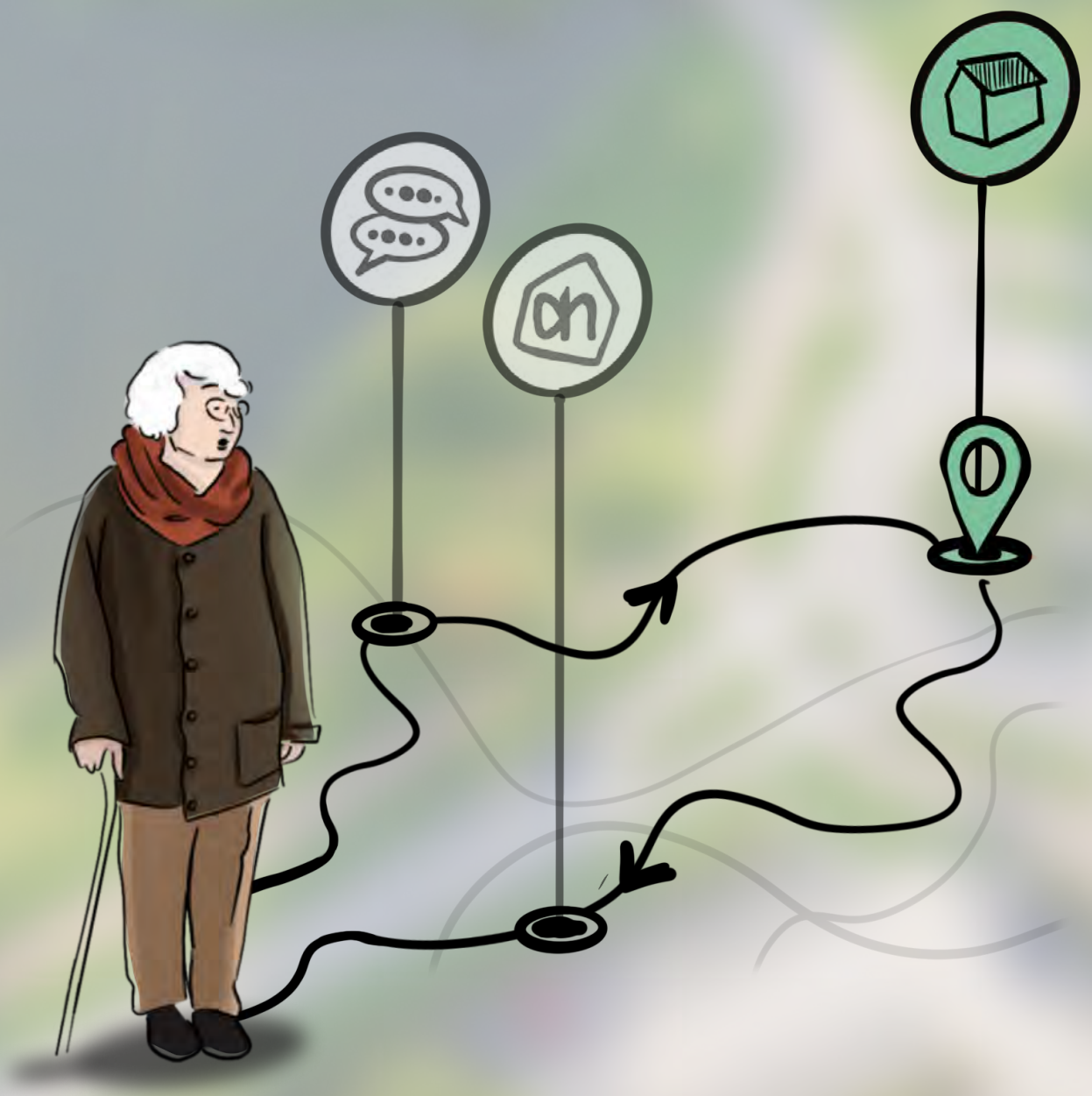
Designing a wayfinding device for people with dementia

By Femke Kriekaard



Colophon

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Author
F.E. Kriekaard (Femke)

Supervisory team

Dr. Ir. M.C. Dekker (Marijke)	Chair	TU Delft
Dr. Ir. W.F. van der Vegte (Wilfred)	Mentor	TU Delft
Ir. J. Zhao (Jiaji)	Company mentor	Tover

Company details
Tover
Hamburgerstraat 28a, 3512NS
Utrecht, the Netherlands

Date
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Tover

Tover is a company that wants to change the way the world looks at people with cognitive challenges. They do this by using purposeful play within their product, the Tovertafel. The Tovertafel consists of games in the form of interactive light projections. Tover positively influences physical, cognitive, social, and sensory levels through engagement in their games. This graduation project is done in collaboration with Tover.

Acknowledgements

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Lastly, I want to give a short shout-out to my grandmother, who tirelessly walked around her neighborhood with me to pose for the best shots in the product video. Grandma, you rock!

Enjoy the read,

Femke

Summary

A majority of people with dementia live at home. Most people living alone experience problems with wayfinding due to symptoms of their disease, like memory impairment, spatial disorientation, and loss of planning abilities. These problems can cause them to reduce their outside travel range or even stop going on independent outdoor visits altogether. The inability to go outside for errands significantly impacts a person's ability to live independently and can contribute to their institutionalization. This problem is challenging since the ability to go outside and maintain your everyday life is seen as a primary need for people with dementia. Furthermore, being outside is found to improve sleep patterns, slow cognitive decline, and reduce agitation in people with dementia.

Current solutions that help people with dementia in the outdoor environment focus on tracking the person with dementia to warrant their safety. In these products, the person with dementia is a passive user dependent on the person who can see where they are. Navigation devices developed to enable people with dementia to find their direction are all designed for research purposes. Furthermore, these devices give too little context information and are not adaptable to different needs and requirements.

Therefore, this project aims to design a wayfinding device that supports people with early to middle-stage dementia to maintain an active lifestyle by enabling them to navigate to frequent and infrequently visited outdoor places. Safe, independent, & with confidence. The primary target group for using the device is people with dementia. However, the needs and requirements of their informal caregivers were also considered.

Workshops, walks, and interviews showed the struggles people with dementia encounter while they go outside. Moreover, these research activities showed the importance of landmarks for people with dementia while wayfinding. Challenges like complex memory-based navigation steps were also revealed during these activities. Therefore, a personalizable landmark base navigation strategy was used as the basis for the final design.

The final wayfinding device uses NFC cards to activate navigation routes on the smartphone. The person with dementia can carry these navigation cards with them and only has to insert them in a card holder on the back of their phone case to start the navigation system. The navigation system will then guide the person with dementia to their destination by showing a yellow arrow on top of footage from their

surroundings using Augmented Reality Navigation. The caregiver's involvement is essential in setting up the navigation system since they must help their loved one by loading the correct route on the navigation card and highlighting personal landmarks.

Multiple tests led to optimizing the interaction between the person with dementia and the navigation app. This resulted in a wayfinding device that supports people with dementia through intuitive navigation cues to visit places independently. This wayfinding device helps people with dementia regain charge over their active lifestyle.

Table of contents

Colophon 3
Acknowledgements 5
Abstract 6

PART 1 - Introduction 10
1.1 Project aim 13
1.2 Project approach 14

PART 2 - Context 16
2.1 The disease dementia 19
2.2 Impact of the disease 21
2.3 Living with the disease 23
2.4 Conclusion 25

PART 3 - Wayfinding 26
3.1 Wayfinding with dementia 29
3.2 Conclusion 33

PART 4 - Current solutions 34
4.1 Tracking devices 37
4.2 Navigation devices 40
4.3 Conclusion 44

PART 5 - Explorative research 46
5.1 Research method 49
5.2 Research findings 51
5.3 Conclusion 56

PART 6 - Design scope 58
6.1 Design goal 61
6.2 Target group 63
6.3 Design opportunities 68
6.4 Design requirements 71

PART 7 - Conceptualization 72
7.1 Ideation activities 75
7.2 Concepts 77
7.3 Concept selection 80

PART 8 - Design 84
8.1 Proposed solution 87
8.2 Design components 88
8.3 Technology 95

PART 9 - Validation 98
9.1 Test method 101
9.2 Validation results 103
9.3 Conclusion 106

PART 10 - Discussion 108
10.1 Discussion 111
10.2 Limitations 113
10.3 Recommendations 114

References 116

PART 1

Introduction

1. Introduction

In the Netherlands the current population of people with dementia is approximately 290.000 (Rijksinstituut voor Volksgezondheid en Milieu, n.d.). Due to our vastly aging society, this number is expected to double in the upcoming 20 years. 79% of the people who are diagnosed with dementia live at home and are taken care of by their family, their informal caregivers (ICs) (Alzheimer Nederland, 2021). Daily these informal caregivers are faced with numerous challenges caused by the disease. Therefore, it is no surprise that 53% of the informal caregivers are heavily burdened by their responsibility to care for the person with dementia (PwD) (Alzheimer Nederland, 2021).

