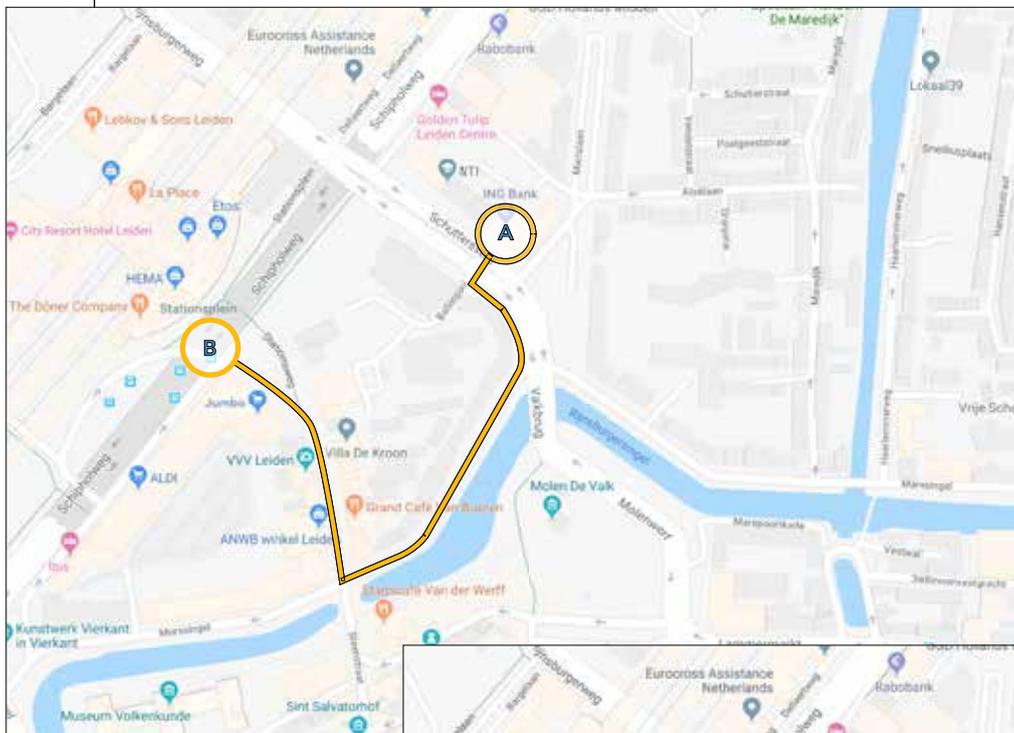
## 2. Autoethnography in Leiden (19-03-2019).

The second instance of this research activity was conducted in Leiden, near the central station. The area around the central station was chosen because one goal of this activity was to find out how people would react to the presence of a visually impaired person in a busy environment. The presence of shops also provided an interesting opportunity to get more data on behaviour and feelings during daily interactions between bystanders and visually impaired people.

This session, similarly to the session in Delft, consisted of two parts, so that both researchers could experience both roles. The detailed plan of this activity can be found in the appendices. The map of the route taken can be seen in the figures on the adjacent page.

The time schedule for this second autoethnographic study was as follows:

- **11:00: Start of first session.** (Veronika guided, Thijs was VI).
- **11:00: Start walk from ING** (Schuttersveld). in the direction of Leiden Central Station. Similarly to the pilot, Thijs was noting observations about experiencing the walk as VI, and Veronika was observing bystanders reactions.
- **11:20: Arrive at Leiden Centraal.** Enter the station. Entering Leiden Central Station created a possibility to experience navigating among rushing commuters. Differences in bystanders responses were probed, as compared to calmer situations during the pilot.
- **11:30: End of first study. Switching roles.** As opposed to the plan, the researchers switched roles and continued with the observation, as the timeframe available for the study became shorter due to unexpected circumstances.
- **11:30: Start of second session.** (Thijs will guide, Veronika will be VI). In the second part of the study, Veronika was noting observations about experiencing visual impairment, and Thijs was observing bystanders reactions.
- **11:35: Checking in at Leiden Centraal.** Checking in was chosen as an everyday activity that permits how the daily experience changes with retinitis pigmentosa.
- **11:40: Entering Lebkov and Sons.** The activity of buying sandwiches was chosen for this study. After entering, Veronika decided to purchase them at another store.
- **11:50: Buying a sandwich at AH to go.** At AH to Go, Veronika was buying a sandwich. The process of selecting the sandwich and also using the self checkout was observed.
- **11:55: Find the platform to board the train to the direction of Delft.** The last activity was to find the right platform at the train station. Navigation inside the station and on the platform was observed.
- **12:00: End of second pilot and start of reflection.** Writing notes for personal narratives. After wrapping up the session, observations were noted down. Later, both researchers expanded the notes with the help of the audio recording, and completed their personal narratives about the experience.



### 3. Autoethnography in Den Haag (20-03-2019).

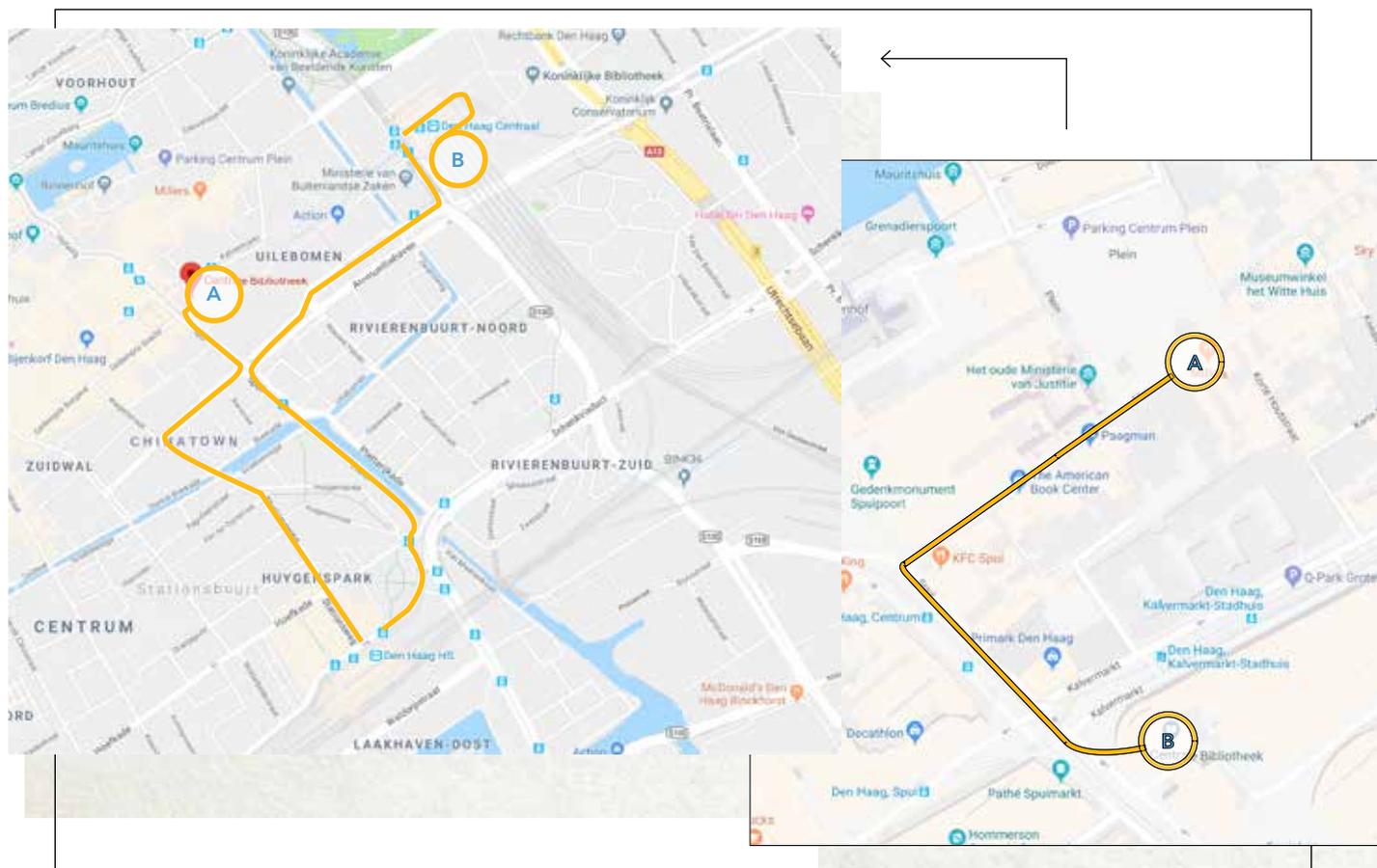
The third instance of this research activity was conducted in Den Haag, in the city centre. This session was substantially longer than previous sessions and was designed to be as diverse as possible. Den Haag was familiar territory for one of the participants, but not for the other. A large amount of diverse activities were chosen to get insights into multiple aspects of daily life for visually impaired people.

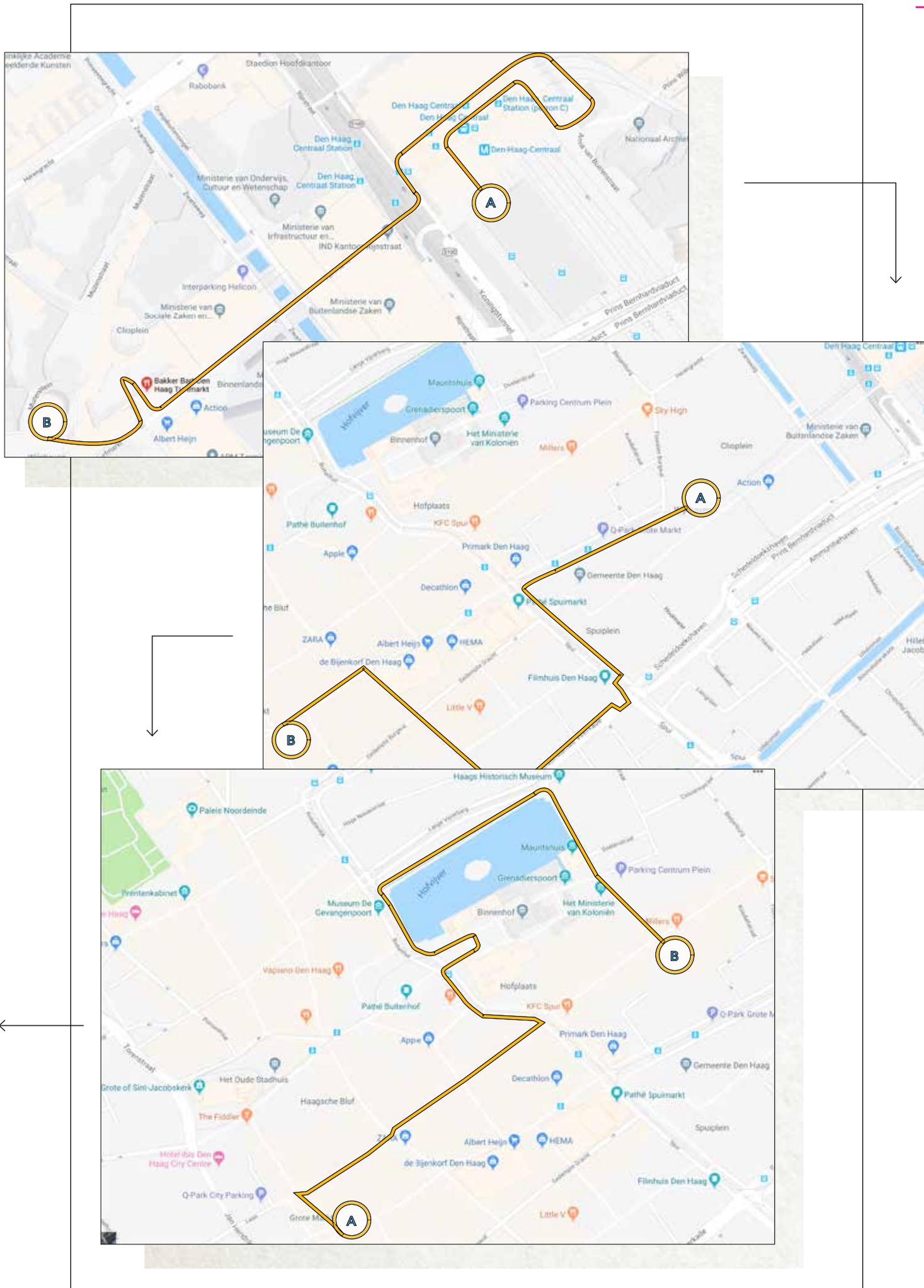
This session consisted of four parts, each researcher taking up both the role of visually impaired and observer two times. In between the parts, small breaks were included to note down observations and insights. The exact routes and activities to include were decided during the course of the session, to experience a more natural way on navigation compared to the first two studies. This gave the researchers the possibility to react on unexpected situations.

The map of the route taken can be seen in the figures on the adjacent page.

The time schedule for this first autoethnographic study was as follows:

- **8:20: Start of first session** (Thijs guided, Veronika was VI). Exiting Den Haag Centraal. Conversation with political activist. Walking to Bakker Bart (Turfmarkt). Enter Bakker Bart. Buying coffee. Walk to Wijnhaven.
- **8:50: End of first part of the study, start of reflection.** Writing notes for narratives.
- **9:00: Start of second part of the study** (Veronika guided, Thijs was VI). Walk from Wijnhaven to the Spuiplein. Cross the Spui at the Filmhuis. Turn to the Amsterdamse Veerkade. Walk to Grote Markt. Take a break. Write notes for narratives. Walk from the Grote Markt to the Binnenhof. Walk around the pond and to the Plein.
- **9:40: End of second part of the study, start of reflection.** Writing notes for narratives.
- **10:45: Start of third session** (Thijs guided, Veronika was VI). Walk from the Plein to the Centraal Bibliotheek. Break. Walk from the Centraal Bibliotheek to the HEMA. Entering the HEMA. Looking around. Exiting the HEMA. Walking to Den Haag HS.
- **11:05: End of third part of the study. Switching roles.**
- **11:10: Start of fourth part of the study** (Veronika guided, Thijs was VI). Walking to the tram stop. Waiting for the tram. Boarding the tram. Travel with tram to Den Haag Centraal. Get off the tram, walk inside the station.
- **11:30: End of fourth part of the study, start of reflection.** Writing notes for narratives.





### Observation of Margot Scheltema

Participant observation is one of the most common methods of qualitative research. As how people often perceive and report their behaviour can be contradicting how they actually believe, participant observation can be used to compare their reported and actual behaviours. Participant observation also serves the purpose of building a positive relationship with the important stakeholders of the project. (Mack, Woodsong, M. MacQueen, Guest, & Namey, 2005). It is important to note that participant observation is subjective in nature, therefore researchers need to be conscious of the difference between the observed phenomena and the interpretations made based on it.

While preparing the research strategy, shadowing was also considered as a method for data collection. As described by Quinlan (2008), the method is suitable to capture behaviours and opinions, and can provide answers to the why questions, and not only descriptive data. The downside of shadowing is that both the data collection and analysis requires considerable time and effort, and to reach the depth and richness of data the shadowing periods are typically longer (several weeks). Due to time constraints present in the graduation projects, the method of participant observation was used instead.

The participants in this research were the students Veronika Szabó and Thijs te Velde, as well as Margot Scheltema. Margot Scheltema is one of the initiators of the graduation projects Thijs and Veronika were working on and was thus chosen as suitable participant. Margot Scheltema is an accomplished commissioner that has served on the boards of multiple companies and has been suffering from progressive retinitis pigmentosa for multiple years now.

In the course of the observations she was accompanied by the researchers throughout her daily activities. In both studies, the goal was to both uncover difficulties in visually impaired persons' day-to-day interactions with the outside world, as well as get a sense of the culture in which Margot Scheltema moves. We perceive this culture as being very significant to achieving a meaningful design intervention.

During the activities researchers noted down their observations and interpretations, and asked questions to the participant to validate the assumptions made. These initial notes were expanded after the observations.

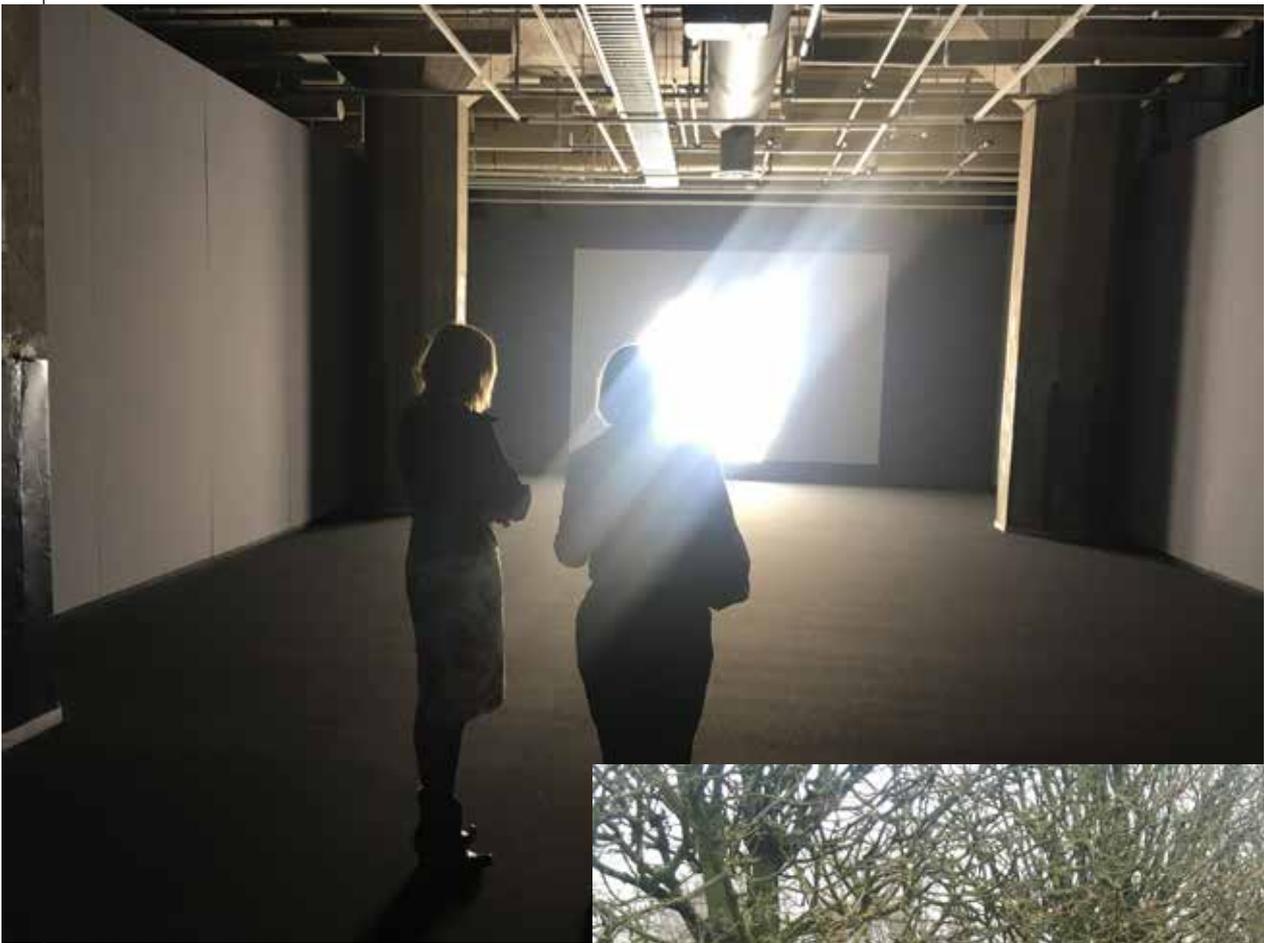
#### 1. Observation in Rotterdam, Den Haag and Amsterdam (07-03-2019).