Some symptoms like forgetfulness, mistaking time and places, and restlessness can cause difficulties in navigation, potentially leading to the person with dementia getting lost (Alzheimer Nederland, n.d.c). Not knowing where you are is a stressful experience for everyone. Let alone for someone who has problems with information processing. Caregivers constantly worry about the safety of their loved ones when they go away for a walk on their own. Safety issues include falling and hurting themselves, becoming a crime victim (due to wandering at night), experiencing hypothermia, and being found too late or not at all. All these issues can have detrimental implications for the well-being of the person with dementia.

Current mobility devices for people with dementia try to overcome some of these issues by constantly monitoring the real life location of the person with dementia. These products treat the person with dementia as an object that needs to be found. Although there is a wide array of tracking devices, there are almost no devices for people with dementia that help them navigate their outdoor environment on their own. That is why this thesis project will investigate the needs of people with dementia while they independently go outside.

1.1 Project aim

There is a shift in dementia care focusing more on person-centered care, which has the core values; independence, well-being, and empowerment of individuals and their families (Dahl & Holbø, 2012). During this project, we want to explore these values within the context of navigating the outdoor environment.

This project aims to research the needs and requirements of people with dementia (and their caregivers) living in the Netherlands when they navigate their outdoor environment. The insights from this research are used to develop a navigation system that creates more independence for the person with dementia while enabling them to build new skills to improve their mobility.

In order to reach the project aim, several research questions are answered over the spread of four chapters.

Chapter 2: How does the disease dementia affect the daily lives of people and the world around them?

a. How does the disease dementia progress?
b. How does dementia impact society?
c. How are people with dementia impacted by the disease?

Chapter 3: What challenges do people with dementia face when they independently visit places?

a. What is wayfinding?
b. How are people with dementia affected in their wayfinding capabilities?
c. How do people with dementia use wayfinding strategies?
d. What are the barriers that restrict people with dementia from wayfinding?

Chapter 4: What can we learn from the current tracking and navigation devices?

1. What are the unique selling points of tracking and navigation devices?
2. What product features of a tracking or navigation device conflict with the needs of the user?
3. What opportunities can a new product address that the current tracking and navigation devices do not handle?

Chapter 5: What are the experiences of people with dementia when they independently visit places?

1. What do the daily mobility actions of a person with dementia look like?
2. What barriers do people with dementia encounter while independently navigating?
3. How would people with dementia benefit from a device that offers wayfinding help?

1.2 Project approach

The project's process is structured according to the Double Diamond model. This model uses four phases of diverging and converging activities to deliver an outcome. As is shown in Figure 1, the different research activities helped to explore the problem space and develop a wayfinding device. A user-centered approach has been used throughout the process to create a solution that fits the needs of people with dementia and their caregivers.

During the discovery phase, the challenges surrounding independently visiting places were explored through literature research, product reviews, workshops, walks, and interviews. These activities gave the researcher a clear picture of the problem space.

In the define phase, results from the discovery phase were analyzed. User journeys, personas, and design requirements were created based on the results to define the project's scope.

The development phase existed out of explorative conceptualization activities. These activities led to the creation of three concepts that experts and a user reviewed.

A concept was selected and further developed into a proposed solution in the delivery phase. This solution was validated with people with dementia and informal caregivers. Through this validation, adaptations to the proposed solution and a set of recommendations could be made.

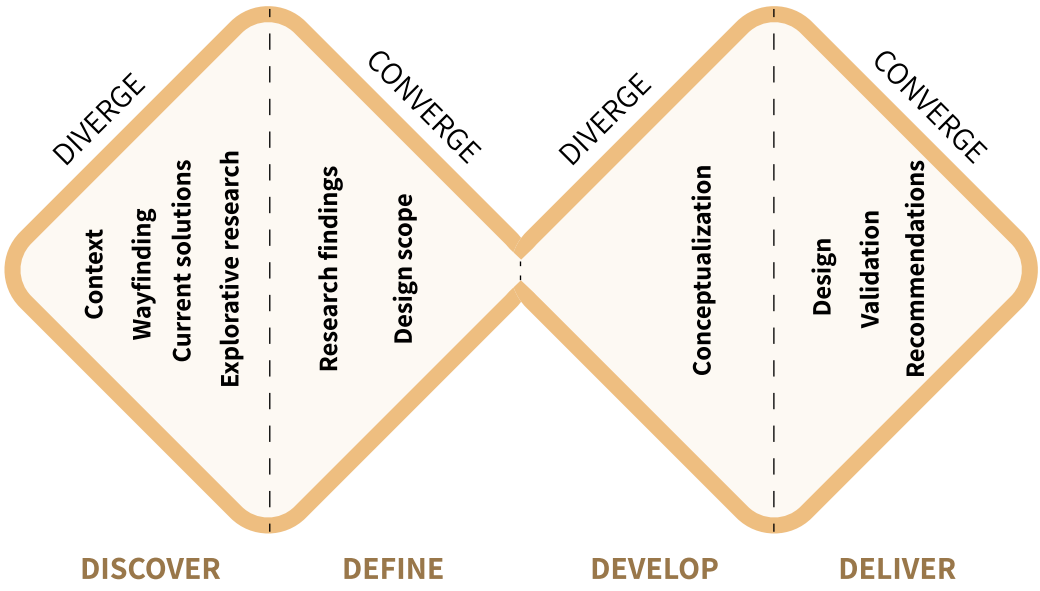


Figure 1: Double Diamond model project approach

PART 2

Context

2. Context

It took until the last of the twentieth century before dementia was considered a major public health issue. In the 1950s, dementia was seen as a condition that was part of the aging process. The discovery by David Rothschild that dementia resulted from the interaction between the brain and the psychosocial context triggered a change in this view of dementia, and more clinicians started to regard it as an actual disease (Ballenger, 2017).

A medicine that cures the disease has yet to be found. In the meantime, research on warm technology and personal care tries to improve the living conditions of people with dementia. Warm technology aims to improve the quality of life of people with dementia by supporting and enhancing human potential, social connectedness, dignity, and self-reliance (Ijsselsteijn, et al., 2020).

The research questions for this chapter are:

1. How does the disease dementia affect the daily lives of people and the world around them?
    a. How does the disease dementia progress?
    b. How does dementia impact society?
    c. How does the disease impact people with dementia?

2.1 The disease dementia

Dementia is the umbrella name for more than 50 diseases that affect the brain (Alzheimer Nederland, 2023). Out of the different forms of dementia, Alzheimer's disease is the most common, being diagnosed by 60-70% of people with dementia (World Health Organization, n.d.). Other common forms of dementia are vascular dementia, frontotemporal dementia, and dementia with Lewy bodies. Most of these forms have similar symptoms and can co-exist.

Symptoms

The translation of the Latin word dementia means de-spiriting, which refers to some of the symptoms that people with dementia experience, like mood and behavior changes (Alzheimer Nederland, 2023). Other symptoms are disorientation, memory loss, restlessness, concentration difficulties, and language problems (Alzheimer Nederland, 2023). On average, people with dementia live 6-8 years with disease and often die of other diseases that occur from the symptoms of dementia (Alzheimer Nederland, n.d.b.).

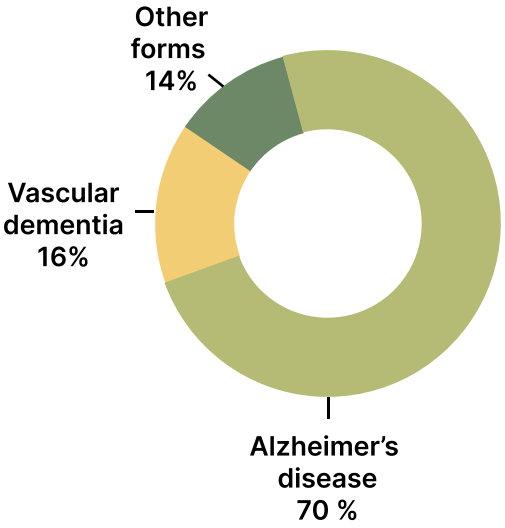


Figure 2: Most common forms of dementia (Alzheimer Nederland, n.d.a.)

Phases

The progression of the disease can differ from patient to patient. However, a pattern of decline can be seen throughout three phases (Alzheimer Nederland, n.d.c.). In this study, a product is developed that fits within the early to middle phase of dementia.

Early phase

During the early phase, small changes in behavior start to occur. A person can begin to have short-term memory difficulties, speech problems, and act egoistic or numb. The disease will impact their decision-making, planning, social and conversational skills (Alzheimer Nederland, n.d.c.). However, since these symptoms can also be accounted for other things like a burnout or heart disease, it is often hard to detect the changes in functioning and character as symptoms of dementia during this phase.