During this day the participant was observed during several activities. First she gave a tour in the Nederlands Fotomuseum in Rotterdam. After the tour the researchers accompanied her to her home in Den Haag, and to a reception in the Tropenmuseum in Amsterdam by public transport. In addition to the goals previously described, an additional goal for this study was to get to know Margot Scheltema personally and build a professional and friendly relationship with her. A detailed research plan can be found in the appendices.

#### 2. Observation in Den Haag and Baarn (28-03-2019).

In this observation, the participant was observed during an hour-long drive to Baarn, where she was to give a presentation. This day was chosen because the participant expressed concern in giving the presentation because of several factors. Both parties thought that concern could offer an interesting day of observation. After giving this presentation, the participant was observed during the car drive back to her house. A detailed research plan can be found in the appendices.

*The pictures on the adjacent page show Margot Scheltema during observations in both Rotterdam and Baarn.*



### Observation of various activities at Visio

The researchers were invited to a full day of observation at Visio Den Haag. A schedule was prepared in which the various activities were indicated, but one of the clients ended up canceling later in the day. Another observation session was quickly arranged.

#### **1. Observation of the training of a cane walker (02-04-2019).**

In this session, the researchers observed the training of a completely blind cane-walker learning a specific route from the Visio location to the nearby station. This man had been learning how to use a cane for the last five years, so was moderately skilled in using it. The goal of this session was to uncover common problems visually impaired people have when learning how to use a cane, both practical problems relation to navigation as well as emotional problems relating to the social implications of using a cane. The observation notes can be found in the appendices.

#### **2. Observation of an ICT-related training (02-04-2019).**

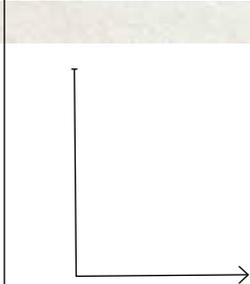
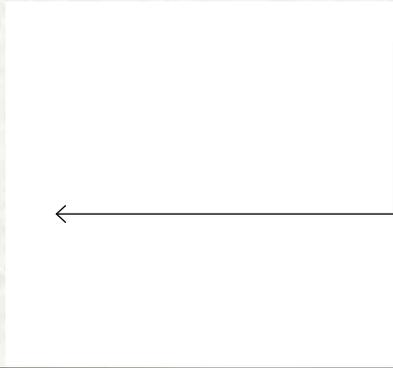
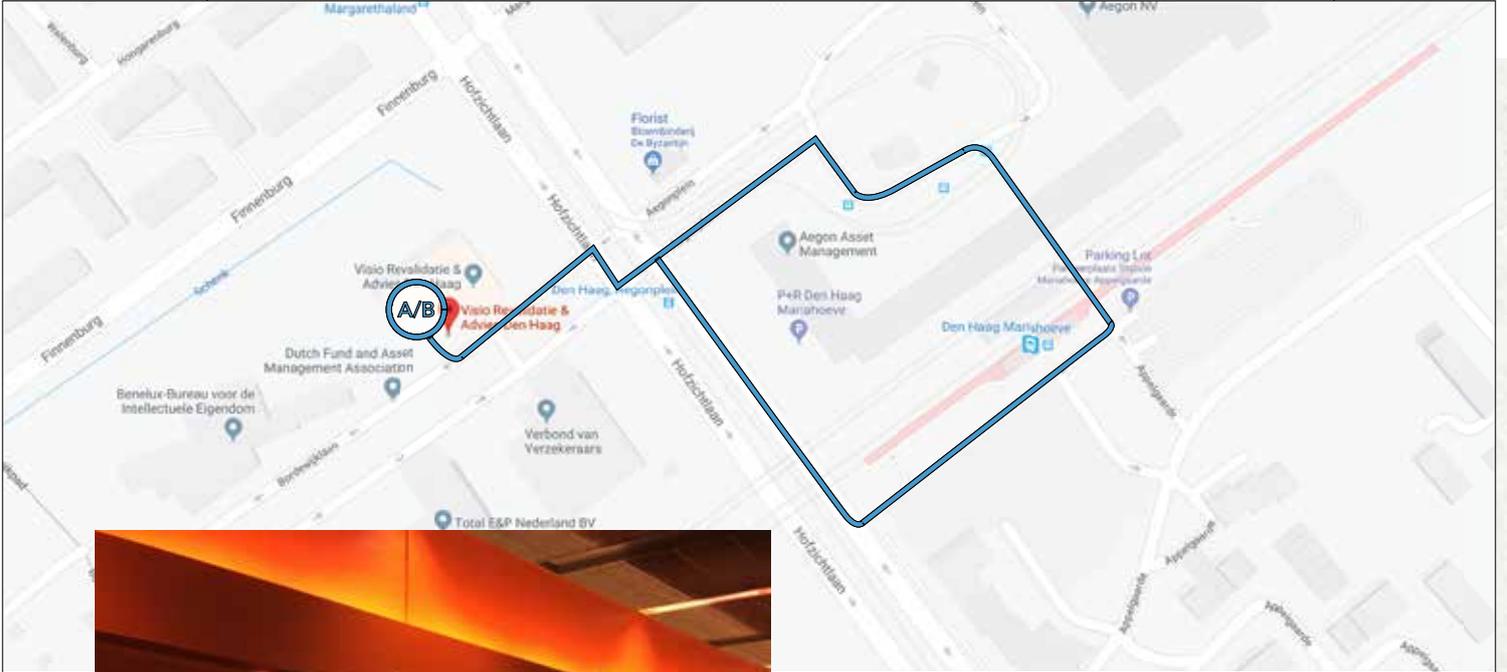
During this activity the researchers observed an ICT training at the Visio facility. During the lesson the researchers were sitting near the client and the instructor, and were noting down observations. At times short questions were asked to the participant. After the lesson, a short interview was conducted with the instructor about the training observed and her experiences with ICT trainings in the past. The goal of this research was to find specific problems relating to visually impaired users and their interactions with (digital) products. The observation notes of both researchers can be found in the appendices.

#### **3. Observation of a talk with a social worker (02-04-2019).**

During this activity the researchers observed as a newly visually impaired person and their spouse having a meeting with a social worker. The main topics of conversation as well as the reactions and behaviour of the parties were noted down. No recording was made of the conversation out of respect to the personal nature of the conversation. The observation notes of both researchers can be found in the appendices.

*The pictures on the adjacent page show two of the observed activities at Visio: a cane training and an ICT training.*





### Miscellaneous activities

Some miscellaneous activities were also executed that cannot be put in any other categories. These will be presented here.

#### **1. Expert meeting at Visio Den Haag (01-03-2019).**

To start the collaboration with the Visio expertise center, an initial meeting was held with the two researchers, the manager of the Visio Den Haag facility and two occupational therapists. Firstly, expectations were discussed along with opportunities to collaborate. During the meeting, one of the occupational therapists offered the opportunity to experience what it's like to be visually impaired, which the researchers gladly accepted. Several modified ski masks were tried on, starting completely blind, which simulate various visual impairments. This first experience was meant to be a starting point for subsequent autoethnographic studies. Personal narratives of the experience can be found in the appendices.

#### **2. Visiting the ZieZo Beurs in Utrecht (16-03-2019).**

In order to explore what is currently available for visually impaired users in the domain of mobility tools, the ZieZo Beurs was visited. The secondary goal of this activity was to build connections with possible stakeholders of the project. Firstly, the researchers explored the selection of exhibits. Their offering was assessed visually, to have an overview of the technology and visual style. The exhibitors of interest were selected, favouring the topics related to mobility and the booths who sported an original approach. During the course of the visit several discussions were held to acquire more information on the projects and products exhibited. After the fair the researchers completed personal narratives on the visit, which can be seen in the appendices.

#### **3. Visiting the Retinadag in Utrecht (22-06-2019).**

The retina day in Utrecht was useful because it both provided some technical knowledge about retina diseases and how to combat them, as well as give insights towards how the afflicted deal with loss. Margot Scheltema was also present at this event.

*The pictures on the adjacent page show an impression from both the Ziezo fair and the Retina day.*

## Generative sessions

To synthesise and complement the findings through means of observation and autoethnography, a set of focus groups or generative sessions were held. These were used to contextualise the insights previously gathered and kickstart ideation.

### 1. Generative session at Delft University of Technology (17-04-2019).

The first generative session was meant to get a sense of which attributes are essential for products to show their users' identity. The session was carried out with four students, three being master's students at the Industrial Design Engineering department at Delft University of Technology, the other being a master's student at the Erasmus University Rotterdam. With the results from this session, the researchers hoped to find relevant parameters to produce designs with that could alter the identity assistive products for the visually impaired signal to bystanders. This was attempted by means of a few exercises.

The first exercise was both a means of introducing participants and getting them to think about product identity. Five bottles were placed on the central table around which participants were sitting and participants were asked to pick the bottle most appealing to them. They were then asked to introduce themselves and compare themselves to the bottle they picked. A discussion was then started to in which ways personal characteristics can present themselves in product attributes.

After this, the problem statement was more clearly defined by the group.

The second exercise was collage making. Participants were asked to make A4 collages using magazines that represent their personalities. Afterwards, the collages were slowly presented and a discussion was held on whether the message in the collages was congruent with the choice of bottle.

The third and last exercise consisted of making associative "flower" diagrams around the themes of "identity" and "elements of a product". These were then written down on post-its and clustered on flip-over sheets on the wall. All participants were given two dots, one to indicate the most feasible concept or aspect, the other to indicate the most novel one. The session was then wrapped up.

A detailed session planning can be found in the appendices.

### 2. Generative session at Visio Den Haag (23-04-2019).

After the data collected previously was processed, the most insightful pieces of observations or narratives were selected by the researchers. The subjectively selected insights were then turned into GEMs. The GEMs were clustered by the researchers to identify the main themes.

To further explore the chosen directions, a generative session was carried out with visually impaired participants. When planning a generative session with visually impaired participants, a slightly modified approach is necessary. The majority of the commonly used creativity techniques build strongly on visuals stimuli and cues. There are a few examples on how to overcome this difficulty in literature.

Metatla, Bryan-Kinns, Stockman and Martin (2015) describe an iterative method consisting of several workshops with the same participants. The workshops are carried out using audio-haptic mock-ups, audio diaries and highly malleable prototypes. But, counterintuitively, the use of mock-ups and prototypes hindered the communication in the workshops, suggesting that replacing the focus of the prototyping methods from visual to haptic is not a sufficient solution. Sahib, Stockman, Tombros, & Metatla (2013) provided a participatory design approach that is built on using scenarios to simulate the user interaction, to engage VIP users at different points of the design process. This approach was used as a basis of the ideation in the generative session planned. Brock et al. (2016) included a locomotion trainer in the session to ease the communication, and a researcher to note down the ideas and group them in categories. They suggest to limit the number of participants to 5-8, in order to make it possible for the participants to identify the speakers based on voices. These guidelines were also considered when preparing the session plan. The detailed session planning can be found in the appendices.

The final generative session at Visio Den Haag was carried out with five visually impaired participants, as well as two Visio employees, one of which was a secretary, the other a general advice employee. Especially the presence of the general advice employee helped because she was able to steer conversation and filter out irrelevant directions in the group discussions. In the first part of the session, participants introduced themselves and an open discussion was started within the topic of assistive products for visually impaired. The topic was steered towards specific problems daily users face. These problems were to be used as primers in the second part of the sessions, which focused on solving specific problems in specific scenarios. Three scenarios were chosen, consisting of "at home", "having a drink with friends" and "talking a walk in town". Audio recordings were selected and played to aid in imagination. Participants were split up in three groups of two and were asked to come up with specific solutions to problems in these contexts. To aid creativity, no constraints were placed on the ideas by placing the context in the year 2050, where the government funds all assistive products for the visually impaired.



### 1.2.3 Results.

In this chapter, we will describe the results of the research activities separately. Key insights will be presented and discussed. The majority of insights were turned into GEM-cards for later analysis, all of which can be reviewed in the appendices. A few observations and statements that were used as input for the GEM-cards will be presented in their relevant sections.

#### Autoethnography

The autoethnographic studies yielded results pertaining to the daily experience of visually impaired persons, as well as reactions of bystanders. These results were instrumental in gaining a better understanding of the effects of using assistive products and the stigma surrounding impairment in the public domain.

#### 1. Autoethnography in Delft (06-03-2019).

The first autoethnographic study was intended to be a pilot study, used to get the researchers comfortable in using the methodologies of both autoethnography as well as participant observation. This goal was reached, and interesting initial insights into the visually impaired experience and reactions of bystanders were noted. One interesting result is that the researchers did not feel the same amount of exposure. This can be illustrated in the following two quotes from the personal narratives resulting from this study:

“*From the moment I put on the glasses and started walking with the white cane, I felt like everybody was looking at me from the corner of my eyes and approaching me more carefully.*”

“*I noticed that people reacted on the cane and the glasses, but it didn't feel like they were staring. I was walking knowing that passers by will look out for me a bit more, this gave me a sense of safety.*”

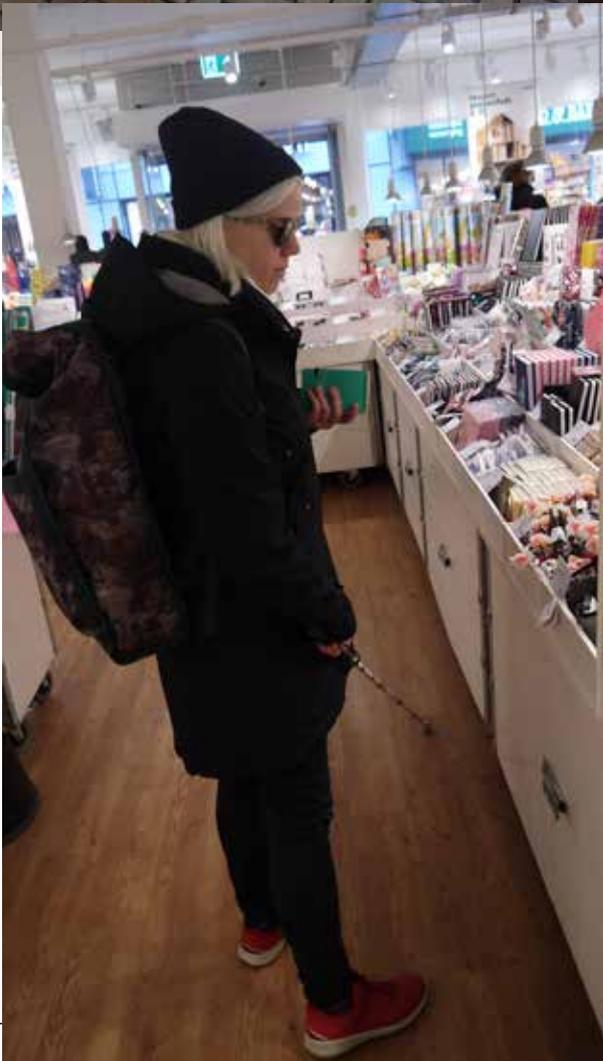
It was also found that bystanders react very differently to both researchers. Some bystanders did not seem to react to the presence of a visually impaired person at all, while other went out of their way to help. The following observation from the observation notes illustrates that nicely:

“*A driver at a crossing near the central station stopped for us at a very large distance, signaling with headlights that we could cross.*”

“*In the cheese store I felt that the interaction was normal, and I didn't notice people staring at us or acting unnatural.*”

These quotes and observations show that this first pilot study gave the researchers a nice first look into how bystanders react to the presence of visually impaired people, how that makes them feel and the interplay between bystanders' reactions and self-image of visually impaired persons.

*The pictures on the adjacent page show the researchers engaging in various activities during autoethnography in Delft.*



## 2. Autoethnography in Leiden (19-03-2019).

This study yielded results pertaining to the visually impaired experience in busy places, as well as small interaction to which visually impaired are subject on a daily basis. Various factors determining the reactions of bystanders in certain contexts were hinted at in the results. Some of these factors can be seen in the following quotes from the personal narratives and observation notes:

*“The passers by didn’t pay a lot of attention to us. Possibly they were in a hurry, they also saw that Thijs is not alone, or they just didn’t care.”*

*“When I put on the goggles in Leiden I felt a little more insecure than in Delft. The people, environment and culture were new to me and I had a hard time anticipating how these people would react.”*

*“Everyone on the platform is glancing at Veronika. People are very aware of her presence. Maybe they notice it more because they are just waiting around and have nothing to do.”*

This strengthens the belief the researchers gained during the last participant observation, which is that the interaction between environment, bystanders and visually impaired person is what determines the kind of stigma and degree of visibility in certain contexts. This can make certain day-to-day activities daunting for visually impaired people, as evidenced by this observation taken from the observation notes:

*“Veronika punches in the wrong PIN-code, gets scared for a bit. People seem to be moving around us in quite a large circle.”*

Another key insight was that knowledge of a place does inform the confidence with which a visually impaired person moves about. This, in turn determines the reaction of bystanders to them. This phenomenon could also explain the previously found discrepancy between feelings of exposure between the researchers during the Delft study.

*“When I put on the goggles in Leiden I felt a little more insecure than in Delft. The people, environment and culture were new to me and I had a hard time anticipating how these people would react.”*

With these results, the researchers decided to focus their next autoethnographic study on forcing themselves to partake in more forced interactions.

*The pictures on the adjacent page show the researchers engaging in various activities during autoethnography in Leiden.*



### 3. Autoethnography in Den Haag (20-03-2019).

This extensive study yielded all kinds of results in the visually impaired experience and bystander reactions. This study also helped the researchers empathise with the experiences described by clients at Visio Den Haag, who also have to move throughout Den Haag on a daily basis.