Middle phase

In the middle phase, the minor symptoms progress into symptoms that are noticeable. The person with dementia will need more help

remembering standard tasks like eating or going to the bathroom. Their memory will deteriorate faster, and they will start having difficulties remembering the names of people they see regularly. Dangerous situations can occur because of a disturbed day-night rhythm, wandering, and the misuse of appliances (Alzheimer Nederland, n.d.c.). During this phase, a higher burden will be placed on the informal caregiver, and the person with dementia could be placed in a care facility if the burden proves to be too high or if it becomes too dangerous for the person with dementia to remain living at home.

Late phase

The dependence of the person with dementia on others characterizes the late phase. The memory loss has increased to a scale where the person with dementia sometimes has brief moments of clarity but most of the time has no grasp on reality (Alzheimer Nederland, n.d.c.). Bursts of anger or sadness start to occur more often because of this. Apart from the mental decline, the person with dementia will experience physical problems with walking, eating, and incontinence (Alzheimer Nederland, n.d.c.).

2.2 Impact of the disease

Due to the aging society, dementia is expected to grow explosively. Currently, there are 48 million people suffering from dementia worldwide (which is roughly 5% of the world's elderly population). This number is expected to increase to 131 million by 2050 due to population growth and population aging (Wolters & Ikram, 2018). The rising number of people with dementia creates a massive burden on patients, caregivers, and society as a whole.

Healthcare costs

Rising dementia costs threaten the stability of our economy. The dementia cost in 2015 was estimated to be 818 billion dollars worldwide. This number is expected to rise to 2 trillion in 2030 (Prince et al., 2015). Medical care, long-term care, and unpaid care costs have been estimated to be around 700,000 dollars for a person with Alzheimer's disease after the age of 70 years. For a person who does not have Alzheimer's disease, this sum is only 250,000 dollars (Aranda et al., 2021). Most of the dementia costs can be attributed to the daily care costs for people with dementia who are institutionalized. Beside the care costs, people with dementia are also more likely to be hospitalized, require more extended hospital stays and more specialized nursing care during their rehabilitation (White et al., 2019). The overwhelming costs of dementia care have stimulated governments to make it a public health issue and activated them to prioritize research in this area (Wolters & Ikram, 2018).

Personnel shortage

The increasing number of people with dementia will lead to a higher burden on those working in the healthcare system. World Health Organisation (WHO) and the World Bank estimate that around 58 million new health and social care workers will be needed in 2030 (World Health Organization, 2017). These health workers are essential to successfully prevent, diagnose, treat, and care for people with dementia. In the Netherlands, currently 44 % of the health workers report experiencing a high or very high workload (Centraal Bureau voor de Statistiek, 2019). Administrative load, new or more complex tasks, and a lack of staff mainly cause this experience.

Burden on the informal caregivers

An informal caregiver is often a spouse, family member, or friend who takes care of the person with dementia on a daily basis (Schoenmaker et al., 2010). An informal caregiver is not professionally trained for the care activities. Caregiving for people with dementia is associated with physical, emotional, and financial burdens. The leading causes for these burdens lie in the invasive nature of the disease (Schoenmaker et al., 2010).

Dementia is invasive because it impacts both the physical and cognitive capabilities of a person. Caregivers must watch their loved ones decline through all the stages of the disease, which can feel like a series of 'mini-deaths' (Holley & Mast, 2009). Over a certain timespan they will grieve the loss of meaningful communication, emotional closeness, and loss of certain personality traits (Holley & Mast, 2009). In addition to their grief about the person's decline, the loss of personal freedom also burdens the caregiver. Moreover, caregivers can also experience isolation due to the intensity of caregiving. All these things create an exceptionally difficult situation. Therefore, it is no surprise that research found that caregivers of people with dementia suffer more often from depression, take more medication, and are in less good health than their peers (Schoenmaker et al., 2010).

The financial burden that the person with dementia and their family deals with comes from the additional costs not covered by health insurance, changes to the living environment, early withdrawals from retirement funds, and financial errors made by the person with dementia (Aranda et al., 2021). On top of this, caregivers also experience their own loss of wage and productivity and uncompensated labor because of the time spent on caregiving activities (Aranda et al., 2021). These physical, emotional, and financial burdens can eventually become too much for the caregivers and bring them to the decision of the institutionalization the person with dementia (Schoenmaker et al., 2010).

Although caregiving for people with dementia is often associated with burdens, it can also positively impact the informal caregiver. Caregiving can provide satisfaction, enjoyment, gratification, and growth (Connell et al., 2001). It gives people a vital role in the disease processes where they otherwise could have felt lost or insecure.

2.3 Living with dementia

The primary need of people with dementia living at home is to maintain the normality of their everyday life (Miranda-Castillo et al., 2013). Maintaining a lifestyle is of great importance because many activities that create a lifestyle represent a person's identity and value for others (Han et al., 2016). If people with dementia cannot participate in these activities due to the progression of the disease, they can start to feel empty and uncomfortable (Han et al., 2016).

Dementia at home

Most people with dementia are cared for at home by a family member. On a daily basis, people with dementia living at home face challenges regarding activities and domestic tasks. The quality of their daily functioning, together with the ability of caregivers to help them with their daily tasks, often determines whether they can remain home or need to be institutionalized (Wherton & Monk, 2008). Domestic activities that people with dementia struggle with are dressing, preparing food, personal hygiene, and going to the toilet (Wherton & Monk, 2008). In the early stages of the disease, the caregiver will need to remind the person with dementia of the several steps that these activities require, whereas in a later stage, they will need to actively help them with the activities.

For many people living with dementia, it is important to live at home because that is where they feel at peace and experience the most comfort (Han et al., 2016). Research by Wilkes shows that this feeling of peace extends further than people's actual homes. They found that people with dementia living in an institution with a homelike environment displayed reduced overall aggression, verbal agitation, and anxiety (Wilkes et al., 2005). Besides this feeling of home, people's home is also often related to their connection to the neighborhood, social network, and identity.

Dementia and the outdoors

Research has found that people with dementia find the ability to explore their outdoor environment a vital aspect of their life (Raynes et al., 2005). The study by Duggan (2008) discovered multiple reasons why people find this important. People mentioned going outside as an opportunity to have enjoyable informal encounters with friends and neighbors. These interactions form a source of identity and social inclusion, enlarging their feeling of belonging. Moreover, outdoor walks benefit mental health since they offer a sense of freedom and help against depressive thoughts. Multiple studies emphasize the positive impact time spent outdoors has on mental health. The study of Detweiler shows how it reduces agitation, aggression, and the use of behavioral medications (2008). Similarly, the study of Calkins found that institutionalized

people with dementia who spent more time on outdoor activities have a better sleep pattern and are less agitated (2007). Literature even indicates that outdoor exercise reduces the risk of dementia and slows the cognitive decline of elderly (Larson et al., 2006; Scherder et al., 2005; Weuve et al., 2004).

Although people can experience many positive effects from being outdoors, limited wayfinding skills caused by the disease make the outdoor area that can be covered to become smaller and smaller. Wayfinding is the process of finding your way to familiar or unfamiliar places using environmental cues (Farr et al., 2012). Confusion, declining memory, disorientation, reduced confidence, and anxiety are mentioned as factors that limit and restrict outings (Duggan et al., 2008). Moreover, unfamiliar environments or changes in the familiar environment are experienced as stressful and can cause the person with dementia to stop going outside altogether. The inability to go outside for errands significantly impacts a person's capacity to live independently. Making people with dementia more dependent on their caregivers. To change this people need to be guided in a way that makes up for their lost wayfinding abilities. However, before we can start finding solutions we need to understand how the wayfinding process of people with dementia works.

2.4 Conclusion

1. How does the disease dementia affect the daily lives of people and the world around them?

Dementia drastically changes the world of the person diagnosed with the disease and their family. It physically affects their cognitive capacities, puts a lot of new responsibilities on the caregiver, and creates a financial strain on the country.

a. How does the disease dementia progress?

Dementia progresses through three phases; early, middle, and late. The product designed in this thesis only focuses on users in the early and middle stages of dementia. People in the first two stages of the disease can often still live at home (depending on the ability of informal caregivers to help). People in these stages encounter problems with decision-making, planning, and memory, directly impacting their wayfinding ability.

b. How does dementia impact society?

Dementia is expected to grow exponentially, increasing healthcare costs and burden on healthcare workers. Therefore, reducing costs by enabling people to live at home longer has become increasingly important for governments. A product that enables people with dementia to go outside for errands independently could help them stay longer in their own homes, thereby positively affecting the institutionalization rate.

c. How does the disease impact people with dementia?