Normal things can be alien when visually impaired. The researchers noticed that in an environment unknown to the visually impaired, confusion can quickly set in. This is illustrated by the following quote:

*“When passing a group of people in front of the T-mobile shop, Thijs asks what they are doing there. They are employees waiting for their shift, but Thijs does not recognise them.”*

*“I asked Veronika if we could enter the Bijenkorf. When she told me it was closed and a man was still cleaning the floor, I felt a little ashamed that I did not see that.”*

*“We ended up walking behind two men talking loudly amongst themselves. One of them was wielding what looked like a stick that I supposed he must have found somewhere and was carrying home. They suddenly walked slower and moved out of their way and I could feel their eyes burning in the back of my head. They stopped talking when we passed, which felt threatening. I turned the corner and was relieved when they did not.”*

In busy areas, sensory overload can quickly set in for visually impaired persons. Because they rely that much more on their other senses, they need them at all times in order to be able to navigate. Coupled with the unfamiliar environment one of the researchers found himself in, this provided some struggled during navigations as evidenced by the following observation:

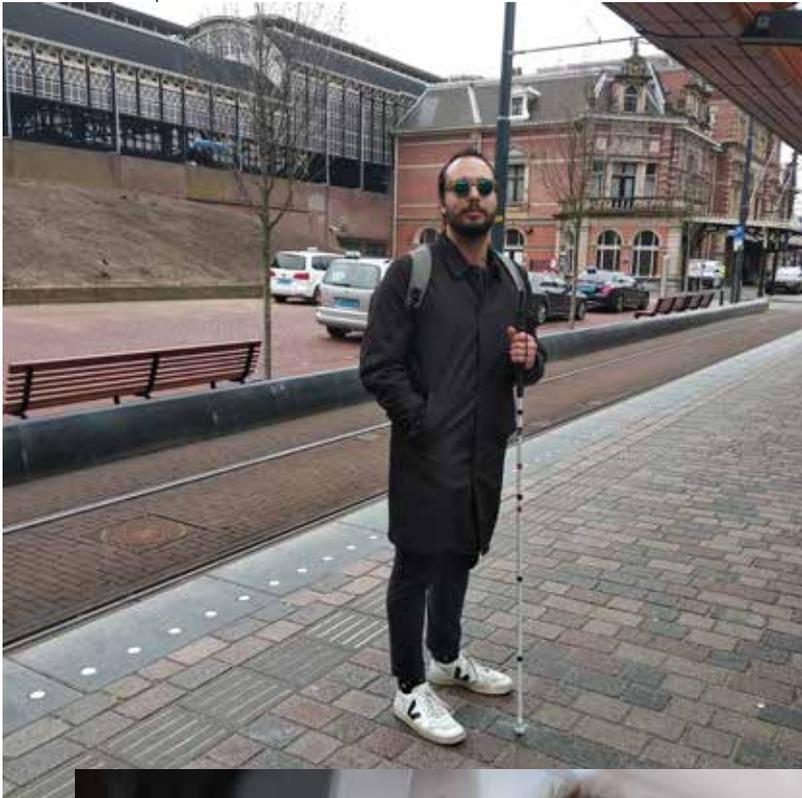
*“I felt my senses were overloaded, and conditions were swiftly changing. I felt that I couldn’t keep up with it, and I just got tired of trying to. I wasn’t feeling very much in control of the situation, so I mostly passively consented to the suggestions Thijs made. I was led by him through a crossing and I was feeling quite vulnerable.”*

Face-to-face interaction can also be quite weird, as it is hard or impossible for visually impaired people to gauge the reactions of the people around them. This often makes them struggle in daily life. This helplessness can also cause bystanders to overreact to their struggles, offering help when not needed or doing other unpleasant things to them. These situations can be illustrated and put into context by the following quotes and observations:

*“Veronika talked in a very low, almost trembling voice when ordering coffee. The lady serving the coffee acted completely normal.”*

*“Some ladies blocking the guidelines with their bikes apologised a lot. The ladies apologising to Veronika touched her on her shoulder while talking to her.”*

*The pictures on the adjacent page show the researcher engaging in various activities during autoethnography in The Hague.*



### Observation of Margot Scheltema

The observation studies with Margot Scheltema attempted to look into the culture surrounding one of the main target users of the project and the results reflect that. Along with insights into Margot Scheltema's culture, other daily problems facing visually impaired persons surfaced during these studies. The most valuable and relevant insights are those reflecting problems that occur below the surface, and play a part in the visually impaired person's construction of their new world.

#### 1. Observation in Rotterdam, Den Haag and Amsterdam (07-03-2019).

During this observation, the researchers observed Margot Scheltema in different contexts, including a board room, museum and large-scale event. The results from this study were enlightening and told a lot about the culture in which Margot Scheltema lives, her daily trials and tribulations and underlying concerns. Some key insights about her environment, the people in it and the role it plays in the experience of her newfound visual impairment can be found in the following observations:

*The room is very dynamic, with people moving about, meeting and mingling. Margot has difficulties recognising people in this dynamic atmosphere. It's hard for her to recognise faces in this dim environment.*

*Women are also in formal clothing, but are more trendy. They show their individual style with their earrings and handbags.*

*Margot remarks: "When I have to look for the button to call the elevator, I'm always happy when no-one's around".*

Trying to still be a part of this dynamic, cultured scene takes extra effort on the part of visually impaired people. A lot of tricks and adjustments are necessary in order to still be able to participate. These often go unseen but a few can be found in the following observations:

*She only goes to stores where they already know her and her condition, as it is a hassle to explain it, and what kind of help she needs.*

*"I'll just bluff if I don't recognise someone, it takes too long to explain" she said about the event later on.*

*She decided to just walk around and then someone will recognise her. "I will just walk around and someone will recognise me."*

A lot of insights were also gained in the role specific environments can play in the experience of visually impaired persons. Due to them experiencing their surroundings in a very different way than sighted people, certain behaviour can seem out of place, as well.

*At the reception she was first hesitant to mingle, she felt disoriented and overwhelmed by the crowd. "There are a few people I want to meet, but I don't see where they are."*

*Margot bumps into a door and the bystanders get startled. One of the bystanders asks Margot if she's okay.*

*A gentleman coming down the stairs, did not know what to do when Margot - who was going up the stairs - suddenly stopped walking up. He kept standing, waiting for Margot to pass.*

*The pictures on the adjacent page show Margot Scheltema engaging in various activities during the observation in Amsterdam.*



## 2.Observation in Den Haag and Baarn (28-03-2019).

This observation yielded a lot of insights into the behaviour of visually impaired persons when in the spotlight and the reaction of an audience on that. It is interesting to see that Margot can be very open about her impairment when necessary, and reserved about it otherwise.

*Margot has trouble sitting down on her chair after the talk and almost falls down. Some people in the audience gasp or talk amongst each other after this.*

*Margot tells the technicians that she is visually impaired. She is not ashamed to talk about her impairment and mainly wants the talk to go well.*

It showed the researchers what is necessary for visually impaired people to succeed in life and be a leader. It also gives insights into how bystanders react to these needs.

*During the drive, Margot mostly takes the time to make calls and answer emails. Margot says during a call "I'm calling you now so you don't have to read about it in the newspaper." The talks on the phone during the drive are pretty serious in nature and large in scope.*

*Upon arrival, Margot is received by someone that guides her to the room downstairs carefully. The event's organisation is expecting her and does know of her visual impairment.*

*The first thing Margot does as part of her talk is announce her visual impairment.*

Apart from these findings, some additional specific struggles in the daily life of visually impaired people were found that provide a richer picture of the visually impaired experience:

*Margot: "I hate not knowing what the room will look like and what I will encounter."*

*Margot asks us to describe where a hot air balloon is, instead of pointing at it. People tend to point things out to Margot. This obviously doesn't work and she tells us so in a deliberate but slightly annoyed tone.*

*She would still like to do everything, but has no bucket list. "I sometimes do feel like my life is almost over."*

*The pictures on the adjacent page show Margot Scheltema engaging in various activities during the observation in Baarn.*



### Observations at Visio Den Haag.

These studies, that were executed over the course of a day at the Visio Den Haag location, were insightful because they provided insights into the great lengths visually impaired persons go to in order to be able to live a fulfilling life. These observations allowed us to better understand pain points with current (digital) products for visually impaired people, the great effort it takes to learn how to use assistive products effectively and social implications of impairment.

#### 1. Observation of the training of a cane walker (02-04-2019).

This observation gave us insight into the elements that make navigation hard for the visually impaired. It also showed us just how much effort goes into learning to navigate a specific route. We also learned about how bystanders and the environment play a role in either discouraging or enabling mobility for the visually impaired. Some quotes are provided to illustrate these findings:

*The bumpy road is hard for Jaap to walk on. He sometimes trips.*

*When asked whether people are more careful with him now: "Not all of them. Some people don't. Central Station sucks."*

*The traffic lights turn red way too quickly for Jaap to be able to comfortably pass.*

*While walking, Michelle tells Jaap what is on the square, and which of these things make a noise. Michelle notes that the fountain in the square is probably only working in the summer. Small differences in height can be very invasive when trying to walk straight.*

*Jaap tells us that learning this route to the bus really opens up options. He is going through this hardship in order to still be able to live a rich life in possibilities.*

*Jaap sighs after the first practice lap. "Now, now." It is exhausting for Jaap.*

#### 2. Observation of an ICT-related training (02-04-2019).

This observation exposed problems visually impaired users have with certain assistive technologies. Its results lay out the flaws inherent in speech- and gesture-based controls and the social difference between walking with a cane and a guide dog. Some quotes are provided to illustrate these findings:

*Irene remarks that lists can take very long to go through. She is bored or annoyed with the entire process.*

*"It sometimes doesn't work, so most people do it the old way. There is some level of distrust towards newer technologies."*

*The keyboard consists of little keys that all feel the same. It is not designed for visually impaired, but for sighted users. However, many people use the keyboard because "typing things is better than dictating them, especially for emotional content."*

*"The cane seems very confronting, pointing people to facts they don't want to accept. When walking with a dog, people offer you help a lot quicker."*

#### 3. Observation of a talk with a social worker (02-04-2019).

Attending this conversation gave us great insight into the reactions of people close to a recently visually impaired person. It gave the researchers a lot of insight into misunderstandings that occur and the hard dilemmas that visually impaired people are faced with. Some quotes are provided to illustrate these findings:

*Menno is working hard to get his old life back. He has used a viewing strategy training to get his driver's license back.*

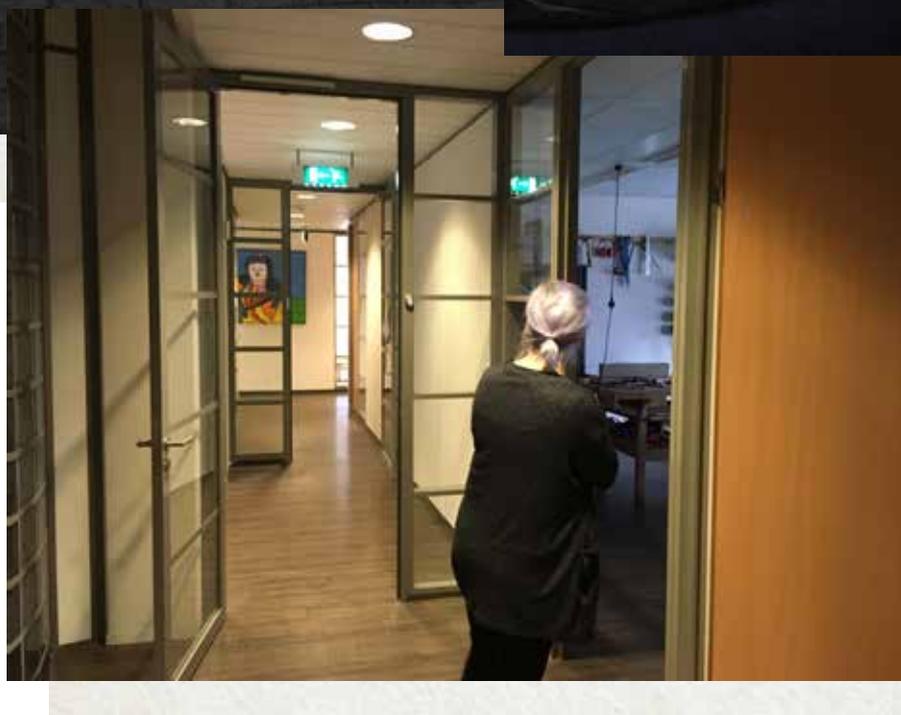
*People in his surroundings have hard time understanding the implications of his condition, in what way can it cause problems. "You have bad vision? You just have to put on glasses."*

*Menno: "You can't see anything about the impairment so that's the problem, really."*

*Ria is tired of explaining her husband's behaviour all of the time. "People keep asking me, why isn't he joining this time?"*

*Ria: "We still try to do everything, but then a little bit adjusted." Menno: "While in fact, we can't."*

*Menno has the dilemma of going to a dance performance of her granddaughter. Menno: "These are dilemmas that people just don't get."*



*The pictures on this page show three of the activities that were observed at Visio Den Haag: a cane training, an ICT training and a talk with a social worker.*

### Miscellaneous activities

These two miscellaneous activities both served as starting points to greater parts of the design project.

#### 1. Expert meeting at Visio Den Haag (01-03-2019).

The expert meeting at Visio allowed the researchers to structure their collaboration with the people at Visio, as well as get a first glimpse into what it is like to be visually impaired. This set the stage for subsequent autoethnographic research as well as build a relationship with the people at Visio Den Haag, which would prove instrumental in the further development of the project. To illustrate the experience during this study, we provide a few relevant quotes from the autobiographical narratives written by the researchers.

*“Walking towards the elevator, we met another of Femke’s co-workers, with whom it was hard to get a normal interaction. I felt a little bit awkward and just waved in all directions, making jokes to alleviate my own distress.”*

*“After arriving back to the Visio facility, I was relieved and exhausted. Being tense all the time needed a lot of effort.”*

#### 2. Visiting the ZieZo Beurs in Utrecht (16-03-2019).

Visiting this trade fair gave the researchers insights into the current state of assistive technology for the visually impaired. The researchers also met employees from Bartimeus and got insights into how visually impaired people still like to present themselves to the outside world. We also got to see visually impaired people interact with each other for the first time. This was very interesting to see and can be illustrated with the following quote from one of the reflections both researchers wrote:

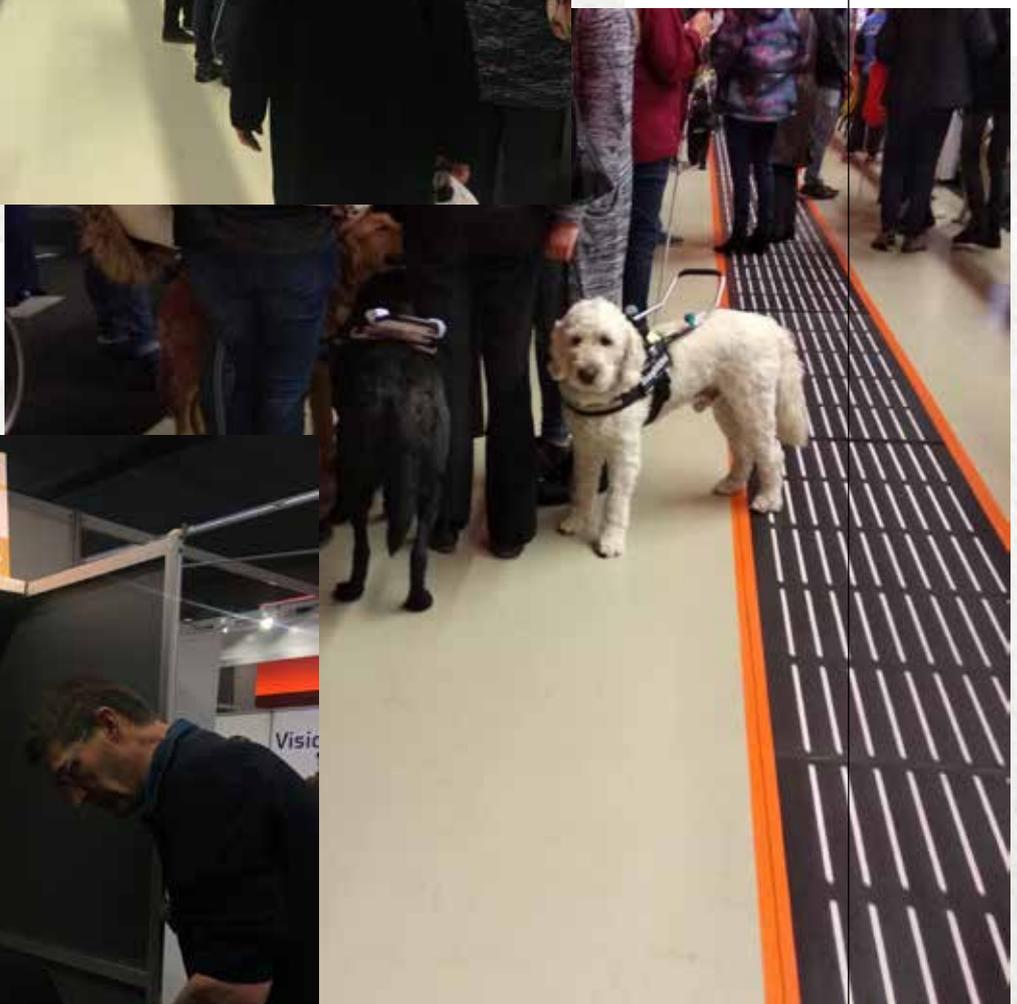
*We saw that VIPs who attend were in a positive mood, greeting each other. I don’t suppose they meet so many fellow sufferers very often, and at this fair they were the “normal people”, the sighted were the ones out of place.*

The second striking observation is that there are, next to technological advances, quite some efforts that help visually impaired people to integrate into society, as evidenced by the following quotes:

*Another highlight was a voting booth, adapted for the visually impaired. I thought it was wonderful to see that there are efforts to give these people the means to participate in and put their mark on society.*

*We encountered a booth from Bartiméus with an interestingly unusual approach: at the Oogverblindend Mooi workshops they help VIPs regain control over how they present themselves to the seeing society. This includes style and colour advising, make up, but also self presentation and body language. I did find it inspiring that they leapt over offering purely functional help, and are giving tools of self expression to their clients.*

*The pictures on the adjacent page show people and dogs at the Visio trade show in Utrecht. A highlight is the voting booth for the visually impaired.*



### Generative sessions

The two generative sessions were meant to kickstart ideation in this project. The insights gained in these sessions mainly dealt with concrete problems faced by visually impaired people, suggestions towards solutions and important aspects to take into account while work on solutions.

#### 1. Generative session at Delft University of Technology (17-08-2019).

The first of the generative sessions was held at the university in Delft and was designed to explore in which ways products can express their users' identity to the outside world. Numerous ways to do this were found and were rated in terms of novelty and feasibility. The highest rated items in terms of feasibility were 'novel shape', 'geometrical shape' and 'embracing'. The most preferred items in terms of novelty were 'shows your capabilities', 'ethics' and 'the meaning and what it represents'. The session notes are in the appendices.