Over time domestic activities become increasingly difficult for people with dementia, and they will require more help from the caregiver. Moreover, due to decreased wayfinding skills, people with dementia become more isolated and confined to their homes. Living at home and going outdoors is very important for people with dementia since it gives them a feeling of peace and allows them to maintain a connection to their social network. Additionally, spending time outdoors is also proven to have positive health effects on seniors making it extra important that people with dementia can safely go outdoors.

PART 3

Wayfinding

3. Wayfinding

Wayfinding is the process of finding your way to familiar or unfamiliar places using environmental cues. The general process of wayfinding involves decision-making, decision execution, and information processing (Farr et al., 2012). All these tasks are things that people with dementia struggle with due to their disease.

The research questions for this chapter are:

2. What challenges do people with dementia face when they independently visit places?
    a. What is wayfinding?
    b. How are people with dementia affected in their wayfinding capabilities?
    c. How do people with dementia use wayfinding strategies?
    d. What are the barriers that restrict people with dementia from wayfinding?

3.1 Wayfinding with dementia

Symptoms that directly influence the wayfinding abilities of people with dementia are spatial disorientation, memory impairment, loss of planning abilities, diminished ability to adapt to environmental stress, and restlessness (Marquardt, 2011). Most of these symptoms already start within the early phase and progress throughout the disease (Pai & Jacobs, 2004). Therefore, wayfinding is a struggle that people must deal with during their whole dementia journey.

4 steps of wayfinding

In 1973 Downs and Stea proposed a 4-step process that breaks down the principles of wayfinding.

1. **Orientation**: finding out where you are concerning nearby landmarks and the required destination
2. **Route selection**: choosing a route that will lead to the desired destination
3. **Route control**: confirmation that you are following the selected route
4. **Recognition of destination**: realizing that you have reached the desired destination

Other models, like the one of Brush and Calkins (2008), that analyze the wayfinding process also come down to these four steps. The ability to successfully complete the 4-steps of wayfinding depends on a person's individual characteristics, their age, gender, cognitive development, perceptual capability, spatial ability, and mental and physical conditions (Kikiras et al., 2009). The environment also impacts people's wayfinding ability by stimulating and assisting a person in their sense of orientation and direction, for example, by using signs or luminosity (Farr et al., 2012).

Spatial disorientation

As mentioned before, spatial orientation is an integral part of wayfinding. Spatial orientation is the ability of a person to form a cognitive map of their surroundings. Forming a cognitive map involves acquiring, coding, storing, recalling, and manipulating information about the spatial environment (Farr et al., 2012). Spatial orientation is needed to identify the most efficient route to bring you from your current location to your destination.

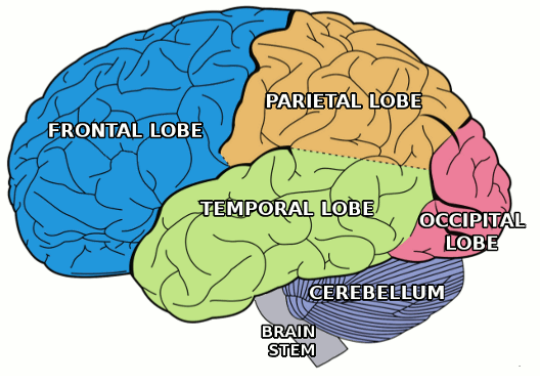


Figure 3: Anatomy of the brain (Anatomy Info, n.d.)

Spatial disorientation is linked to the degeneration of the temporal and parietal brain regions (Tu et al., 2015) (see Figure 3). A vital function of the temporal lobe is the conscious processing of memories related to facts

and events (Squire et al., 2004). The parietal lobe processes sensory information and plays a key role in location awareness, making the medial temporal and the parietal lobe crucial for wayfinding (Cleveland Clinic, 2023). Overall spatial disorientation plays a role in most forms of dementia. However, research has found that these regions in the brain are particularly affected by Alzheimer's disease (Tu et al., 2015). Initially, a disorder in spatial orientation can make it difficult for people to find their directions in unfamiliar environments. Later, this will also extend to familiar environments (Monacelli et al., 2003).

Environmental cues

The environment gives cues that aid in wayfinding. According to Lynch, the built environment can be divided into paths, edges, districts, nodes, and landmarks (see Figure 4) (1960). These different environmental elements give information about how to move across the built environment. Out of these elements, especially landmarks, play an essential role in the tasks of wayfinding.

Landmarks

Research found that landmarks are important for older people and people with dementia to successfully navigate their environment (Mitchel et al., 2004; Sheehan et al., 2006). A landmark is a feature in the environment used to identify a location and guide navigation (O'Malley et al., 2017). Landmarks can have five functionalities depending on the context of the navigation tasks (O'Malley et al., 2017).

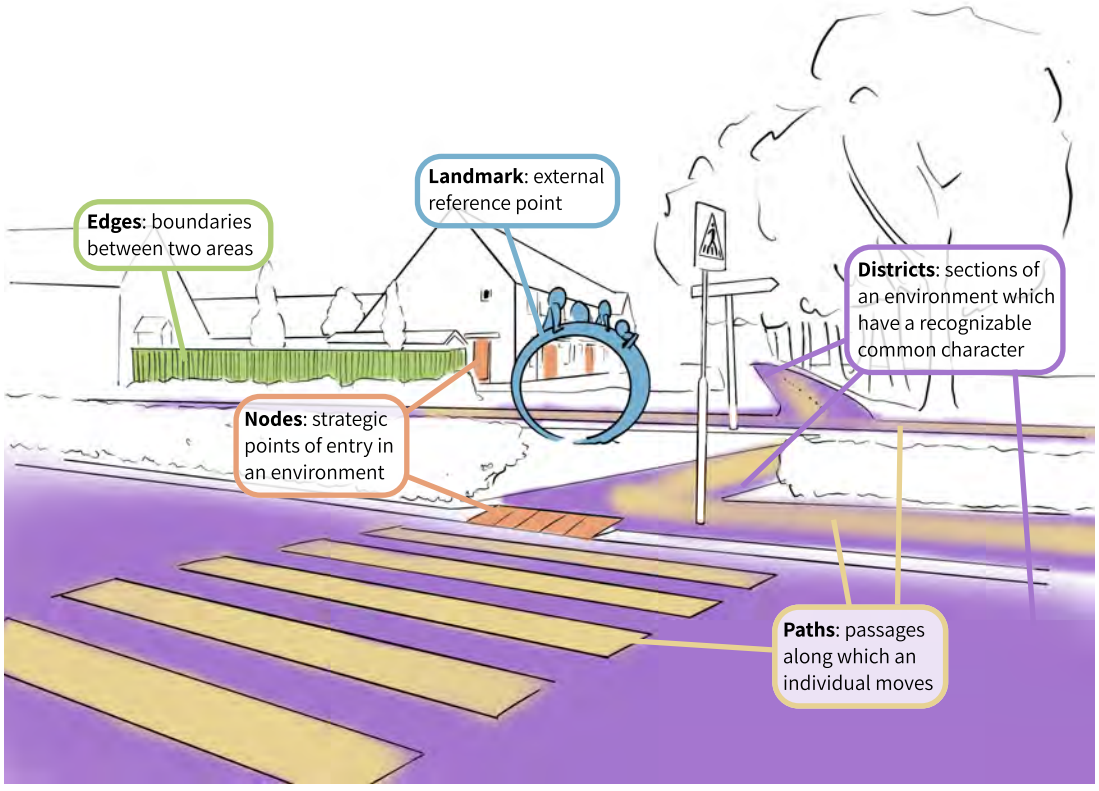


Figure 4: Environmental cues

1. **Landmarks as beacons**: Landmark beacons are landmarks positioned close to the destination. These landmarks have been proven effective for long and complex navigation routes because they lead people close to their goals (Waller & Lippa, 2007).
2. **Landmarks as orientation cues**: These global landmarks are often prominent, making them visible from a distance. They function as a compass because people can use them to reorient themselves (O'Malley et al., 2017).
3. **Landmarks as associative cues**: Associative cues are landmarks positioned at navigational decision points on familiar routes and trigger a correct navigation response when recognized (Waller & Lippa, 2007).
4. **Landmarks for recognition**: This is the most fundamental function of a landmark. It helps people orientate themselves in the environment (O'Malley et al., 2017).
5. **Landmarks for cognitive mapping**: Landmarks are the reference points for forming cognitive maps of the environment (O'Malley et al., 2017).

All five functionalities in landmarks can be used during the wayfinding process; however, which type of landmark you prefer is different across gender. Men are found to use landmarks as orientation cues more often, while women tend to focus on associative cues for wayfinding (Lawton, 2010). Moreover, people with dementia use landmarks differently from people without dementia. Sheehan found that people with dementia are more consciously aware of landmarks, whereas people without dementia use them automatically (2006). Not all features in the built environment function as landmarks. For a feature to be a landmark, it has to be memorable, salient, and distinguishable from the environment (Klippel & Winter, 2005). Landmarks are vital for wayfinding; however, having too many features in the environment that can function as landmarks can result in information clutter, which negatively impacts wayfinding (Marquardt, 2011).

Signs

Signs and maps in the built environment are wayfinding devices that provide information about orientation, direction, and connectivity between locations (Lynch, 1960). There are three types of signs.

- **Directional signs**: direct people to a destination (Farr et al., 2012).
- **Identification signs**: identify an object, place, or event (Farr et al., 2012).
- **Reassurance signs**: confirm whether a person is going in the right direction (Farr et al., 2012).

Sheehan found that people with dementia used road signs in wayfinding, just like people without dementia (2006). Therefore, the study mentions signage as a promising solution to help people with dementia with wayfinding. Signs are already used in care homes for people with dementia to identify common areas (Marquardt, 2011).

Wayfinding strategies

The most frequently used strategy by people with dementia for wayfinding uses landmarks as features to find the destination and get confirmation while following the route (Marquez et al., 2017). This memory-based technique, however, can often lead to difficulties due to the memory impairment that people with dementia have. The study by Olsson found that other strategies are focused on senses, repetition, or asking directions (2021). People mentioned following the sound of the railway and the smell of trees to find their destination. The research by Marquez showed that most seniors ask for help to select the route to their destination (2017). Some seniors also use maps to look up directions, but only a few use a navigation app on their phones to find directions (Marquez, 2017).

Wayfinding barriers

Many elements can help people with wayfinding, but there are also barriers to wayfinding. The study of Marquez identified a lack of familiarity, difficulty in judging distances, not knowing when the destination is reached, and not finding a trustworthy stranger to ask for help as a barrier (Marquez et al., 2017). Similar to these findings, in the study of Duggan, people with dementia mentioned that they felt safe and comfortable in familiar places but would become confused and stressed in unfamiliar places (2008). The unfamiliarity of new places can cause people to restrict themselves to only walking familiar routes or routes they can walk to and back from with the same route as if they are walking in a loop (Olsson et al., 2021).

3.2 Conclusion

2. What challenges do people with dementia face when they independently visit places?

The cognitive decline of people with dementia increases stress and confusion when navigating outdoors.

a. What is wayfinding?

Wayfinding is the process of finding your way to familiar or unfamiliar places using cues from the environment. This process includes orientation, route selection, route control, and destination recognition.

b. How are people with dementia affected in their wayfinding capabilities?

Symptoms of dementia are spatial disorientation, memory impairment, loss of planning abilities, diminished ability to adapt to environmental stress and restlessness. These symptoms make wayfinding challenging for a person with dementia. Especially spatial disorientation has a considerable impact on a person's wayfinding skills because this affects their ability to form a cognitive map of the environment, which is needed to identify routes.

c. How do people with dementia use wayfinding strategies?

Landmarks are most frequently used for wayfinding by people with dementia. Landmarks can help by giving directions, orientation, or triggering a navigation response. Researchers see landmarks and signs as main opportunities to aid wayfinding for people with dementia. Enhancing landmarks or providing triggers that help people with dementia use this memory-based strategy could help them with wayfinding.

d. What are the barriers that restrict people with dementia from wayfinding?

Barriers to exploring/visiting new places are the need for familiarity, difficulty judging distances, not knowing when the destination is reached, and lack of familiar landmarks. Loud sounds, pressure from other pedestrians, and the possibility of asking a stranger for help are seen as barriers in familiar and unfamiliar environments. A product that minimizes these barriers can cause people with dementia to extend the outdoor areas that they visit.

PART 4

Current solutions

4. Current solutions

Various products aim to make the outside world more accessible for people with dementia, ranging from tracking sensors to compasses. Tracking and navigation products are analyzed to show where these products conflict and where these products meet the needs of people with dementia and their informal caregivers. This analysis provides an overview of how a new product can separate itself from the existing competition.

The research questions for this chapter are:

3. What can we learn from the current tracking and navigation devices?
    a. What are the unique selling points of tracking and navigation devices?
    b. What product features of a tracking or navigation device conflict with the needs of the user?
    c. What opportunities can a new product address that the current tracking and navigation devices do not handle?

4.1 Tracking devices

Tracking devices use technology to monitor where the person with dementia is. These products help the caregiver keep track of the safety and security of the person with dementia, which has a reassuring effect on the caregiver (Rialle et al., 2008). The main benefit for the person with dementia is that these systems allow them to go outside independently with the reassurance that their caregiver can find them if something happens (Olsson et al., 2012). However, there are also downsides to these systems, like lack of privacy and stigmatization.

Functionality

There are a lot of different versions of tracking devices that are used in home and institutionalized settings. Most of these devices are similar in functionality but have different aesthetics. All trackers must be carried by the person with dementia when he/she goes outside. Global Positioning System (GPS) technology is often used to determine the location of the wearer of the tracker. This location can be viewed through an online application only by the caregiver, allowing them to see the real-life location of the person with dementia at all times. Most systems use geofencing to set a specific area (safe zone) where the person with dementia can wander around without alerting the caregiver. Once the person with dementia leaves this area, a notification is sent to the caregiver, making them aware of the places the person with dementia visits outside the safe zone. Some devices have an emergency button that can be pressed by the person with dementia when he/she falls, gets lost, or wants to contact their caregiver. The emergency button sends a message to a selection of contacts of the person with dementia or sets up a voice call connection between the person with dementia and their caregiver.

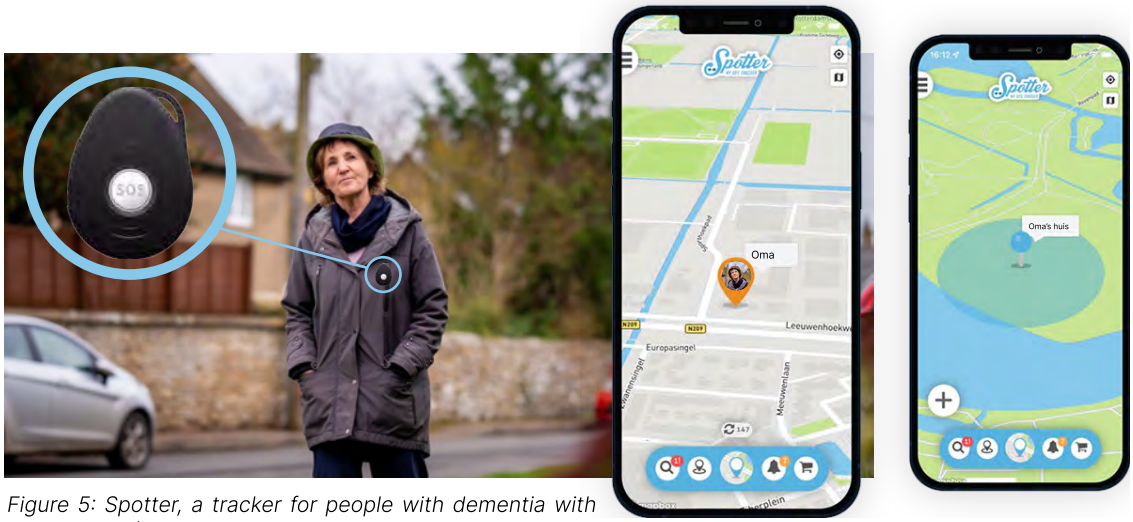


Figure 5: Spotter, a tracker for people with dementia with its interface (Spotter, n.d.).

Passive users

Tracking devices are great for tracking down a person with dementia. However, in doing this, they reduce the person with dementia to an object that needs to be tracked, like a lost phone. The current devices offer no information to the person with dementia about their whereabouts or how they can navigate to the place they want to reach (Dahl & Holbø, 2012a). Therefore these products always require a second person to come and help the person with dementia.

Privacy

Tracking devices infringe on privacy and human dignity due to their need for minute-by-minute monitoring of a person with dementia (Dahl & Holbø, 2012b). Multiple studies show a need from informal and professional caregivers for a sensitive approach in handling location information by only providing selective information about the whereabouts of the person with dementia (Dahl & Holbø, 2012a, 2012b; Wan et al., 2014). This need comes from the wish to protect the privacy of the person with dementia or to protect the caregiver from unnecessary anxiety. Unfortunately, current tracking devices monitor the location of the user 24/7. Therefore, tracking devices align with the old care regime of control and restraint instead of the new form of person-centered care.

Stigmatization

Tracking devices are also used for monitoring animals or criminals, which can create a stigmatizing image of the product (Dahl & Holbø, 2012b).