#### 2. Generative session at Visio Den Haag (23-08-2019).

The generative session at Visio Den Haag was held with five visually impaired participants and two caretakers at Visio. The session was centred around common problems in using assistive technologies. The first part of the session was spent identifying these problems while the second part focused on creating novel concepts to solve these problems in a variety of contexts. The detailed session notes can be found in the appendices. The issues raised during the session can be illustrated with the following quotes:

*"One of the cons is that people see there's something wrong with your eyes, so you feel that you're being treated different. I could always see, I became blind in 2016, and you do notice definite difference coming from your environment."*

*"You do lose a lot of friends."*

*Murat (when the subject gets changed to going out in a busy bar): "Avoid." People agree.*

*"Sometimes I'm using my phone in public and that also makes people curious: "You're blind right? But you still have an iPhone!" Especially when the voice speed is fast, people are amazed you can use it. And then there's already a loss of a social barrier."*

*"I once had dinner in a themed restaurant, and a magician got mad at me for not responding to his tricks. You experience things that are quite weird."*

*"You choose visibility, and the degree of visibility would be nice to be able to control."*

Their relations with the cane can be illustrated with the quotes below:

*"When someone walks with a cane, people won't talk to you that often, but a dog gives people a lead to make small talk with you. And that gives life a different colour."*

*"The cane is empty. It doesn't have any qualities that attract people."*

*"I don't often use my cane, because I see just enough to see the world around me react to my cane. And I don't have the need to be seen as dependent and pathetic."*

*"If there's a genuine interest in for example a guide dog or an iPhone, that breaks barriers. But you don't accomplish that with a white cane."*

*"I know I can carry a larger cane and the solution is there, but my emotions say that I'm not up for that yet."*

*"If you don't walk around using a white cane, the world will judge you as a sighted person. And that's what you'll have to deal with."*

*The pictures on the adjacent page show the participants engaging in various activities during the generative sessions.*



# Chapter 1.3

## analysis and results.



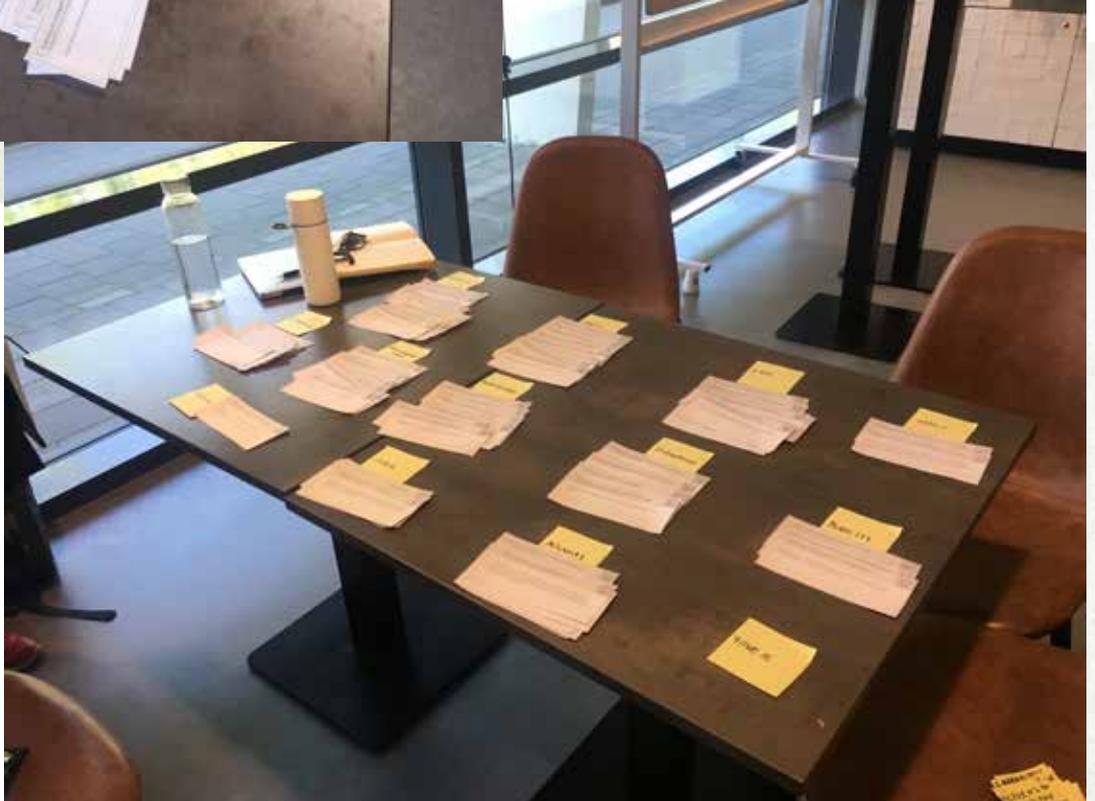
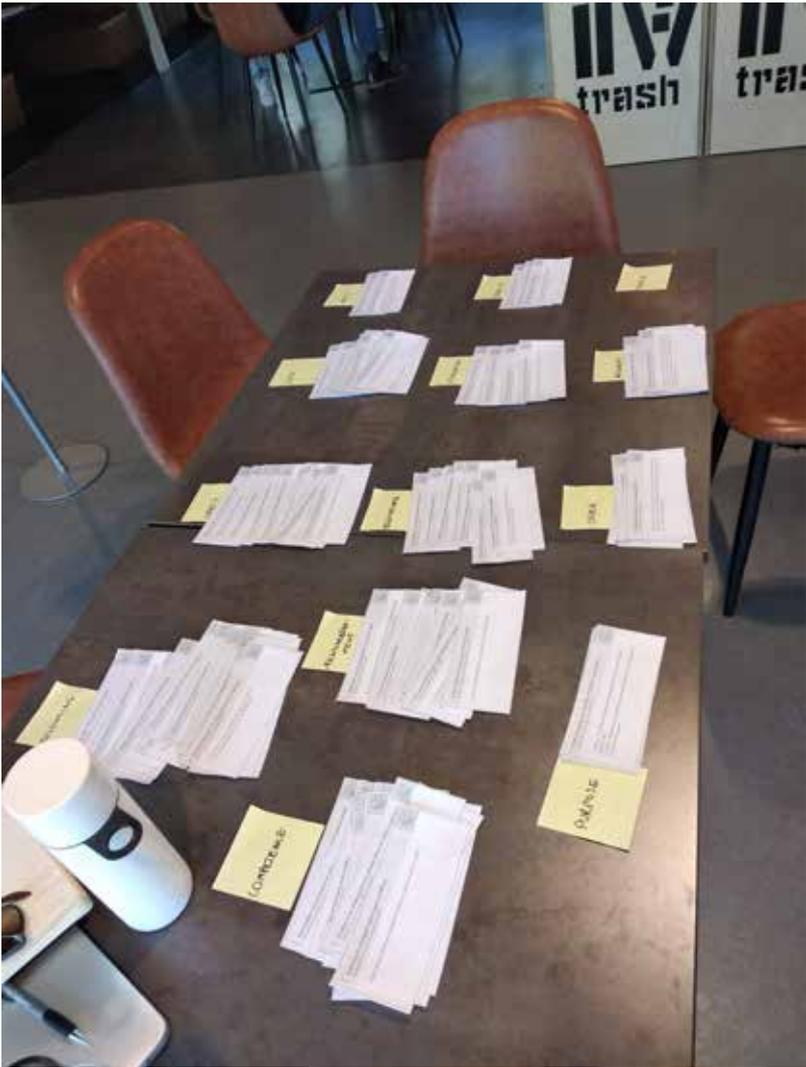
### 1.3.1 Clustering.

After the observation notes and autoethnographic texts were completed from research activities A-D, both researchers selected the most important insights and observation on subjective basis keeping in mind how much do they reveal about the main research question. From these valuable insights and observations GEM cards were created.

The GEM cards were clustered by the researchers to create a shared understanding about what is present in the data (see appendices). The main themes identified are in the following section.

As the result of the data analysis, several themes were identified. Some themes were formed from a higher number of GEMs, and some clusters only contained a few. This doesn't necessarily translate into a hierarchy among the themes. In this section each theme is described and illustrated with examples. Along with the clustering presented here, another clustering was done based on the Elementary Human Needs framework by Desmet and Fokkinga (2018) . However, no real results were gathered from this clustering, other than that all needs were represented in the data.

*The pictures on the adjacent page show the clustering in various phases.*



### 1.3.2 Results.

The research activities outlined in this report and their results will ultimately be used in the context of a design graduation project. These research activities have had multiple results that will prove beneficial in the final design project. These beneficial results will be outlined in this section.

First of all, the clusters and GEM-cards that result from the analysis of data will help focus ideation during later stages of the design project. They can be used to construct concepts focusing on either one cluster, one GEM-card or the space in between clusters or GEM-cards, signifying untapped opportunity.

The research activities also helped the researchers form a solid network of stakeholders. This network consists of visually impaired stakeholders in various stages of their impairment, offering a rich dataset that touches multiple facets of the visually impaired experience. It also consists of trained professionals that help these visually impaired people reach their full potential, among which are professional mobility trainers and social workers.

This research phase also allowed us to empathise with the visually impaired target group more deeply. Experiencing both practical and social difficulties through autoethnography and talking to and observing actual visually impaired people in their daily routines will allow for more empathic design solutions and ultimately more added value.

The research questions we have set for ourselves at the start of the report have been answered. As a reminder, they were the following:

**1. What are the struggles visually impaired people face when it comes to mobility?**

**2. What are their attitudes towards assistive devices (especially the white cane)? What other ways are in use to overcome them?**

#### **What are the struggles visually impaired people face?**

To answer the first question, there are many. We have found such issues as sensory overload, having a tough time avoiding obstacles and people offering unnecessary help. Apart from the issue of mobility, we have found many social struggles in visually impaired people, such as having trouble explaining their impairment to bystanders and perceiving social stigma due to their impairment and its signifiers.

#### **Increased visibility due to (effects of) impairment**

Visually impaired people face a lot of issues executing mundane visually-oriented tasks. This can have great effects on both the enjoyment of life and the way visually impaired people present themselves to the outside world. This problem is illustrated by this quote: Ines has a small amount of mascara in her hair. We assume she has a hard time maintaining her appearance. When asked about this, she confirmed that choosing the right clothes became harder and shopping is not as much fun as it used to be.

These problems can cause visually impaired people to stand out from the general populace, drawing even more unwanted attention to themselves. The researchers regard this as a strong design direction, possibly offering great amounts of value. This extra level of visibility is supported by the following quote from an observation during one of the autoethnographic studies:

*A man was looking at Veronika, noticed he caught my eye and then looked away all the way behind him. He proceeded to pretend like he was looking around at his surroundings with great interest.*

VIPs can be oftentimes reminded of their increased visibility in public spaces:

*One time, she walked outside with a cane and a child yelled she saw a blind woman. "That was very rude and confronting."*

On a deeper level, this increased standing out leads to a reduced sense of belonging in many visually impaired people, causing them to lose their bonds with communities they were once tied to:

*Rachid: "I think that, when you finally do walk with a cane, people will drop out." Bruce: "You don't fit in their image of you anymore." Bert: "It's also the fact that people don't know how to behave, themselves. So they might avoid you for that reason. Rachid: "It's new for them, as well."*

### Loss of agency

Visually impaired people experience a loss of agency in almost all facets of life. The most obvious example is their inability to, in most cases, go out in public by themselves. This is a mobility issue, as illustrated with the following quote.

*She uses public transport as much as she can, but in the evening she is not able anymore. She travels a lot less than she used to.*

But the loss of agency runs a lot deeper than that and can be way more subtle and, in some ways, more impactful than just mobility issues. Visual impairment can cause people to not only limit their mobility, but also avoid entire environments altogether. This can be illustrated with the following quotes and observations:

*Jaap remarks that at the central station people are blocking the guideline, but their luggage there or stand on it. He is reluctant to go there.*

*When asked how he would deal with going to a crowded bar, Nick answers he would always “avoid it”. The others in the room agree.*

Another aspect to this loss of agency is the difficulty to ask for or receive assistance when a visually impaired person needs it. Many visually impaired people experience intrusive behaviour from bystanders that offer them help. Oftentimes, this is coupled by touching, tugging or other unwanted actions. On the other hand, asking for help can be embarrassing. This is a recurring problem that can be illustrated with the following data from the research:

*Ines: “The worst thing about these kind of nights is asking for help in mundane tasks.”*

### Difficulty communicating the (effects of) impairment

Some visually impaired people have a hard time communicating their impairments to the people close to them, causing all kinds of misunderstandings. This may be due to ignorance in the general population about the various kinds of visual impairment, or the impaired person's own inability to talk about their struggles. This can be nicely illustrated by the following interaction, taken during an observation of a talk between a newly visually impaired person and a social worker.

Menno has had a stroke and lost a part of his vision. This is called hemianopsia. His newfound visual impairment costs him a lot of energy and the company doctor doesn't recognise this. Neither does his brother. He is not very good at sharing concerns with friends.

*Aviva: “When people see the words “visually impaired”, they think it can be solved with glasses.”*

*Menno: “You can't see anything about the impairment so that's the problem, really.” Ria agreed, saying she is tired of explaining her husband's behaviour all of the time. “People keep asking me, why isn't he joining this time?”*

Face-to-face communication can also become a challenge, as it is, for the sighted, heavily reliant on visual cues and nonverbal communication elements.

*When ordering, I was completely incompetent in reading the situation. It wasn't a pleasant experience, I was extremely self-conscious. I felt I was missing out on the reactions, the facial expressions. It was exhausting.*

### Having a negative or changed self-image because of the impairment

The impairment, the assistive products use to mediate it and the message they both send to the outside world can change the self-image of visually impaired people. Most visually impaired people get confronted with that on a regular basis. We would like to share this quote as an example:

*One time, she walked outside with a cane and a child yelled she saw a blind woman. “That was very rude and confronting.”*

As was established in section 5.2.3, there are plenty of misunderstandings about visual impairments in the general populace. These misunderstandings can often have a large impact on visually impaired people. There are various coping strategies, the foremost being the use of humor to ease tension:

*Lars: “You're not seen as being full. I have a button that says “visually impaired”. One day someone walked up to me and said “I don't believe it. You don't look retarded.” Literally.”*

*Although it has affected him very much, Menno is very humorous about it all: “The bus (that disabled people use in Holland to go to work) has arrived and here I am!”*

### What are the attitudes towards assistive devices?

Through multiple observational studies and a generative session, several different attitudes towards the use and stigma surrounding assistive technology have been uncovered. These particular attitudes will form the base of personas to design for in the next steps of this project. Some attitudes here will be discussed and illustrated using quotes.

### Connecting assistive products to self-image

As already discussed in the section above, impairment can greatly change one's self-image. Assistive products, often used by impaired people, play a big part in this change. Numerous points of evidence were found that indicate this is one of the main psychological aspects of using assistive products. Users often feel like they are seen by others as less capable, or in some occasions even less human. This sentiment is illustrated by the following quote:

*Lars: "I don't often use my cane, because I see just enough to see the world around me react to my cane. And I don't have the need to be seen as dependent and pathetic."*

This often causes visually impaired people to postpone the public use of assistive products such as white canes. Because the cane is a signifier that its user is visually impaired, making the step to using a cane is often seen as admitting to oneself that one is indeed visually impaired:

*Lars: "I know I can carry a larger cane and the solution is there, but my emotions say that I'm not up for that yet." Ines remarks that "the white cane is stigmatising".*

*Peter: "As long as I can go without a cane, I won't. Reason one is that I see it as a step backwards in independence. That to me weighs more than the extra effort needed to get around."*

As time goes by, some visually impaired do get over this dilemma:

*Irene became visually impaired slowly and took twenty years to admit it to herself. "Walking with a cane is admitting. Eventually you have to, and you get over the fact that people see you differently."*

### Facing the reality of the situation

Some visually impaired people take the assistive products for what they are and use them regardless of the negative effect they might have. Most of these people became visually impaired due to an accident or rapidly progressing illness, causing them to not deal with the transition people other visually impaired people might face. They use their assistive products because they have to and often indicate that they were left with no other choice. This sentiment is echoed in the following quotes:

*Jaap (when asked whether the pros outweigh the cons in using a cane): "I don't have a choice, I don't see anything."*

*Jaap: "For my self-image, I would not like everyone to see I am blind. But I am, I am someone with a double impairment. This is the way it'll have to be. If I don't use the cane, I won't be able to go outside."*

Some assistive products for visually impaired people are designed with sighted people in mind, and have a layer of added functionality that makes them usable. Some people still use these products because they offer a lot of benefit, and put up with the discomfort of use. This is what we observed during an ICT training for the visually impaired:

*Even the teacher doesn't know the answer when confusion arises whether they are in "rotor mode" or not. The teacher suggests rebooting the iPad.*

*A lot of people use the keyboard because the gestures don't always work as intended. The gestures are finnick.*

*The teacher and Irene complain about updates changing shortcuts.*

### Not letting the opinions of bystanders affect you

Some visually impaired people are not affected by the reactions of bystanders to their impairment, and thus don't feel the stigma. Others have felt that stigma in the past, but are now so acclimatized to it that they don't let it bother themselves any longer. Oftentimes, these are either individuals that were born visually impaired or have been so for a long amount of time. See the quotes for examples:

*Bert: (when asked about whether he feels eyes on him when walking in public): "No, I'm over that. I don't feel it and I don't care." Robert F: "Do you still register that people look at your more?" Bert: "No, I'm preoccupied with my own route and my own thing."*

*Jaap: "If I try to hide it, I'm only kidding myself and spend unnecessary energy on other people's opinions."*

### Being concerned about the social effects of using specific assistive products

While the visually impaired people in section 5.3.1 are mostly concerned with their self-image due to using assistive products, this participant group is mainly concerned with their changing social roles due to their impairments. They worry that their use of certain assistive products limits their social interaction when out and about, and base their choices of and attitudes towards assistive products on that. We provide some quotes to provide some perspective on this attitude:

*Bert: "If there's a genuine interest in for example a guide dog or an iPhone, that breaks barriers. But you don't accomplish that with a white cane. It's a dead object that signifies your impairment. They should have made the bands black instead because it's a black-and-white object."*

*"I walked into a restaurant with a cane a few times, and it instantly became quiet."*

*"When walking with a dog, people offer you help a lot quicker. They don't do that when you're using a cane."*

*Lars: "If you don't walk around using a white cane, the world will judge you as a sighted person. And that's what you'll have to deal with."*

### 1.3.3 Personas

---

Apart from these answers to the research questions, a set of four personas was developed that could be used as starting points for ideation. The idea behind developing these personas was that they could be placed inside of a point in a journey map, and coupled with some quotes and observations from research. These rich situations would allow for empathic design. This concept was later fleshed out into an ideation sheet or model which is described in section 2.1.

The personas were put on two observed axes. These axes are the following:

#### **Experienced – novice:**

This axis described for how long the persona has lived with their visual impairment. It has been observed that this oftentimes says something about their attitudes towards both the reactions of bystanders and their impairment itself. It does not detail the severity of the impairment, as visual impairment can be caused in a variety of ways both rapid and slow, such as accidents or progressive eye diseases.

#### **Skeptical – embracing:**

This axis described their attitude towards innovation in assistive technology. The personas on the skeptical side are not fully convinced the benefits of using the white cane weigh up to the negative effects it has on their lives. These people might be concerned about social stigma or might not at the stage in their acceptance process that allows them to use the white cane and admit to themselves that their lives have changed. The other side of this axis describes personas that are fully embracing of the white cane because it helps them live their day-to-day lives. As a byproduct of this, they are often not open to innovation in the realm of assistive devices as they see the white cane as being good enough.

These two axes divide the persona space into four quadrants, each holding one persona. These personas will be described here, along with some quotes from research that support their existence.

# **the hopeful champion.**

## **Experienced & skeptical.**

Involving themselves in all kinds of initiatives that better the lives of fellow visually impaired, the hopeful champion fully committed to making a change for the better. They are often open-minded and open for innovation, but deeply critical of the available assistive products. Though not always positive, they try to make the best of not only their own, but their peers' situations as well.

---

*“I was walking down the street a while ago and saw a man walking with a cane using sonar to determine where a pole was. I was in awe.”*

*“You’re not seen as being full. I have a button that says “visually impaired”. One day someone walked up to me and said “I don’t believe it. You don’t look retarded.” Literally.”*

*“When someone is handicapped, you’re automatically being put in the category of unusable material. So apparently there’s a lot wrong with you.”*

# **the stubborn warrior.**

## **Novice & skeptical.**

The stubborn warrior has a progressive eye disease resulting in gradually increasing visual impairment. Despite this, they still live their old life like they had always done. Over time, this takes more and more energy but the stubborn warrior is reluctant to use assistive technology. They want to feel independent and not to be seen as less than their fellow human beings.

---

*“When somebody is handicapped, you’re automatically being put in the category of unusable material. So apparently there’s a lot wrong with you.”*

*“I don’t often use my cane, because I see just enough to see the world around me really to my cane. And I don’t have the need to be seen as dependent and pathetic.”*

*“I think that, when I do finally have to walk with a cane, people will drop out.”*

# **the industrious learner.**

## **Novice & embracing.**

The industrious learner has had to adapt their way of life dramatically due to rapid onset visual impairment. They are forced how to walk with a white cane from the get-go or face the risk of not being able to go outside any more. This makes the industrious learner a practical person that is willing to use any assistive technology as long as it gets the job done.

---

*“You have to remember it all: a pole here, letterbox there... I’m now at the letterbox so in twenty meters there will be little pole on the left. It’s exhausting.”*

*“I’m also learning braille. Just a few classes to pick it up again.”*

*“I don’t have a choice, I don’t see anything.”*

# **the focused veteran.**

## **Experienced & embracing.**

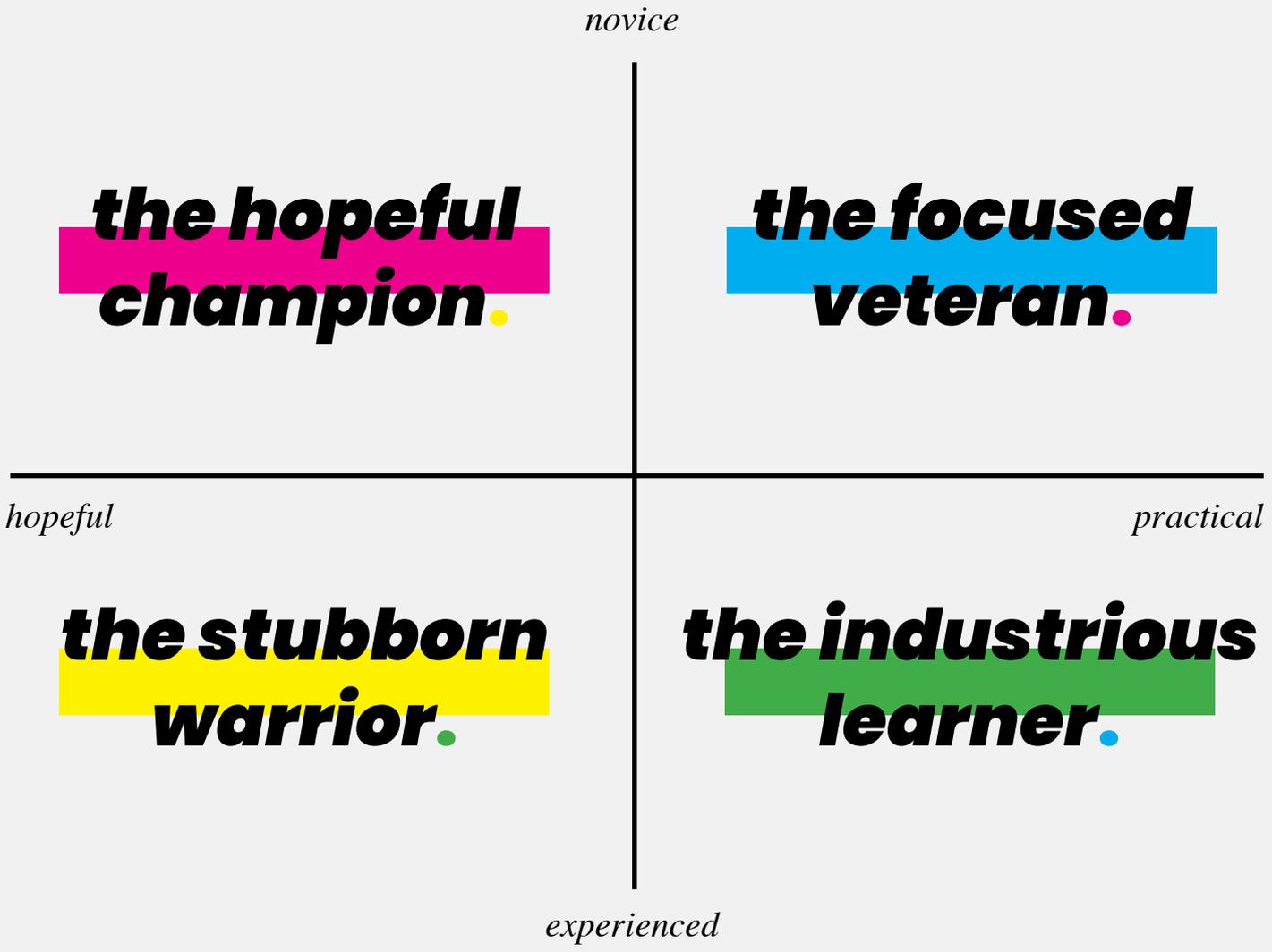
The focused veteran has been visually impaired in some shape or form for most of his or her life. They have gone through all the phases and have finally learned to accept their impairment for what it is. Social stigma associated with visual impairment and its signifiers does not really bother them as they are more so focused on navigation and their own goals.

---

*“I don’t feel staring eyes on me anymore. I’m preoccupied with my own route and doing my own thing.”*

*“If I try to hide my impairment, I’m only kidding myself and spend unnecessary energy on other people’s opinions.”*

*“Eventually you have to [start using a cane] and you get over the fact that people see you differently.”*



From the generative session, a simple journey map was created that is comprised of three different situations. These situations will be described here and the associated problems will be presented. These situations will ultimately be used in the aforementioned ideation tool to keep focus during ideation.

### At home

The location of the part in the journey speaks for itself. Visually impaired people encounter a variety of hardships at home, some of which will be illustrated here with quotes. Some of these quotes return in the ideation tool that was used in developing the final concepts.

*“Things you drop on the floor are unable to be found, so goggles or your phone that tells you if you have to reach in some ways in order to grab it for you.”*

*“Facial recognition for doorbells would be very nice.”*

*“A lot of automatisations and making accessible for people that cannot see anymore [is desirable]. To make daily life easier.”*

### In transit

Navigation is a big part of why life is exhausting for the visually impaired. Because the modern urban environment is not necessarily designed to keep the visually impaired in mind, a lot of training is needed to get around. Some of the challenges the visually impaired encountered are described in these quotes.

*“The most important thing is learning how to use technology and learning to trust it.”*

*“Contact with people will always be a point. You will always have to ask people for help.”*

*“The cane might lead to unwanted help, that’s something I want to avoid at all costs. That is my stage. I only use it in very busy streets when I otherwise run risks, that’s when it has benefit to me.”*

### Out and about

Visually impaired people like to go out just as much as any other person. However, it is a different experience for them in multiple ways. These experiences can be summed up with the following quotes.

*“If you go to a cafe, you are the one having to adapt most of the time. Sometimes bad things happen like bumping into people, you can apologize in a nice, breezy way or annoyed way, and that makes all the difference. If you do that in a place you come often, they will often look out of you.”*

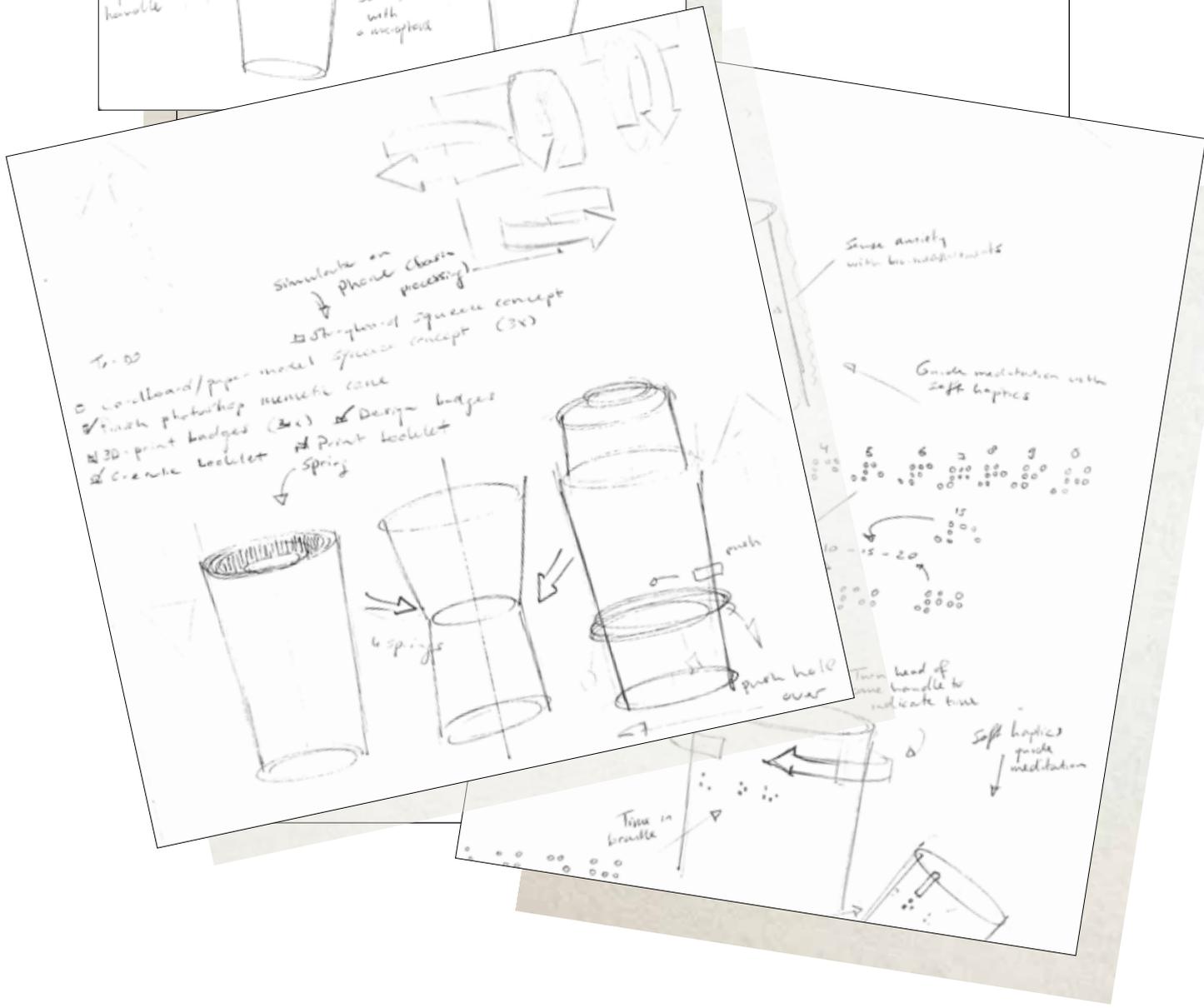
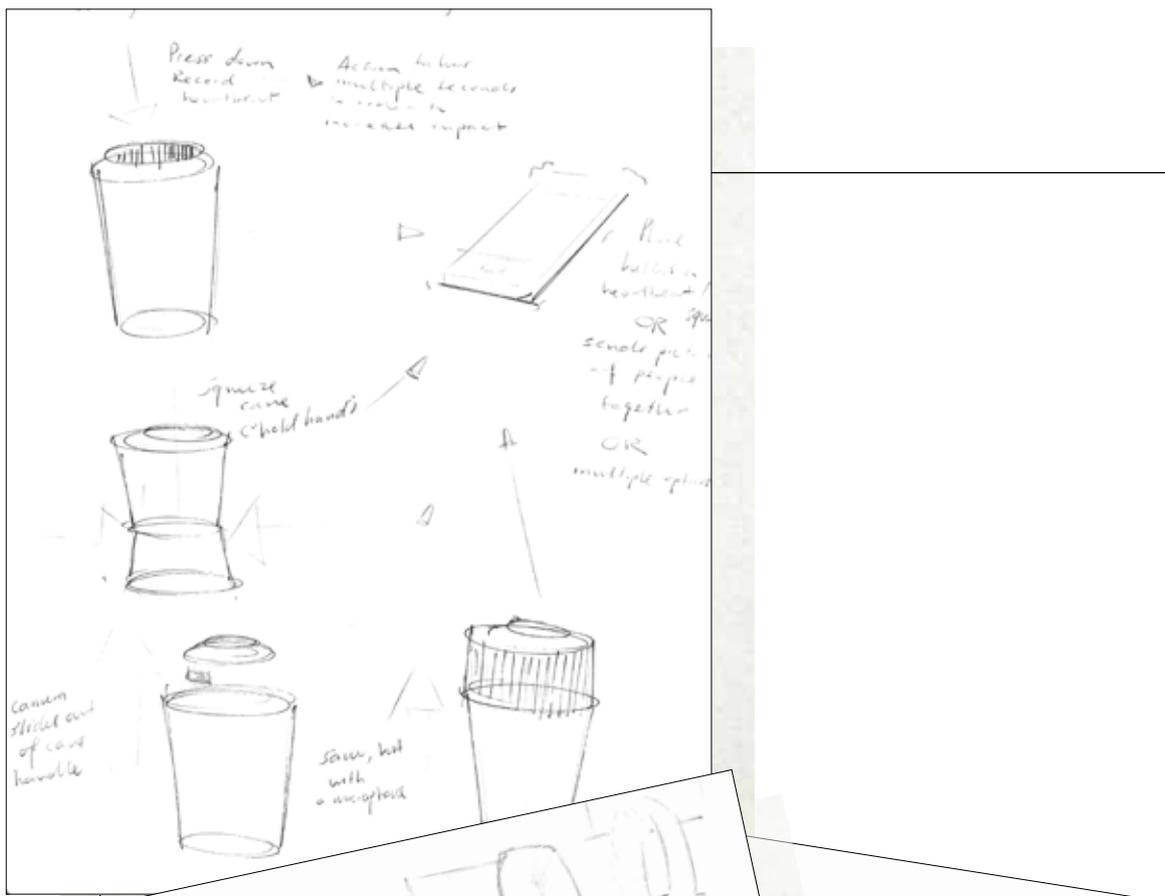
*“The smart glasses came up again. You enter, the glasses tell you where there’s a free spot, it reads the menu for you and helps you pay. On top of that, it helps you read the receipt, show you the road to the bathroom and call a taxi.”*

*“I would like something that measures the decibel levels, finds places where there is an ideal sound level where you can talk. A lot of sounds hampers visually impaired persons in social interaction.”*

*“Last time I met a friend in a bar I walked into a black hole and only had my phone to count on. A host that does that would be nice.”*







**Mentic cane.**

This cane comes from the idea that the fact that every cane looks the same reinforces its existence as a stigmatising product. One of Vaes' strategies for decreasing product stigmaticity is to develop a strong personal identity for the product itself (Vaes, 2014). This can be done by developing an ultrapersonalised product-service system that caters the look and feel of individual canes to the aesthetic preferences of its users. This system is envisioned to consist of the cane users, trainers, designers and manufacturers that all interact to produce personalised canes that the user can identify with. These canes will be produced by means of rapid prototyping to keep costs low and repairability high. The following quotes indicate a need for this type of solution:

“

*“It's a dead object that signifies your impairment. They should have made the bands black instead because it's a black-and-white object.”*

*“If there's a genuine interest in for example a guide dog or an iPhone, that breaks barriers. But you don't accomplish that with a white cane.”*

*“I know I can carry a larger cane and the solution is there, but my emotions say that I'm not up for that yet.”*

”



**Visual passport.**

Visual impairment and its effects are often hard to explain to bystanders. People that have not gone through the hardship of visual impairment themselves find it in turn hard to empathise with those that have and don't often know how to deal with these hardships. This makes visually impaired people feel misunderstood. A visual passport might help the visually impaired explain their handicap better. This passport would contain basic information about the specific disease or impairment its carrier suffers from as well as more specific tips and tricks in dealing with these impairments. These specifics can be discovered during training or consultation with an organisation such as Visio. The visually impaired could also collect a set of badges after each round of training, showing to the outside world the amount of work that is necessary to live a rich life while being visually impaired.

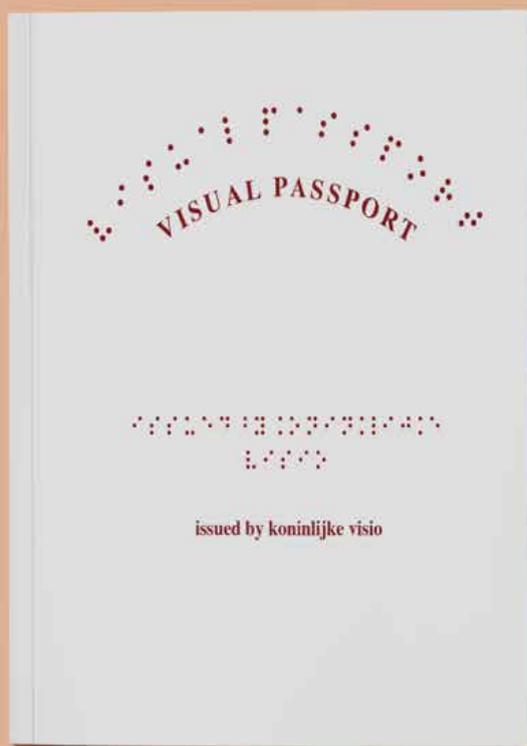
“

*“If you don't walk around using a white cane, the world will judge you as a sighted person. And that's what you'll have to deal with.”*

*“His newfound visual impairment costs him a lot of energy and the company doctor doesn't recognise this. Neither does his brother.”*

*“When people see the words “visually impaired”, they think it can be solved with glasses.”*

”



**name**  
**te Velde**  
**birthdate**  
 Thijs Kornelis  
**date of birth**  
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**place of birth**  
 Enschede  
**type of visual impairment**  
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### Guided meditation.

Being visually impaired causes people to experience frequent moments of stress throughout their day. Especially in the first stages of the the impairment, when its effects first become apparent, or early days of walking with canes, this anxiety and stress can cause a lot of self-doubt and exhaustion. Using smart technology, the cane's handle could measure stress levels and offer guided breathing whenever it's necessary. The cane could also learn which situations its user finds particularly stressful and respond proactively by indicating these moments of stress, potentially helping the user identify them. For this concept, the makers of the meditation app Headspace were contacted. They showed interest in the concept but commented that they were only looking for long-term research partnerships.

### Margot's white cane.

After presenting the three concepts to Margot Scheltema, a combination of both the memetic cane and guided meditation was settled upon. The reasoning behind this combination is that Margot is postponing the use of the cane because of its stigmatising features. Walking around with a (in her own words) "fancy, stylish cane" would lower that degree of stigma and get her to walk around with the cane. She is interested in this as she does recognise the many benefits the white cane can offer. The guided meditation aspect was incorporated into the concept because Margot likes to operate on a very high level, going to board meeting at major firms and giving presentations all over the country. Because she is such a busy woman and is involved in multiple projects at any given time, she sometimes feels stress, especially with the added challenges her visual impairment brings. Since she already uses the Headspace application, the addition of the meditation feature seemed very beneficial to her.

“

*“A few wines will make this less intimidating”, Margot says.”*

*“When we encounter some traffic, Margot keeps checking by how much we are delayed. Margot: “We are getting close now.” She says this out of nerves.”*

*“When we encounter some traffic, Margot keeps checking by how much we are delayed. Margot: “We are getting close now.” She says this out of nerves.”*

”

“

*“Margot remarks that “the white cane is stigmatising”.”*

*“Margot says during a call “I’m calling you now so you don’t have to read about it in the newspaper.” ”*

*“A gentleman recognises Margot: “Are you Margot Scheltema?”*

”



# Chapter 1.5

## midterm and pivot.



### 1.5.1 Pivot

After the midterm, a project pivot was decided upon. The concepts that were presented were deemed not academically valuable and a clear link with research was missing. The graduation team decided to look into both social and technological trends that could, together with the research already executed in this project, lead to a more meaningful and relevant design challenge. Initial directions that were formulated during the midterm evaluation included looking into the emergence of smart cities and the implications that could have for a connected white cane. This was the direction that was eventually decided upon and further literature research was done to understand the relevant factors more deeply. Those factors are described in section 1.1.5. Over the course of conceptualisation, it was also decided to make the connected white cane modular. One of the reasons for this is that during conceptualisation, it was found that there were so many distinct needs in the target group that a single solution was impossible. By broadening the scope of the product to that of an ultra personalised product-served system (UPPSS, Nachtigall, 2016), a service can be built around a modular product that does not only allow for customisation in terms of functionality, but also allow for the creation of additional models by associated parties should the need arise.