Product analysis

Spotter GPS Tracker

99,95

AUTONOMOUS Enable the user to find their way to a location without the intervention of a second party.	✗
ADAPTABILITY The ability to adapt the product to the different needs and wishes of the user.	✗
STIMULATING Stimulate the user to use their skills and thinking.	✗
INTERACTIVE The user can interact with the product.	✓
PORTABILITY The product can be easily carried around.	✓
FORGETTABILITY The product is not forgotten by the user when going outdoor.	✗

Additionally, the user can see the tracking device as a visual reminder of their decline and need for assistance in basic activities (Dahl & Holbø, 2012b). How people feel about tracking devices, however, differs a lot from person to person. In the study of Dahl & Holbø, participants who lived in a care home expressed pride and gratitude when they got to wear the tracker, while in another study by these researchers, a participant mentioned that he felt spied on (Dahl & Holbø, 2012a, 2012b). The execution of the product will likely influence whether people find the product stigmatizing.

			
LifeWatcher Senior 129,95	**Life360** 4,99 p/m premium version	**Smart Sole** 279,- +29,- p/m abonnement	**Smartstick**
✗	✗	✗	✗
✗	✗	✗	✗
✗	✗	✗	✗
✓	✓	✗	✗
✓	✓	✓	✓
✗	✗	✓	✓

Table 1: Product analysis map showing five different versions of tracking devices.

Product analysis

Nineteen tracking devices were analyzed to understand the different features of this product category. The complete overview of this product analysis can be found in Appendix A. A selection from the complete product analysis is presented in Table 1. The requirements for scoring the products were defined during initial research by both the researcher and Tover. The first three products are the most popular according to user reviews and dementia forums. These devices are all designed for seniors.

Main insights

- Autonomous: A second person is needed to guide the user to the correct location for all products.
- Adaptability: The products do not offer the option to save preferences regarding notifications.
- Stimulating: The person with dementia is a passive user in all the tracking devices
- Interactive: The first three trackers have an emergency button that the user can press
- Portability: All products can easily be carried by someone with dementia.
- Forgettability: The last two trackers are integrated into a product that the user needs to take with him/her when going outdoors.

4.2 Navigation devices

Navigation devices can strengthen the confidence of a person with dementia and allow them to visit places independently. Although there are many tracking devices for people with dementia, only a few navigation devices are designed for this target. All of these navigation devices are part of research studies. Therefore, a selection of navigation prototypes from studies will be discussed, as well as a selection of commercial navigation devices designed. Since these products differ significantly in their functioning, they will be discussed separately.

RESEARCH PRODUCTS

Homing compass

The homing compass is a navigation device that always directs the user toward home. A person with dementia must follow the arrow, like a compass, to find their home. The researchers who created this product wanted to keep the navigation system very simple. During a usability test with the product, they found that the lack of context information could be confusing. Moreover, the device sometimes would point in a direction impossible to follow. In these moments, the user has to decide which path to take, which puts pressure on the user. Although the device can create some struggles, all eight participants were able to find their way home when they used the compass. (De Jong & Brankaert, 2015)

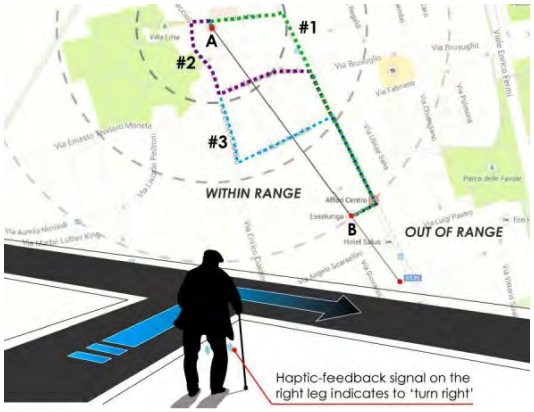


Figure 7: Wearable haptic-feedback navigation (Rosalam et al., 2020)

Figure 6: Homing compass (De Jong & Brankaert, 2015)

Wearable haptic-feedback navigation

This device gives people information about whether they need to turn left or right to reach a destination. The device is worn around the waist and gives vibrations at the left or right waist side of the user to indicate the left or right direction. The researcher's main reason for using haptic feedback was that they wanted to create a navigational system that seniors with dementia with visual or auditory difficulties could use. The navigational assistance is kept very simple by only giving directional information, making it easy to

Figure 8: Automated wayfinding system (Liu et al., 2009)

understand. However, results from the study with six participants showed that besides haptic feedback, auditory or visual feedback should also be provided. Moreover, the prototype proved to have a high learning curve due to its unfamiliarity to the users. (Rosalam et al., 2020)

Automated wayfinding system

This system uses path planning techniques to determine the best route and guides the users using landmarks and arrows on photos to their destination. The system automatically selects the photos based on popular online photos of the location points. Therefore, the system is very easy to use and requires little preparation. In this study, participants with cognitive impairments from the ages 21-49 used the device for wayfinding. They preferred using this device over standard navigation apps because of the images that this system showed. Moreover, it was seen as a great tool that could help them explore new cities. In the study, the researchers found that a navigation device needs to be adaptable to the different needs of users. Some people prefer to navigate with landmarks, while others prefer arrows. Additionally, it can be challenging for users to find specific landmarks if the photo of the landmark does not match the reality due to weather conditions of different approach angles. However, all seven participants were able to find their destination with this device. (Liu et al., 2009)

Figure 9: HAIZE (Onomo, n.d.)

COMMERCIAL PRODUCTS

HAIZE

HAIZE is a commercial navigation device for urban cyclists. It has a very minimalistic and simple design, making it easy for users to understand the product. The product has two dots that

guide the navigation; the blue dot gives the direction toward the destination, and the green dot shows an approximation of the distance from the destination. The device functions like a compass, with the blue dot always pointing toward the final destination. A mobile application is used to upload the destination on the navigation system. Although the system is straightforward, the mobile application used to instruct the system can be pretty complex, especially for people with dementia. Moreover, the same problems of the Homing compass apply here. (Onomo, n.d.)

Figure 10: Sightguide (Blindsight Mobility, 2021)

Sightguide

Sightguide is the electronic alternative for a guide dog. It helps people with visual impairments maneuver past obstacles and safely reach their destination. Standard routes can be uploaded through a mobile application to the product. The sight guide will then search for the most blind-friendly route and take the user along the route. All the user has to do is follow the product. Additionally, the product is also aware of the safety issues. Although this product is not designed for people with dementia, its simplicity and safety do meet some of the criteria that a navigation product for people with dementia needs to have. However, since it is a verily large and noticeable product, users can perceive it as stigmatizing. (Blindsight Mobility, 2021)

Product analysis

Homing compass

AUTONOMOUS Enable the user to find their way to a location without the intervention of a second party.	✓
ADAPTABILITY The ability to adapt the product to the different needs and wishes of the user.	✗
STIMULATING Stimulate the user to use their skills and thinking.	✓
INTERACTIVE The user can interact with the product.	✗
PORTABILITY The product can be easily carried around.	✓
FORGETTABILITY The product is not forgotten by the user when going outdoor.	✗

Product analysis

Similarly, as with the tracking devices, these five products were analyzed to understand the different features of this product category (see Table 2). Out of the five, the first two devices are designed for people with dementia.

			
Wearable haptic-feedback navigation	**Automated wayfinding system**	**HAIZE** 83,75	**Sightguide**
✓	✓	✓	✓
✗	✓	✗	✗
✗	✓	✓	✗
✗	✓	✗	✗
✓	✓	✓	✓
✗	✗	✗	✗

Table 2: Product analysis map showing 5 different versions of tracking devices.

Main insights

- Autonomous: All products are designed to be used independently by the user.
- Adaptability: The Automated wayfinding system is customizable because it offers multiple ways of navigation. The other devices do not consider the different wayfinding needs of users.
- Stimulating: Both the Homing compass and HAIZE rely on the user's decision making skills to reach their destination. These products offer a sense of direction instead of specific navigation cues.
- Interactive: All products automatically react to the location changes of the users. However, only the Automated wayfinding system has a help button with which the users can interact when they do not understand the navigation cues.
- Portability: All products can easily be carried by someone with dementia.
- Forgettability: All products will need additional features that attract the attention of the user when going outside, because they are currently not part of the things people with dementia take with them when going outside.

4.3 Conclusion

3. What can we learn from the current tracking and navigation devices?
Both types of devices deal with the consequences of dementia (getting lost) and try to impact the quality of life of people with dementia positively. Tracking devices mainly try to do this by reassuring the informal caregiver and the person with dementia, while navigation devices try to broaden the independence and confidence of people with dementia.

a. What are the unique selling points of tracking and navigation devices?
Tracking devices give through GPS monitoring and the emergency button people with dementia the reassurance that their caregiver can always find them if something happens. This helps caregivers trust their loved ones to go outside independently. Navigation devices help people with dementia become less dependent on their caregivers in their wayfinding abilities. These devices enable people with dementia to individually go to activities they otherwise would not be able to reach.

b. What product features of a tracking or navigation device conflict with the needs of the user?
People with dementia that use tracking devices are passive users of the product. Moreover, tracking devices do not consider the user's privacy when gathering data, which can give users the feeling that they are spied on. Additionally, tracking devices can be seen as stigmatizing due to their image as a monitoring device. Navigation devices not designed for people with dementia are too complex, while navigation devices designed for people with dementia provide too little environmental information, like landmarks, that can guide them in wayfinding.

c. What opportunities can a new product address that the current tracking and navigation devices do not address?
A combination of the reassurance that tracking devices offer and the independence that navigation devices provide would result in a product that helps people with dementia maintain their daily life while giving the informal caregiver the trust to allow the person with dementia to participate in their daily activities. Furthermore, both product types show room for improvement in adaptability, stimulation, and interactiveness.

PART 5

Explorative research

5. Explorative research

The literature review gave a lot of insight into how wayfinding works and is used by people with dementia. To deepen this understanding with the personal experiences of people an explorative research is carried out.

The research questions for this chapter are:

4. What are the experiences of people with dementia when they independently visit places?
    a. What do the daily mobility actions of a person with dementia look like?
    b. What barriers do people with dementia encounter while independently navigating?
    c. How would people with dementia benefit from a device that offers wayfinding help?

5.1 Research method

This research aims to understand the past, present and future experiences of people with dementia when they independently visit places. By understanding the experiences, opportunities could be identified to improve the experiences. The research questions for this explorative research are investigated through workshops, walks, and interviews with people with dementia.

Context mapping

To research the experiences, needs, and context of people with dementia regarding independent wayfinding context mapping, a generative research method, was used. In context mapping, generative techniques allow participants to explain their thoughts through making/creating (Sanders & Stappers, 2016). This helps participants share deeper emotions and thoughts they might not have been aware of. The participants are viewed as the experts. Typical qualitative research techniques like interviews often only reach the surface of what people think. However, combining them with generative activities makes participants more inclined to explain their dreams and emotions (Sanders & Stappers, 2012).

Workshops

The workshops were held at meeting centers for people with dementia; the VIEF groep in Houten and Molenschot in Soest. These meeting centers are places where people with dementia who still live at home come up to three times a week to participate in activities with peers. The workshops aimed to learn from the participants what their positive and negative experiences are with independently visiting places. All participants were asked to make a collage that showed their negative and positive experiences. Participants could express this by putting pictures in (positive) or outside (negative) a circle on an A3 paper. When the participants were making their collages, the researcher walked around and asked questions about the collages. At the end of the activity, every participant had to present their collage and explain their thought process behind it. See Appendix B for the workshop and interview guide.

The groups for the workshops consisted of 5 and 6 people (total of 11 participants). The meeting center's group supervisor was always present during the workshop and actively participated in the collage-making activity.

Walking

The researcher joined an afternoon walk with a group of people who have dementia from the King Arthur Group in Utrecht. Together with 3 group supervisors and 12 people with dementia, the researcher went to a forest for a 5 km walk. The goal of

joining the walk was to talk with people who have dementia about their experiences of independently walking in their neighborhoods. The researcher could have one-on-one conversations with 5 people with dementia in a neutral environment. Walking while talking helped people with dementia to talk freely without feeling stressed or pressured.

This group consisted of people aged 54 to 78 in the early to middle stage of dementia. Everyone in the group was very mobile.

Interviews

Four interviews were conducted with people with dementia and their caregivers. The goal of these interviews was to understand the experiences, emotions, and thoughts of people with dementia when they independently visit places. The interview questions focused on barriers to outdoor wayfinding, getting lost, and products currently used in wayfinding.

The participants were sent a sensitizing booklet covering the research questions' main topics. The booklet can be seen in Appendix C. The sensitizing booklet proved very helpful because it took the pressure to perform off the participants. Especially people with dementia can have problems answering questions in the moment. Moreover, using a sensitizing booklet aligns with the context mapping method because it allows the participants to share their explicit knowledge before the interview.

At the end of the interview, the people with dementia were asked to prioritize elements they needed to independently visit places on a canvas (see Figure 13). This generative exercise showed what the main functionalities of the product need to be. Additionally, it gave some interesting insights about what information of the person's whereabouts should be shared with their caregivers.

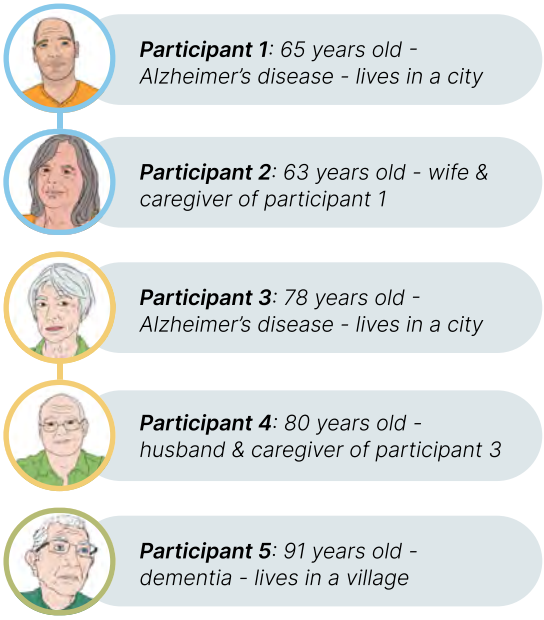


Figure 11: Overview of the characteristics of the interviewees.

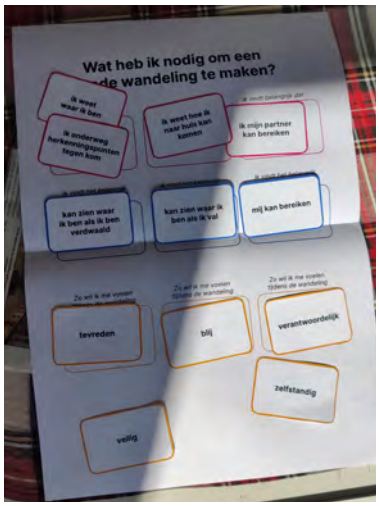


Figure 12: Overview of the characteristics of the interviewees.

5.2 Research findings

The research findings give form to what a navigation device for people with dementia would look like. The findings accomplish this by answering the research questions; how do the daily mobility actions of a person with dementia look like, how would people with dementia benefit from a device that offers wayfinding help, and what barriers do people with dementia encounter while independently navigating?

Means of transport

The mobility capabilities of people differ per person. Older people with dementia can experience more difficulty walking or cycling due to age-related health problems. However, some seniors do not have these problems. Walking and cycling were mentioned as the most frequent ways of transportation. People also mentioned public transport; however, using it was often together with the caregiver. If people independently used public transport, they went on a simple train track where they only needed to access and enter the train at the right station. One participant used a mobility scooter to visit places independently. Only one participant, aged 54, could still drive independently, but all the other participants were not allowed to drive a car due to the decline of their disease. Some male participants expressed sadness about their inability to drive a car.

Therefore, for the product to be effective, it will need to be used when walking or cycling since these are the two most used ways of transport.

> *"I am not allowed to drive anymore and I cannot cycle because of my health so the mobility scooter was my only option to go to places by myself."*
> ***84 year old male with dementia***

Travel range

A typical week for people with dementia is very structured and exists out of activities related to their interests and activities organized by meeting centers for people with dementia. Participants mentioned that they went to the meeting center up to three days a week. People without an extensive social network would go more often to meeting center activities to overcome their loneliness. In comparison, people with a retired spouse who was their primary caregiver would go fewer days. Other activities that participants mentioned were part of their routine are; watching over the grandchildren, attending piano lessons, singing in a choir, shopping at the market, and working in an allotment garden.

Since these activities are part of their routine, they would individually travel to them. The risk of getting lost on these

routes is lower. However, several participants still mentioned getting lost on routes they often use due to environmental changes or because they experienced a moment of disorientation.

"The last time my husband got lost he was just a few blocks away from our house."
Participant 2

There was a division between the participants, with some who had no desire to discover new routes and places and some who had. The participants that expressed the desire to be able to visit places wanted to travel to meaningful places which currently were out of reach for them. One participant mentioned that he used to go to his mother's birthplace when she was still alive. Now he tries to go there on his mobility scooter, but it is 12 km away from his home. Another participant mentioned that he could not visit his son without his wife because he lives in a busy part of another city.