Using Vaes' product intervention model for stigma (PIMS), we can find different design interventions that alleviate product stigmaticity (Vaes, 2014). An especially relevant one when talking about the concept of a connected white cane are reshaping the meaning of the product through advances in technology, integrating additional benefits and experiences in product use and in some ways, strengthening the institutional identity of the product. Through the application of a strong design language, the product can also have a strong individual identity which makes "(...) users wish to associate themselves with that product, and possibly value it as an extension of or addition to their personality". These strategies will be described in the sections below.

#### **Integrating additional benefits and experiences in product use.**

Connecting the white cane to the smart city and allowing the user to customise the white cane using functionalities that play off of that network will offer a wide variety of new functionalities. By going beyond the core functionality of the traditional white cane, the designer can "... create product experiences that take the user away from its physical dependency of the product" (Vaes, 2014). These functionalities will decrease the product's stigma even more when recognised as useful by the general population - they will be appreciated as useful tools for society at large.

#### **Reshaping the meaning of the product through advances in technology.**

This strategy is more of a nuance of the one previously described. Through use of new technologies, a product's functionality can be enhanced or altogether changed, thus changing the meaning of the product in society and alleviating stigma.

#### **Strengthening the product's individual identity.**

By placing the connected white cane in the context of an UPPSS, the cane's functionality can be tailored to the user. This tailoring of the white cane would be done in accordance with the user's needs as discovered by both the visually impaired person and their trainers at an organisation like Visio. Although Vaes mainly talks about customisation in terms of aesthetics (Vaes, 2014), it is assumed that customisation in terms of functionality will also work to strengthen the bond between product and user. Using theory from Belk, effort put into the selection of a product increases product attachment as well (Belk, 1988). This effort will be exerted through the conversations between visually impaired user and trainers.

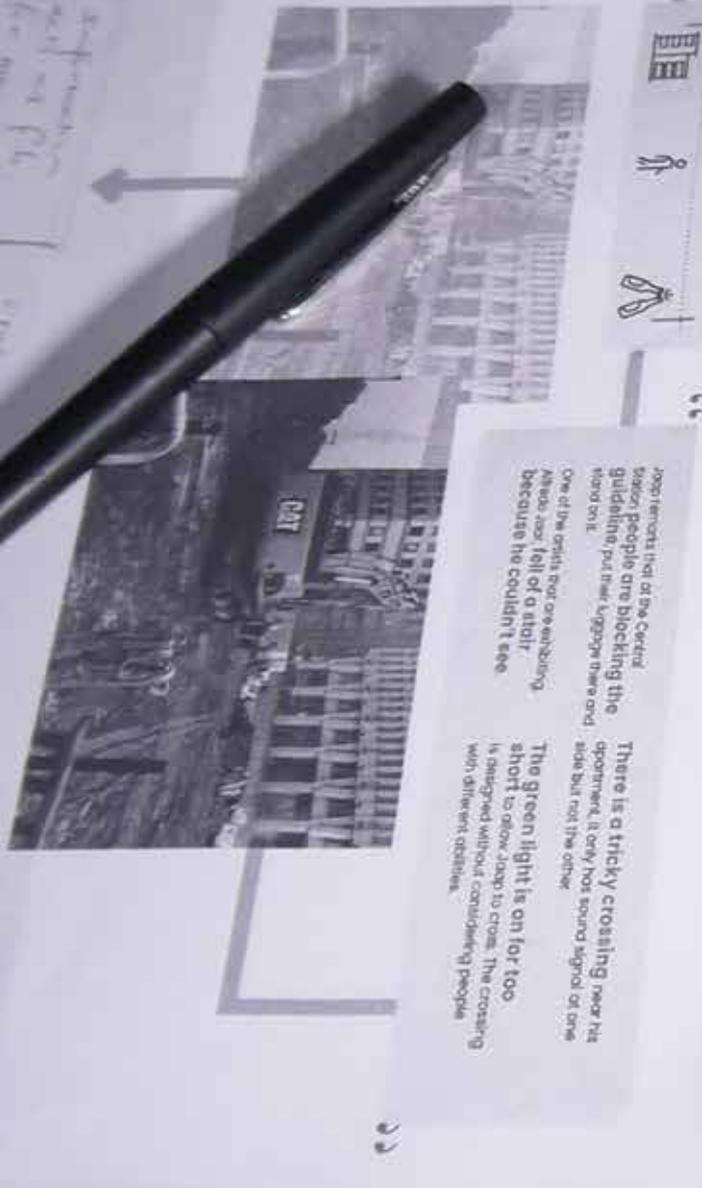
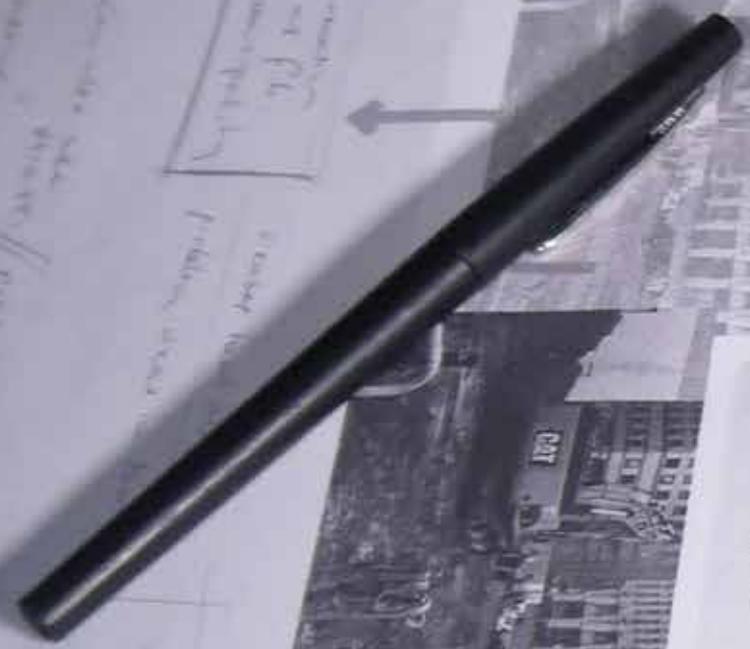
#### **Strengthening the institutional identity of the product.**

The effectiveness of this strategy is far-fetched in this context but could arise if implemented successfully and on a large scale. By creating a larger community around the use and manufacturing of the connected white cane and making the cane itself recognisable to the larger population, an institution is formed around it. Because of the positive aspects from which this institution is built (the perseverance, sense of community and unique skills inherent in visually impaired people), the products used by members of this institution will radiate these qualities as well. A strong design language is needed in this case as well. This design language will signal to the public that the products belong to this institution - in other words, make them iconic and recognisable.



# section 2: ideation.

Handwritten notes on a page with a grid background, including phrases like "Performance for...", "Problem areas", and "Strategy".



**Best helpful assumption**

Japan reminds that at the Central station people are blocking the guidelines, put their luggage there and stand on it.

One of the critics that are writing also says 'fell of a chair' because he couldn't see.

There is a tricky crossing near the apartment, it only has sound signal on one side but not the other.

The green light is on for too short to allow Japan to cross. The crossing is designed without consulting people with different abilities.

2





# Chapter 2.1

## second ideation.



### 2.1.1 A new concept

During this ideation phase, a tool was developed that would keep ideation more focused. This was deemed necessary as the previous ideation effort were not fully grounded in research. Due to the sheer volume of insights gathered from research, ideation was very chaotic and some order was needed to come up with meaningful concepts that had a link to real insights. The tool will be shown alongside some sketches before concretising the concepts in scenarios.

#### Holistic concept

The concept is built around a modular cane handle. This cane handle allows for up to three modules at a time, each of which has a different functionality based on the needs of the user and the locus on the product. The place on the handle also determines the loci of interaction and the semantic meaning this interaction holds. The configuration of the different modules will be determined by both the user of the connected cane and their trainers at an organisation like Visio. Next to the concept of this modular connected cane, design rules have been developed to allow for the development of a wide range of different modules. These design rules have been formalised in a form language. More about this form language can be read in section 2.2. By creating a network of involved stakeholders consisting of support organisations like Visio, champions from the visually impaired community, design studios and FabLabs, this concept can be expanded upon by creating new modules and investigating new socially relevant uses for the white cane. To further explain this concept, the core cane handle and its principles will first be described. Afterwards, three potential manifestations of this concept will be presented through a fictional visually impaired person and their personal cane.



### The core handle

The core cane handle was designed to be comprised of three different modules while still maintaining both an ergonomic and recognisable form. Sketches were made investigating form, followed by a series of foam models. The foam models were created by cycling through intervals of intuitive creation, ergonomic testing and reflection. Possible loci of interaction were indicated on the foam models using a felt tip pen. The most suitable form of the core cane was selected and was developed into three different sizes conforming to the width of the human palm as described on Dined. A rudimentary connection system was developed as well, allowing the modular handle to be disassembled and changed on the spot. This concludes the development of the cane handle up to this point (more interactions will be made after the green light meeting). As seen in the pictures, the cane handle is divided in three modules that run along the length of the handle. These will from now on be referred to as "top module", "middle module" and "bottom module".

*The pictures on the adjacent page show various stages in the design of the cane handle.*



# the hopeful champion.

## Experienced & skeptical.

Involving themselves in all kinds of initiatives that better the lives of fellow visually impaired, the hopeful champion fully committed to making a change for the better. They are often open-minded and open for innovation, but deeply critical of the available assistive products. Though not always positive, they try to make the best of not only their own, but their peers' situations as well.

This concept allows the hopeful champion to use their white cane to indicate places of hazard and discomfort, like busy crossings, chaotic train stations and places where roadwork is being done. The connected system allows them to upload their findings straight to a team of urban planners, that can work in collaboration with the visually impaired community to make a better town for everyone.



Jaap remarks that at the Central Station **people are blocking the guideline**, put their luggage there and stand on it.

One of the artists that are exhibiting, Alfredo Jaar, **fell of a stair because he couldn't see**.

**There is a tricky crossing** near his apartment, it only has sound signal at one side but not the other.

**The green light is on for too short** to allow Jaap to cross. The crossing is designed without considering people with different abilities.



## Possible solutions:

1. reshape meaning of product.  
advances in technology.  
identify product with user.  
strengthen product (brand) identity.
2. empowering users.  
additional features.  
boost social skills.  
boost group identity.
3. better fit between user and (interaction) design.

(Vaes, 2014; Rheinfrank et al., 1986;  
Barros, Duarte & Cruz, 2012)

## Digital divide:

1. digital equality.  
Access Digital Divide (ADD).  
Social Digital Divide (SDD).
2. collaboration with sighted people.  
access to same functionalities.  
allow for exploration of system.  
coherent with sighted GUI.

(Winberg & Bowers, 2004; Hargittai, 2002;  
Florida, 2001; Kvasny, 2002; Winberg, 2006)

## The hopeful champion

*"I have been blind for a number of years now, and have adjusted to my new way of life fairly well. Learning to live with my limitations, I have found that many of them are man-made. After developing a new sensitivity to my other senses, I have found many tricks to overcome these obstacles. Together with visually impaired peers, I have come up with solutions to them as well, but implementing these solutions is hard. There is just no easy or direct way to notify municipalities and other policy makers of inaccessible features and a part of the visually impaired community is oblivious to the potential solutions, as well."*

The concept that was developed for the hopeful champion allows them to contribute to their community by indicating less accessible spots in the urban environment to the local municipality. This is done by pointing the top module, which has a camera running along the length of the cane, in the direction of the situation to be reported. The user then turns the back module until the haptic vibration motors in the center module indicate that the user's location is recognised. The user then pushes the back module into the cane and uploads the coordinates of the undesirable situation to a map owned by the local municipality. The haptic vibration motors pulse to signal to the user that the action has been completed. This concept especially plays into the strategy of making the stigmatised product beneficial for society at large.





*Stella is a 26 year old office worker that has been blind for the better part of her life. She goes to work every day and has learned to live with her impairment very well. Next to this, she is actively involved in the visually impaired community.*

*She walks from her home to her office every day. She needed to practice this route for a long time before being able to travel individually, but is now confident in doing so.*



*The only obstacle in the route is set of steps that are not indicated and are treacherous.*



*As suggested by her social worker at Visio, she starts walking with the positive what cane, which has been modified so she can notify the city municipality of any inaccessible areas.*

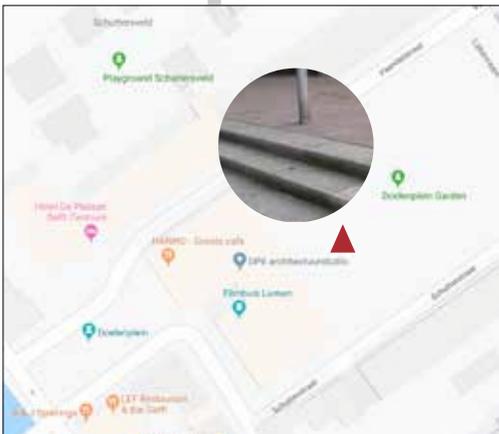
*She arrives at the treacherous steps again.*

*She points it towards the inaccessible area and slides the button up to activate the camera module.*



*When she pressed bottom module, both a picture of the relevant area and the GPS coordinates are sent to the Delft municipality.*

*The municipality reviews this data and acts on it, making the city more accessible for all.*



# the industrious learner.

## Novice & embracing.

The industrious learner has had to adapt their way of life dramatically due to rapid onset visual impairment. They are forced how to walk with a white cane from the get-go or face the risk of not being able to go outside any more. This makes the industrious learner a practical person that is willing to use any assistive technology as long as it gets the job done.

Because the stubborn warrior is fiercely independent, they encounter a lot of stress moments in their daily activities. With this concept, the stubborn warrior can indicate when they have stress and get help from more experienced VIPs. The cane can also sense these stress moments and offer guided breathing exercises.



**You have to remember it all:** a pole here, letterbox there... I'm not at the letterbox so in twenty meters there will be a little pole on the left, so that's exhausting.

**I am a little bit of an illiterate** when it comes to computers.

**Remembering all the shortcuts will always be a problem.** At least it is supposed to help against dementia!

I'm also learning braille. Just a few classes to **pick it up again.**

## The industrious learner

*"It's the end of the week again, which means my weekly cane training at Visio Den Haag is coming up again. I've been looking forward to it. Ever since I lost my eyesight five years ago, I have been feeling dependant on my surroundings. This is in stark contrast with my previous life, in which I worked at an advertising firm. I was training to run a marathon with co-workers when I suddenly felt an immense headache. Three months after, I had lost my entire eye-sight due to retinal detachment. The doctors said it could happen to anyone and that I was just unlucky. I had to say goodbye to my job and most of social life and because only a few close friends remain I have been dependent on caretakers. This unfortunate turn of events has not damaged my willpower, though. I started training with a white cane at Visio from day one because the only thing I want now is to have some of my independence back. Progress is slow though, as I can only do short training sessions once every two weeks. If only I could train on my own... I would do so every day."*

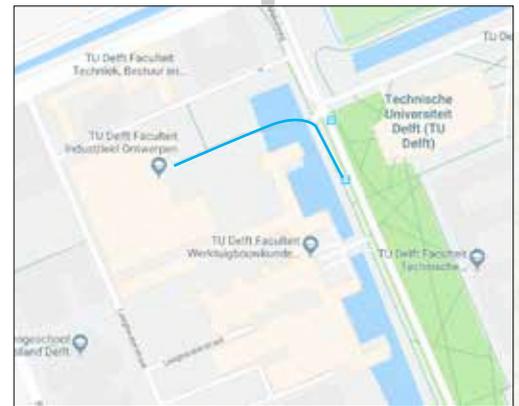
The concept that was developed for the industrious learner allows them to train and practice walking certain routes autonomously. The top module contains a module that sends location signals to a cloud. These signals get compared to a map of the route previously decided on by the cane walker and trainer. The user of the cane is guided through the route using haptic vibrations in the middle module of the cane. These vibrations can go from left to right and front to back, simulating motion and gently guiding the user along the path. Warning signals can also be given to the user and are made by quick pulses of haptic vibrations. Using the bottom module, the user can indicate the amount of help that is desired by turning the cane's pommel. This opens or closes the module, semantically indicating the amount of help that is received through data streams. By pressing on the bottom module, places of interest are added to the user's personal route which can be discussed during training with the mobility therapists. The mobility therapist also receives data from the cane that manifests itself in maps. These maps can be used to discuss progress and potential pitfalls that cane walker might encounter.





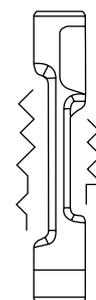
Ayla is 20 years old and a student at Delft University of Technology. After an accident, she has lost 90% of her eyesight and is now legally blind.

She has been training with a professional ergo-therapist once a week in order to be able to walk the route from the campus bus stop to the faculty of Industrial Design Engineering.



Her ergo-therapist at Visio explains to her the benefits of the positive white cane. He suggests a configuration that will allow her to train the route by herself every day.

Using haptic feedback, she begins regularly walking the route by herself.



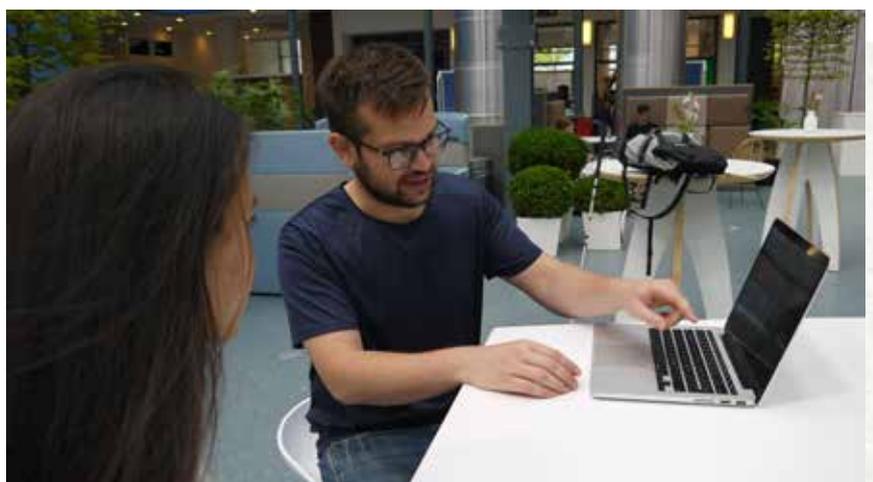
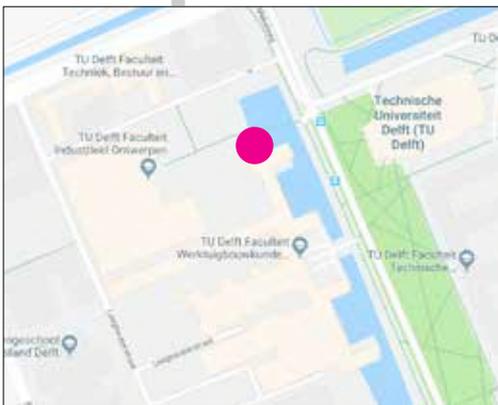
The cane handle employs different kinds of haptics that offer cues that have been decided upon together with the ergo-therapist.



When Ayla wants the positive white cane to track her data, she pushes up to activate the top module.

Ayla can turn the bottom module to determine the amount of data that is being shared within the system. She can also push it to indicate a place of interest.

Using the data, Ayla's ergo-therapist can give her more targeted feedback, allowing her to develop her cane technique in a more pleasant and efficient way.



# the stubborn warrior.

## Novice & skeptical.

The stubborn warrior has a progressive eye disease resulting in gradually increasing visual impairment. Despite this, they still live their old life like they had always done. Over time, this takes more and more energy but the stubborn warrior is reluctant to use assistive technology. They want to feel independent and not to be seen as less than their fellow human beings.

Because the stubborn warrior is fiercely independent, they encounter a lot of stress moments in their daily activities. With this concept, the cane can sense these stress moments and offer guided breathing exercises.

## Possible solutions:

1. empowering users.
  - additional features.
  - boost social skills.
  - boost group identity.
2. better fit between user and (interaction) design.

(Vaes, 2014; Rheinfrank et al., 1986; Barros, Duarte & Cruz, 2012)

## Multimodal interaction:

1. tangible interaction.
  - genres.
  - perceptual-motor skills.
2. haptics.

(Djajadiningrat et al., 2004; Wensveen, Djajadiningrat & Overbeeke, 2014; Gorbet, 1998; Belotti et al., 2002; Hale & Stanney, 2004)

## Smart cities:

1. connectivity.
2. social inclusion.

(Caragliu, Bo & Nijkamp, 2009; Chourabi et al., 2012)



“**The room is very dynamic,** with people moving about, meeting and mingling.”

“**A few wines will make this less intimidating**”, Margot says.

When we encounter some traffic, Margot keeps checking by how much we are delayed. Margot: “We are getting close now.” **She says this out of nerves.**

**She seems tense.** The chaotic nature of the preparations has thrown her off.”

## The stubborn warrior

*“I have been going blind slowly due to retinitis pigmentosa for a good number of years now. At first it was slow and I could live my old life. But now it’s honestly getting harder and harder to stay independent. I have learned many tricks that still allow me to live my old life. I think that’s because I’m unwilling to accept my future impairment and am frankly very scared for what the future may hold. I know I’m going to have to walk with a cane to continue living, but I’m afraid of what people will think when they see me walking down the street holding it, although living without it has been very stressful and exhausting. I did recently meet some fellow blind people through Visio and have started talking to them. Some of them have begun convincing me that trying the cane would be worthwhile, but it doesn’t feel right to me yet...”*

The concept that was developed for the stubborn warrior allows them to hide and show the white cane at will. This will help them to gradually get used to the white cane and its effect it has on both their perception of self and the reactions of bystanders through stigma. The top module includes motors that allows the white cane to fold into itself, turning less visible. This is controlled by the bottom module, that can be turned to increase or decrease the size of the cane and pressed to either fully retract or expand the cane, depending on the current mode. The middle module measures stress levels and offers guided breathing exercises when moments of stress arise. Both these moments of stress and the user’s behaviour pertaining to either showing or hiding the cane are shared with the professional at an organisation like Visio. This will help the professional understand the specific fears and anxieties of their clients better and allow them to come up with more target exercises to overcome these hurdles.

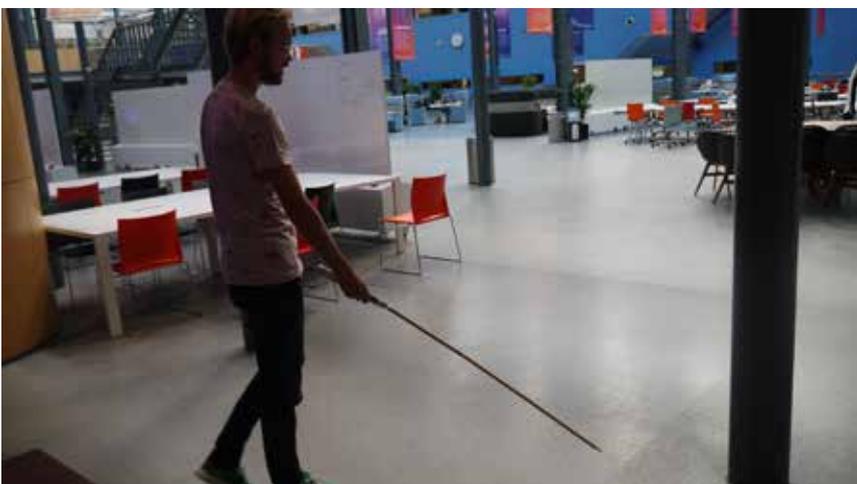




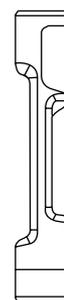
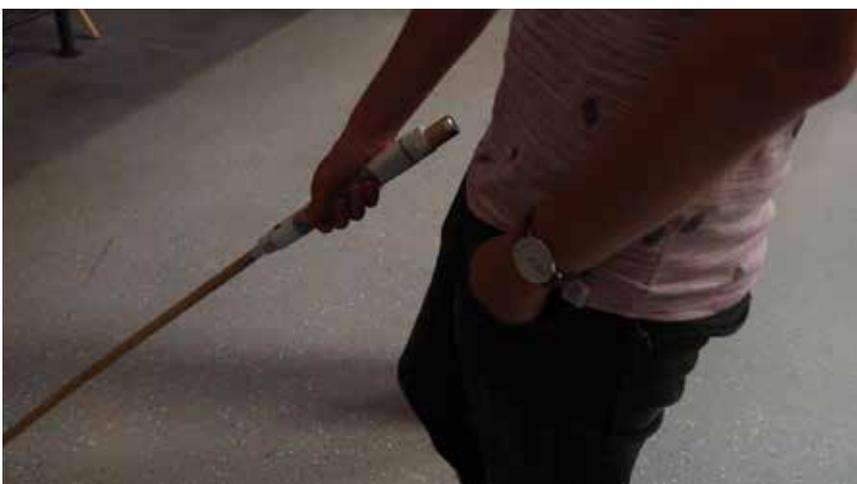
*Peter is a 25 year old man that has been going blind due to retinitis pigmentosa for some years now. He has been postponing the use of the white cane because he does not want to be seen as pitiful.*



*He has been having multiple discussions about this fact with his social worker at Visio. The social worker at Visio recommends Peter walks with the positive white cane. She says this will allow Peter to slowly get used to walking with the white cane out in public.*



*Peter tries walking in public with the positive white cane for the first time. He feels the eyes of people in his back. This makes him very anxious. The positive white cane senses this.*



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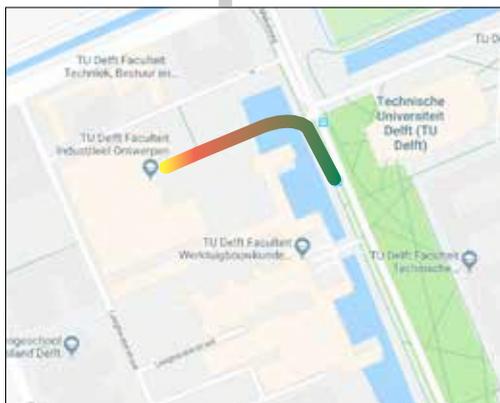
*Peter synchronises his breath with the haptic feedback the cane provides, breathing together with it until his heart rate has slowed down.*



*Peter tries walking walking with the white cane more and more, closing the bottom module more and more to indicate to the system that he is in less need of help.*



*Peter has fully learned to let go of the fear of walking with a white cane in public. This has made him considerably more independent. Peter and his social worker at Visio can now discuss freely whenever moments of anxiety show up in the data.*



# Chapter 2.2

## form language.



Form language and form trends are important in this product for the visually impaired for a multitude of reasons. The first reason is adoption. Through interviews, observations and focus groups it was discovered that many prospective cane users either postpone the adoption of the cane or forego it altogether. This has mainly to do with the stigma that these assistive products come with, a fact also observed by academics (1.1.1). Other research has pointed out ways to alleviate this aspect of stigma in assistive products. An affective way of doing is to present the product as a consumer good or to give the product its own distinctive (positive) identity apart from the user.

### Exaggerated affordances.

Affordance was discussed before in the literature review sections and all over this report because it is a very important concept in interaction design. Exaggerating affordances in ways such as adding colourful accents to handles, enlarging use cues and using very simple form to indicate affordance is an emerging aesthetic all by itself. Apart from this, it can help the impaired to interact with product in a more intuitive way.

It is however observed that exaggerated affordances can contribute to a more medical look. This is to be avoided if we intend to decrease the amount of stigma produced by our white cane. The Together Canes project by Lanzavecchia and Wai presents an exemplary application of this trend and manages to use it in a modern way without having the product feel like an assistive product.

### Macro patterns.

Macro patterns is another recent trend in product design. Accenting entire surfaces with subtle repeating patterns does not only give a product a modern feeling, but could also be very valuable in the design for the visually impaired as it allows them to differentiate between different parts of products by touch. This trend is arguably started by Yves Behar's work on the Jawbone set of products.

Another way is to reshape the meaning of the product. Form language can help doing that by presenting the users of the product as, for example, an early adopter of new technology (see section 1.1.1). Because stigma is not only generated by the product and the user, but by bystanders' reactions as well (for more information, see also section 1.1.1), the look of the product can affect the occurrence of stigma in products. In this section, some trends that are relevant in developing this product's form language are discussed. Most of these trends are not only aesthetic, but also functional, and have been chosen for this property. A fascinating relationship to interaction genre was also found, which will be presented in the next chapter.

### Modular elements.

Another current trend in formgiving is modular design. Because the design proposal in this project is modular, it is logical that the form language would leverage that. As observed by examining this trend, it is important that all modular elements differ slightly in orientation, finish or colour as to produce a cohesive whole while still allowing the user to discern the different elements.

#### *Images on next pages, by number:*

##### *Exaggerated affordances:*

- 1. Dexcom G6 by Design Concepts*
- 2. Stand by Judy Kong*
- 3. Waytap by frogdesign*
- 4. Adaptive controller by Microsoft*
- 5. Together Canes by Lanzavecchia & Wai*
- 6. Homehero by Jonas Damon*

##### *Modular elements:*

- 1. PR/01 by Fabien Neuroy*
- 2. Nurture by Yin Wang*
- 3. Voice BLOX by Yang Gao*
- 4. Fuego by Ammunition group*
- 5. Elvie by Chiaro Technology*
- 6. Krobo bench by Torbjorn Arfdal*

##### *Macro patterns:*

- 1. Jet backpack by Tessel*
- 2. Speaker + Microphone by Antoni Botev*
- 3. NDM City Sock by Adidas*
- 4. Hennessy XO bottle by Mark Newson*
- 5. Vision Alpha by NONOBJECT*
- 6. Digital Camera concept by Abidur Chowdhury*
- 7. Jawbone bracelet by Yves Behar*

# Exaggerated affordances.



# Modular elements.



# Macro patterns.



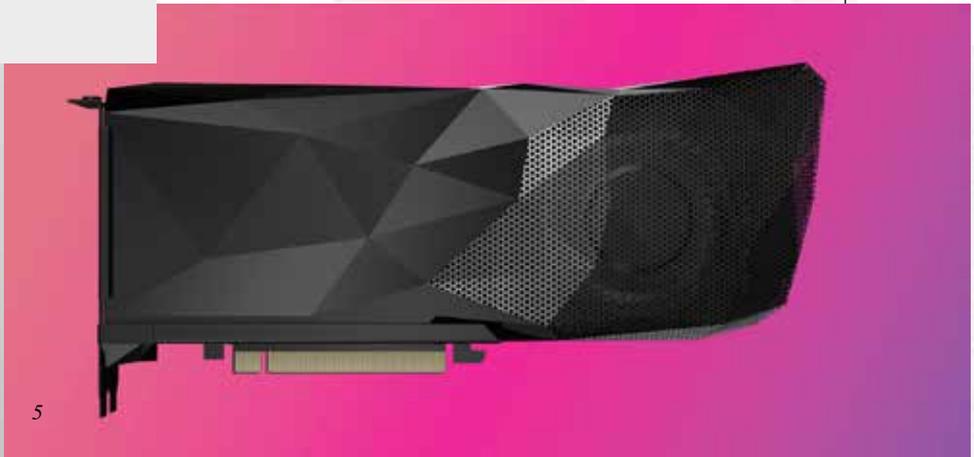
2



3



4



5



6



7

# Chapter 2.3

## colour studies.



With the cane design finished, a high-definition prototype could be built with which user tests could be conducted. Before doing this, however, a colour scheme had to be decided on. A large number of renders were made to determine this colour scheme. These renders were subsequently shown 10 fellow students in total. These students were asked to rate the colour schemes relative to the three characteristics 'modern', 'high-tech' and 'unique' on a scale from 0 to 5.

A cane that scores the highest on these three characteristics is not only assumed to embody a unique identity of its own, but also show that it offers features that go beyond the functioning of the current white cane. In other words, the colour scheme is meant to represent the technologically advanced nature of the cane while still showing a unique and personal identity. The colour schemes and their ratings can be seen in the figures on the next pages. The final colour scheme that was decided upon is highlighted.

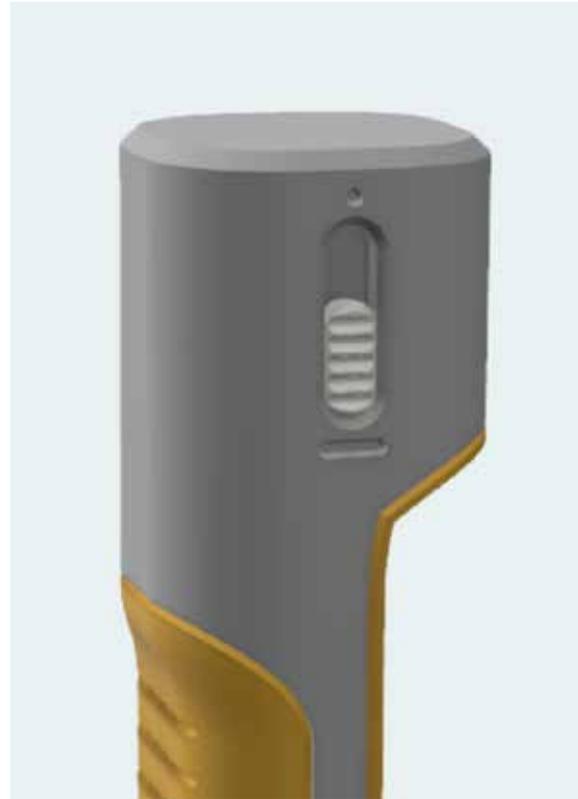








*modern:* 2  
*high-tech:* 2  
*unique:* 3



*modern:* 3  
*high-tech:* 3  
*unique:* 5



*modern:* 3  
*high-tech:* 4  
*unique:* 3



*modern:* 5  
*high-tech:* 4  
*unique:* 3

# Chapter 2.4

## prototyping.



The design that is highlighted was chosen for the final prototype. The prototype was made by 3D-printing the more complex parts and applying layers of spray plaster that could subsequently be sanded to give a smooth finish. The colours were applied by masking areas of the 3D-printed model and spray-painting on top of the spray plaster. The simpler parts of the cane were turned out of wood and aluminium on a lathe. The model was made in parts to ensure better portability. This was deemed important in carrying out the user tests.

The construction of the prototyped will be presented using a timeline of pictures with added descriptions on the following pages.

1. The general shape of the handle is investigated by making foam models.



3. Some other shapes are investigated, as well as suitable cane materials.



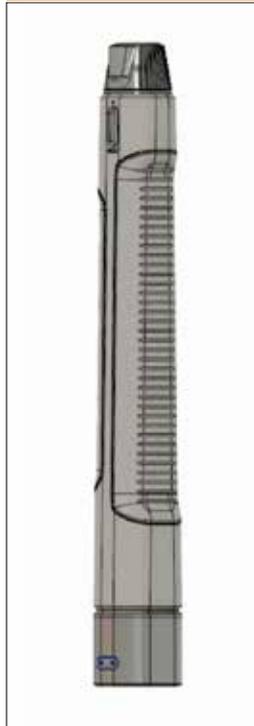
5. The cane parts are milled out of beechwood. Three parts are milled to allow for two bands.



2. The shape is 3D-modeled and printed. After testing, it is deemed suboptimal.



4. The final cane design is modeled and set to the Ultimaker 2+ printer.



6. The wood is treated with beeswax to bring out the grain and make it more weather-resistant.



7. The core handle is done! It is then repeatedly treated with spray plaster and sanded for a smooth finish.



9. The rest of the parts are printed. This is done because it allows for more accurate painting later.



11. The rest of the handle is done. Time for assembly!



8. The indicator rings are milled out of aluminium. They also serve as connectors.



10. Parts of the handle are masked and the handle is spraypainted, giving a clean product line.



12. The finished prototype is complete and ready to be tested on its stigmatic properties. Here it is next to the current white cane.



# section 3: validation.







### 3.1.2 Meaningful data.

To explore and test the meaningfulness of the multi-layered data gathered by the three concept canes, a session was set up at Visio. This session was meant to gather insights from professionals and visually impaired people in how this data could be meaningful in their relationships and how it might allow them to work together more effectively or pleasantly. The data gathered from this session would prove to be useful to nuance and provide meaning to the extensive amounts of data that could be gathered by a connected white cane.

#### Stimuli, setup and participants

The session was held at Visio in Den Haag, next to the Mariahoeve station on Wednesday August 14th and lasted from 14:00 until 16:00. The session was conducted in a room with a table in it around which all participants were sat. Some cookies were brought to enjoy during the break. A cellphone was brought to record audio of the session.

Five participants were gathered for the session. Three of these were visually impaired, one of these was a social worker from Visio and the last was the spouse of one of the visually impaired participants. Amongst the three visually impaired participants, two were legally blind. One of these had been legally blind for most of their lives, while the other lost their eyesight recently. The last visually impaired participant has a progressive disease in the intermediate stage. These three participants were selected to ensure a balance in visually impaired experience. This was taken into account to make the outcomes relevant for as large a target group as possible.

#### Method

At the start of the session, participants are welcomed and the intent and setup of the session is presented. Permission to record audio was gained. Afterwards, participants are asked to introduce themselves to each other. An icebreaker was not deemed necessary, as the last session at Visio showed that the people that make the effort to come to such a session are mostly motivated to share their opinions and are not scared to do so.

The bulk of the session consisted of a guided fantasy. The guided fantasy consists of three parts and is described as follows:

1. It is Wednesday morning. You leave your home, and start off on a familiar route. You walk a few minutes and listen to the sound of the traffic.

You arrive at a street crossing not far from your home. This is a place that you know very well. Stop here for a bit, and pay attention to the moment you stand still. What do you listen to? What do you do? What comes to your mind? What do you need to know to continue your route?

What would you like to share or receive from your companion? What is the difference in companions in terms of information sharing? What do you want to keep private? Why these types of information?

2. You continue your walk. You are entering an unfamiliar neighbourhood. What changes? Who are you accompanied by?

You arrive at a crossing. This place is new to you. Stop here for a bit, and pay attention to the moment. You are standing still. What do you listen to? What do you do? What comes to your mind? What do you need to know to continue your route? How can your companion help you in this? How is it different from before?

What information would you like to share or receive from your companion? What is the difference in companions in terms of information sharing? What do you want to keep private? Why these types of information?

3. Let's say you explore this new neighbourhood by yourself. How is this different from exploring it with a companion?

You arrive at a crossing. This place is new to you. Stop here for a bit, and pay attention to the moment. You are standing still. What do you listen to? What do you do? What comes to your mind? What do you need to know to continue your route? How is it different from before?

What information would you like to share or receive from your companion? What is the difference in companions in terms of information sharing? What do you want to keep private? Why these types of information?

A fifteen minute break took place after the guided fantasy, after which a half-hour plenary reflection was held. This reflection was meant to gain deeper insights into points that were discussed during the guided fantasy. After the plenary reflection, the session was wrapped up by having participants reflect on the insights once again and ranking the different takeaways from the session. After this, the session ended and participants were guided out of the Visio facility.

## Results

Through a semi-open discussion that was structured using the three guided fantasies, several topics that have to do with data when being visually impaired emerged. These topics will be presented below and discussed.

### Indicating danger

Participants remarked that some of the premier topics of information they wanted to know about and could not always get access to pertain to danger. Traffic flow is not always obvious and can be treacherous when navigating densely populated urban spaces. They would also like to be notified of obstacles that are close by, especially citing “amsterdammertjes”, which are little poles that dot the urban landscape of Amsterdam and which they frequently run into.

### Navigation

Navigation was also a key topic of information the participants wanted to know about. Particularly the topic of staying on-route was mentioned. Participants wanted to know if the direction they were facing in was the right one and if they were on track. However, this information is not always welcome, as visually impaired people get thought a personal navigation style by their ergotherapist. This suggests a certain flexibility in the information, and the fact that visually impaired people will not always take directions as gospel. This notion is reinforced by the following quote:

*Peter: “In navigation, you have to find your own way. So the system should enable for that kind of flexibility”.*

### When to share

Some reasons to share data were mentioned by participants. While they couldn't find any reason to share data with just anyone that had access to the system, some occasions were identified as exceptions. They wanted to share information pertaining to danger, such as the one mentioned in that relevant section. They also wanted to share data when trying something new of difficult as they thought that could add to the body of knowledge in the visually impaired community.

### Emotional data

Emotional data is data that the participants indicated they were only willing to share with people close to them. In nuancing this notion, however, the conclusion was reached that quantifying emotions should never be the goal, as that wouldn't help in reaching a higher level of understanding. Data with emotional qualities could lead to conversations instead, which will help to bring the visually impaired users and the people around them closer together. Also, emotional data was deemed useful to be recorded for oneself, as it could give insights into your own habits.

### Information they would like to receive

Information visually impaired people would like to receive are on multiple levels. On one hand, there is the practical information that they don't have easy access to. On the other hand, there is information that is more

hedonistic in nature. The more practical information pertains to things like the locations of curbs and slopes. Additional information that is practical in nature can be found in the section pertaining to practical information above.

The more hedonistic kind of information that they are interested in learning about mostly pertains to context. Visually impaired people find it hard to get a sense of the kind of environment they are navigating within. That is why they are interesting this kind of information. They would like to know the type of buildings in the neighbourhood, the people walking through the streets, the sights on vacation and may other less practical, but more emotive kinds of information. This notion is reinforced by the following quotes:

*Ines: “I have an artist friend that's very visual. When I'm with her, she tells me what she sees and my surroundings come to life”.*

*Peter: “The world is changing. Hearing what surroundings that I remember fondly look like now would make me very happy”.*

*There has to be a balance between the two kinds of information that are gathered, though. While both types of information are very valuable, they each have their place. This notion is reinforced by the following quote:*

*Jaap: “When I go to a new neighbourhood, I would love to hear about the general vibe there, and the kind of people walking around. When I just want to go to the store, I don't care about those kinds of things”.*

**Discussion**

The most interesting thing to see is that a certain system of data can be found in which the emotional or hedonistic character of data can be plotted among an axis of level of desired privacy. Participants also mentioned that as they mastered their environment more, the need for practical data declined and the desire for more hedonistic data increased. This axis is called 'novelty'. A representation of this can be seen in the figure below.



### 3.1.3 Dyadic distance.

This experiment was conducted to test whether stigmaticity is decreased in the positive white cane as opposed to the old white cane. This test is partly appropriated from Vaes (2014). Minor adjustments were made, these will be indicated where appropriate.

#### Stimuli, setup and participants

This experiment is carried out in six times, each time using different stimuli. Firstly, the experiment is carried out using both a male and female participant. This is done to mitigate the effect the participant's gender might have on the results. Both participants perform the experiments while not wielding a cane (this is the reference condition), wielding the traditional white cane and wielding the positive white cane.

The chosen location for the experiment is Delft central station, both because it is a very realistic situation for visually impaired to be in (they have to rely on public transit to get around) and because it offers a large amount of participants. Because the researcher had no access to a measurement device such as described by Vaes (Vaes, 2014) distance between research confederate and participants was measured by comparing it to objects from which the distance between research confederate and object was known. Notes were made, placing the participant between the objects and the research confederate using an observation template (see figure on adjacent page).

Due to the selection of the location, the set of participants is very diverse. A lot of people pass by Delft railway station on a daily basis, ranging in nationality, gender age and social background. The sample size in this experiment was 161. Passers-by had to meet a few qualifications in order to be considered a valid participant (Vaes, 2014):

1. Because people behave differently in groups, only singular passers-by were considered as valid participants.
2. Passers-by who were accompanied by a pet were not considered as valid participants.
3. If passers-by were obstructed or otherwise hindered during the interactions, they did not count as valid participants. This also counts for passers-by engaging in focused activities such as listening to music or talking on the phone.
4. If passers-by walked in the reverse direction and were thus not facing the participant, they did not count as valid participants.

The variable measured in this experiment is called the dyadic distance, which is the distance between a "dyad". A dyad is a collection of two people, which is the smallest social unit. The dyadic distance can signify how comfortable people are with each other. Using theory by Hall, we can define certain distances as certain types of space (Hall, 1966). These spaces are the intimate space, personal space, social space and public space. Intimate space is the space utilised for embracing and touching, personal distance is used for interactions amongst good friends or family and social distance is used for interactions amongst acquaintances. Lastly, public distance is used for public speaking. Thus, we can conclude that the dyadic distance can tell us something about the relationship between two persons.

Next to this, the amount of times bystanders looked over their shoulders was also noted. The exact motivation of this response is unclear and can be explained by a multitude of factors including curiosity and aversion. Some interviews were held with bystanders looking over their shoulders to clarify their intentions.

This dyadic distance and staring behaviour of participants are measured by observing the behaviour of people passing by a research confederate without a cane, with the current cane and with the positive white cane. The walking and staring behaviour is registered in a notebook filled with observation templates. For the first 30 minutes, the behaviour of participants regarding the presence of the research confederate was noted without cane. The research confederate then switched to wielding the current white cane. After 30 more minutes, the research confederate switched to wielding the positive white cane. The behaviour of participants regarding the presence of the research confederate wielding the positive white cane was also recorded for 30 minutes. After each round of observations, a short open-ended interview was conducted with the research confederate.

After this, the session ended and participants were guided out of the Visio facility.





## Results

The hypothesis in this experiment is that the dyadic distance would increase when research confederates would wield either of the canes, with the dyadic distance being smaller while wielding the positive white cane. A secondary hypothesis is that the amount of looks would be greater in wielding the positive white cane than the current white cane. A hypothesis in terms of differences per gender was not established. We will discuss the results for the female and male confederates separately and then compare them.

### Results for the female research confederate

The experiment measured an average dyadic distance of 0,60 meters for the female research confederate without any sort of cane. In the other two setups, the experiment measurements indicate an average dyadic distance of 1,38 meters for the current cane and 1,02 for the positive white cane. This theoretically indicates that individuals passing by a visually impaired person wielding the positive white cane are willing to enter into personal space which is a dyadic distance between 46 and 120 centimetres (Hall, 1966), which is the same personal space as the one that is entered when she is not wielding a cane.

Passers-by offered the female participants help on two separate occasions when wielding the current cane, and not once when wielding the positive white cane.

The amount of looks recorded during the experiment was 2 when wielding no cane, 9 when wielding the current cane and 6 while wielding the positive white cane. Because of sample sizes of 20, 29 and 28, respectively, no hard conclusions can be gathered from this data. The open-ended interviews can, however, shed some light on this.

*Veronika (when asked about how she felt wielding the current white cane): "I did not feel out of place, but I did have the feeling that people were paying a lot more attention to me. Like they were looking out for me."*

*Veronika (when asked about how she felt wielding the positive white cane): "I felt very out of place. I feel like when people would ask me what I was doing here, I wouldn't know what to tell them."*

*Veronika (when told that she did get less looks when wielding the positive white cane): "Strange, it sure felt like people were staring at me a whole lot more."*

### Results for the male research confederate

In this experiment, an average dyadic distance of 0,77 meters for the male research confederate without any sort of cane was measured. In the other two setups, the experiment measurements indicate an average dyadic distance of 1,17 meters for the current cane and 1,01 for the positive white cane. This again indicates

that individuals passing by a visually impaired person wielding the positive white cane are willing to enter into personal space which is a dyadic distance between 46 and 120 centimetres (Hall, 1966), which is the same personal space as the one that is entered when she is not wielding a cane and using the current white cane. However, the distance measured when not using a cane is towards the lower end of personal space, while the other two dyadic distances are in the higher spectrum of personal space. Also, far more occasions of passers-by making a circle around the research confederate were observed in the situation looking at the white canes than at the station without the cane.

The amount of looks recorded during the experiment was 3 when wielding no cane, 9 when wielding the current cane and 7 while wielding the positive white cane. Because of sample sizes of 27, 31 and 32, respectively, no hard conclusions can be gathered from this data. The open-ended interviews can, however, again shed some light on this.

*Sven (when asked about how he felt wielding the current white cane): "I think people just treated me as if I were blind. I did not particularly feel in the way, but did feel like I was cheating my surroundings - especially when that truly visually impaired man walked by."*

*Sven (when asked about how he felt wielding the positive white cane): "I think people were mainly looking at me to determine what that stick in my hand was. I didn't feel any negativity."*

### Comparison between male and female research confederate

There are some differences between both the data and reported experiences between the female and male research confederates. The differences will be listed here. Their relevance will be discussed in the discussion.

- The dyadic distance between the female research confederate and passers-by when wielding the current white cane is larger than the dyadic distance observed with the male participant in the same situation.
- However, the dyadic distance when wielding the positive white cane was homogenous between female and male research confederates.
- The amount of looks in all situations did not differ between the female and male research confederates.
- When wielding the current cane, passers-by offered help to the female participants twice, while no passer-by did so for the male participant.
- The female research participant reported feeling much more insecure while wielding the positive white cane than the male participant.

## Discussion

We can conclude that the difference in dyadic distance between the situations without wielding a cane and the situations in which a cane was present (be it current cane or positive white cane) is significant. In the female research confederate, the dyadic distance between the current cane situation and positive white cane is significant while it's not significant in the male confederate. This can be attributed to differences in how society treats males using assistive technology versus how society treats females using those same products. To be sure of this and to find a successful method of coping with this phenomenon, additional research will have to be carried out.

After deliberation with the female research confederate, the conclusion was reached that she felt more out of place because she thought passers-by might recognise the white cane for what it is and respond accordingly. She did not know how to respond to the reactions pertaining the positive white cane because she did not know how the passers-by interpreted the product. She indicated that she did not know whether the looks were out of curiosity, confusion or some other motivation unknown to her.

The chosen location of the train station could also be considered to be a pretty extreme case of a forced social situation. The location was chosen regardless because of its prominence in the experiment replicated from Vaes (Vaes, 2014). An objection to the selection of a train station could be the fact that commuters are in a hurry and might not have the same level of attention as in more general public life. The stationary position of the research confederate might also cause passers-by to treat them differently.

# Chapter 3.2

## conclusions.



Various hardships in the lives of visually impaired people have been found in the user research conducted over the course of this project. Some of these are due to the fact that visually impaired people rely on assistive products, which are heavily stigmatised. This jeopardises their position in society to such an extent that this social group can grow very isolated and experience a multitude of psychological problems. The user research in this project has shown various issues that visually impaired people face on a daily basis, as well as their attitudes towards the devices they have to rely on to overcome these hardships. There are multiple styles of coping with these hardships and the assistive products and each of these styles - which have been embodied into personas - require a different strategy in order to overcome some of their issues.

The functionalities in the three concepts outlined in this report are deemed to be fairly meaningful to their intended users within the visually impaired community. Especially the validation session at Visio has shown that there is a need for this kind of assistance and that the sharing of data pertaining to these functionalities is deemed to be meaningful.

Combined with this, the aesthetics of the positive white cane are also found to have an impact on stigmaticity. Especially in females, the modern, technological look of the proposed white cane seems to make people less weary of its wielder and makes passers-by avoid them to a lesser degree. While this effect is observed less in males remains a topic to be clarified by further research.

The project also shows promising avenues to pursue towards the development of an interaction genre for the visually impaired. It is a shame that the context of this project did not allow enough time for this facet of the project to be fully explored. Would an interaction genre for the visually impaired be developed in the future, it would bring much benefit to the relationship between visually impaired users and their products, which is currently poor because of the fact that products for the visually impaired are oftentimes nothing more than a finicky layer that is built on top of product that are designed for the seeing. This merely allows the visually impaired to make use of these products, instead of achieving mastery over them.

# Chapter 3.3

## recommendations.



While this project has made some steps towards understanding how to design for less stigmatising assistive products for the visually impaired, it gives no conclusive answers. In this chapter, some recommendations will be given. Using these recommendations, the project can be developed further in the future.

### Allowing for selective sharing of data

The concepts as they are presented in this report do not allow their user to select the types of data they wish to be shared or kept private. This is, however, recognised as a valuable functionality in maintaining the privacy of all stakeholders. In the next iteration of the positive white cane, this functionality has priority. In developing this functionality, it will be important to determine the exact types of data that are being exchanged through the system. These types of data will then have to be semantically represented in interactions that allow of prevent them from travelling between users. It is also important that this product functionally be designed in an open way to allow for the introduction of new types of data.

### Prototyping the communications system between visually impaired users and others

Developing a rudimentary prototype that allows data to travel between visually impaired cane walkers and others in their social system will enable us to test certain hypotheses that are put forward in this project. Iterative prototyping and testing of this system will also uncover nuances that can be made into design that were not previously obvious.

### Iterating on the physical design of the positive white cane and the proposed design language

Because only one iteration of the positive white cane was tested on its stigmatic effects, no definite conclusions can be made on the effectiveness of this particular design, other than that it performed differently than the current design. To optimise the design of the positive white cane, multiple iterations should be made that each emphasise one of three design language elements. This will give a more nuanced understanding of each of the design language elements and their role in product stigmaticity. Designing the cane's shape by varying these three parameters could also be an interesting way to bring out new features in the cane's design.

### Identifying relevant new functionalities for the positive white cane

Defining relevant new functionalities for the white cane would expand the three concepts into more of a system and could bring the benefits of the positive white cane to a far wider user group. As found in research, the user group of visually impaired people is wildly diverse and no singular solution will ever solve the problem of designing a positive white cane. Since not all visually impaired people are concerned with the stigmaticity of the white cane, the visual redesign will work as a general solution. These users could, however, benefit from additional functionality, which is another strategy that is used to solve product stigmaticity.

### Producing technology and production roadmaps

Talking to technologists and producing technology roadmaps with them would allow the development of the positive white cane to be more focused. By focusing on cutting-edge technology and anticipating both social and technological developments, the positive white cane could be made both more relevant and more feasible.

# Chapter 3.4

## reflections.



At the start of this project, I set myself six project goals. In this part of the reflection, I will discuss whether or not I achieved these goals and if these goals proved to be relevant in the context of this project. I will also reflect on how I can set myself goals for my future projects.

### Execute extensive user research

I set this as a goal for myself because I foresee myself working as a designer with a strong research background. I also stated that this goal was deemed important for the project because I was unable to empathise with my visually impaired target group in the beginning. I think I have achieved this goal because everything that is done in this project is grounded in research. For example, the concepts are fully based on insights from user research and the aesthetics of the positive white cane are validated through experiments. I also learned a lot about my own design process whilst conducting this research; I learned how willing some people are to talk to you about their most private of problems - I also learned that some people embellish on their own experiences in order to please you as a researcher. This being the first time I took such a research-centric approach, I also found that I really like this approach to designing. It was a huge learning experience for me and I am grateful that I was able to execute it with the help of some amazing people.

### Add to the body of research on assistive products and product stigma

At the start of this project, I wanted to have some scientific impact. I don't know if I fully achieved that as I have not talked to many academics about my work. However, a research group from Delft University of Technology was interested in my process and are talking about using my work in some form. In the end, I think I did not add much to the already existing knowledge on product stigma, but merely deepened it by making it more tangible. I think my example of the positive white cane can serve as a guideline or source of inspiration for future project dealing with assistive products and product stigma.

### Develop an interaction genre for the visually impaired

Setting this goal was too ambitious of me. While I still feel it is a worthwhile pursuit to develop an interaction genre for the visually impaired, in the context of this project it was not possible. While I did give some suggestions for interaction paradigms that are a logical result of the proposed form language, and some prototypes were made and validated, a robust interaction genre had not been found. This is however a very interesting topic that I would love to work on in the future. Setting this goal is an example of me spreading my time thin over the course of a project, which is something I tend to do in every project. Letting this goal go was tough for me, but it did make me realise that good results can be reached when a project is more focused.

### Deliver a graduation project that shows my design process to future employers

I think this project shows a good combination of various skills. It shows that I can do user research, develop shapes through form studies and tests, make relatively high quality prototypes and am able to reflect on both my growth and design process.

### Incorporate prototyping in the design process more

I have always been a big believer in the notion that making is understanding. However, in the projects I had done until now, I had never really conducted a process in which making models and prototypes played a key role in making design decisions. In this project, I went all-out in making models to validate all kinds of assumptions. I have found it works tremendously for me and speeds up my decision-making significantly. From now on, I will incorporate model making into my process and lean on it as a powerful ideation and validation tool.

### The design process

Overall, executing this project went relatively smooth. While there were some roadblocks, particularly in the analysis and ideation phases, I feel like the solid foundation of research that was laid down in the beginning phases of this project made the rest of the process relatively easy. One of the harder parts during this process for me was the transition from working with a research confederate to working alone. I really missed the daily interaction with another design student and the motivation we gave to one another. During the second part of the project, I got stuck on multiple occasions and found it hard to think laterally. I also found it harder to focus at times and had many a day where I was paralysed by the sheer amount of choices to make during the project and its boundless opportunities.

I also found it hard to not let myself get too beat up whenever the project was not going according to plan. This is due to the fact that I found it very hard to separate myself from the project. Because I got so involved in this project and excited about working on it, I took feedback very seriously and had a hard time approaching it more loosely. This made the project gradually less fun and I lost track of my self-care for a while. I am happy I can reflect on this phenomenon now that the project is nearing completion. I think it's dangerous for a designer to get so lost in a project that they forget themselves and their own needs, and it's something I will need to watch out for in the future.

**Implications for design career**

I think a project like this could fit well in the portfolios of companies like IDEO and frog, which are my dream companies to work at later on in my career. The fact that my project has been accepted to exhibit at the Design United exhibition at the Dutch Design Week makes me very proud and I am going to embrace it as a networking opportunity.

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