"I always take new routes when I am cycling. Taking new routes brings you to new places."
79 year old male with dementia

"I am not curious. I am happy when I have safely arrived at my destination. Following a familair route makes me feel relaxed."
Participant 3

Based on these insights, a navigation system should accommodate the travel needs for frequent and infrequent visits. The assistance on routine visits will need to focus on giving confirmation and suggestions when a person is unsure of their direction. At the same time, the assistance on infrequent trips should be extensive and provide a step-by-step process that guides the user from their location to their exact destination. The approach to assist the user in wayfinding should be able to change over time, making it possible for infrequently visited routes to become frequent routes over time and vice versa. Depending on the learning/ memory loss changes of the person with dementia.

Wayfinding strategies

In Chapter 3.1, we already touched upon this topic. However, the explorative research showed new and more in-depth information surrounding the different strategies that people with dementia use to navigate. Similar to the findings of the literature study, landmarks, repetition, and asking directions were identified by the participants as wayfinding strategies. Participants mentioned that they were explicitly looking for landmarks on routes because the landmarks would give them confirmation that they were going in the right direction. One participant even explained that he gave names to the landmarks, which helped him remember them.

"When I go for a walk I am very aware of where I am. That helps me find points that I recognize so that I can find my way back."
74 year old female with dementia

On the way to the KOPgroep there is a pond, actually two ponds, both look the same, which is why I call it the double pond. That is a landmark. It lets me know I've walked there many times before. I know that I am going in the right direction. So I recognize a lot of what I see on the road and sometimes I give it a name.
Participant 1

All participants walked or cycled routes multiple times with their caregiver before independently traveling. In doing this, the participants mentioned that they were able to learn the road and find landmarks that they could remember. Participants only asked for directions when they got lost. This strategy, however, would not always help the participants since they often did not know the address of their destination, or the people they asked for help would not know the directions to the destination. Two participants explained coping with this by asking for general directions to known locations like the city center.

Participants also mentioned calling their partners to find the right direction. Together with their partner, they then had to figure out by looking for street names what their location was. Calling a partner is seen as less of a hurdle than asking a stranger on the street for directions. Moreover, knowing that you can call your partner has a reassuring effect on the person with dementia.

Although the literature stated that seniors use maps and navigation apps for wayfinding. The explorative research showed that maps and navigation apps are too abstract and complex for people with dementia to understand. Moreover in order to know how to use a map or navigation app users need to know the address of their destination which is often something they do not remember or can easily search for.

Lastly the strategy to walk around until you see something familiar was also mentioned. Participants 3 used this strategy when she lost her husband. Fortunately she and her husband were able to find each other by accident, however, this strategy can be dangerous if the person with dementia is not found or does not encounter familiar surroundings.

Based on these insights about the different strategies that people with dementia use it becomes clear that a navigation device should function as a guide that requires minimal interaction of the person with dementia to bring them to familiar points. Additionally it should help the user to ask for help from strangers or their caregiver if they feel unable to use the navigation in for example stressful situations.

STRATEGIES	LITERATURE RESEARCH	EXPLORATIVE RESEARCH
Landmarks	X	X
Senses (smell & sound)	X	
Repetition	X	X
Asking directions	X	X
Call partner		X
Maps	X	
Navigation app	X	
Look for familiar surroundings		X

Table 3: Table that gives an comparison between the strategies found in literature and the explorative research.

Wayfinding barriers

The barriers for Chapter 3.1 were confirmed in the explorative research. However, the interviews and workshops also uncovered a new set of obstacles. Changing weather conditions like rain and navigating at night were the most mentioned barriers for wayfinding. These two barriers alter how the environment looks and offer extra stimuli, which can be stressful and confusing. Similarly, a repetitive environment was seen as a barrier because it made it harder to find a distinguishable landmark from the environment.

> *"I used to be afraid of walking in the forest. All trees look the same, which makes it easy to get lost."*
> ***68 year old female with dementia***

Unexpected changes to a route were also seen as a barrier that can be confusing. Participant 1 always independently goes to his piano lessons. However, due to a closed bridge, he and his wife had to practice going with a different route. After sufficient practice, participant 1 went to his piano lesson alone. Unfortunately, he could not find the correct house because he was used to counting the houses. Counting houses no longer worked because the new route brought him into the street from a different side.

There were also barriers voiced that addressed a specific phase in wayfinding. When planning to go somewhere, not knowing the address of the destination can be a barrier. This barrier is also present when people with dementia get lost and want to ask for directions. Another obstacle in the planning phase is that someone has not gone outside independently for a long time. The sporadicity of the task can make visiting places alone seem and feel extra challenging. Participant 5 mentioned his family as a barrier to independent going outside because they did not feel it was safe for him and therefore asked him not to. A barrier when reaching a destination can be the number of actions needed to arrive at the destination's front door.

These findings show several opportunities for a navigation device to aid a person in preparation, during, and at the arrival point of the wayfinding process.

BARRIERS	LITERATURE RESEARCH	EXPLORATIVE RESEARCH
Route unfamiliarity	X	X
Lack of (good) landmarks	X	X
Loud sounds	X	X
Pressure from pedestrians	X	X
Changing weather conditions		X
Nigh time		X
Repetitive environment		X
Unexpected route changes		X
Not knowing the address		X
Not going outside regularly		X
Family		X
Complex navigation steps		X

Table 4: Table that gives an comparison between the barriers found in literature and the explorative research.

Control over wayfinding

A navigation device can give independence to the person with

dementia and the caregiver. As with Participant 2, some caregivers still have a job, making it impossible for the person with dementia to depend on them completely. Therefore they have to be able to visit places independently.

"I don't have time to be with him all the time either. I still work normally. The idea is that you (person with dementia) can do all things independently for as long as possible."
Participant 2

Moreover, participants mentioned that they try to maintain the things they can still do to keep as much control over their own lives as possible. Participants were willing to use products like an app with a tracker, a watch with a tracker, a walker, or a mobility scooter to keep their independence. However, participants also mentioned that although they are willing to use devices that can help them, these devices should not be considered controlling as this can make them feel dependent on the device. Therefore the product should be seen as something that gives the freedom to the user to follow their path and offer assistance when there is a need for help.

"I think it is important to express my own thoughts. So that not everyone can interfere with what I do or don't want. I don't want to lose control of my household and myself"
Participant 3

Location tracking

The caregivers mentioned that the ability to track their loved one was reassuring for them because it allows them to know without being there if their loved one is lost or needs help. Similarly, people with dementia mentioned that tracking devices give them the certainty that they can immediately ask for help if needed. However, one participant felt spied on when wearing the tracker. Sometimes, the benefits outweigh the privacy issues of tracking someone's location. How people feel about being tracked depends a lot on the relationship that the person has with the person who can see their location.

People with dementia mentioned that they only needed their partner to see their location when lost or fallen. Participant 1 mentioned that he and his wife use a tracker until he feels he knows the route. After that, they only use the tracker again for that route if he gets lost while trying to reach the destination. Participant 1 and Participant 3 found it not necessary for their spouse to see whether or not they had arrived at their destination. Similarly, Participant 2 mentioned that she only watched the tracker until her husband had passed the route's complex parts. For the product to be mindful of the tracking needs of the person with dementia and the caregiver, it must be flexible and provide selective information about the person with dementia's whereabouts.

5.3 Conclusion

4. What are the experiences of people with dementia when they independently visit places?

People with dementia enjoy visiting places and maintaining their everyday lives. However, because of the disease, they can lose confidence in their wayfinding skills, because of situations in which they got lost and had to ask for help. For some people, these bad wayfinding experiences can lead to a decrease in their travel range.

a. What do the daily mobility actions of a person with dementia look like?

It depends a lot per person on how mobile someone with dementia is. The most mentioned travel methods are walking or cycling. Some people can still use public transport. However, the route needs to be familiar and straightforward. The places that people with dementia travel to independently are always familiar. There are people who also want to travel to less frequently visited places that are meaningful for them. However, they will need support from their caregiver to get to these places. A navigation product should therefore allow people with dementia to travel by bicycle or on foot to frequent and infrequently visited places.

b. What barriers do people with dementia encounter while independently navigating?

There are many barriers, from changing weather conditions to family members. Most barriers offer the opportunity to simplify the wayfinding process either by taking steps away from the person with dementia or by highlighting the information that the person with dementia needs. However, the barriers can only be removed if the person with dementia feels safe and trusts that the device will help them find their destination.

c. How would people with dementia benefit from a device that offers wayfinding help?

A device that provides help with wayfinding can give independence to the person with dementia and more freedom to their caregiver. Furthermore, it could stimulate people afraid of independently visiting places to gain self-confidence. However, the wayfinding device must not become controlling and only assist when there is a need for help. Otherwise, it could have a counterintuitive effect.

PART 6

Design scope

6. Design scope

The findings of the previous chapters helped form a solid basis for the project. Based on the findings, a guide for the rest of the project is laid out in this chapter by discussing the parameters to which the rest of the product development needs to adhere.

6.1 Design goal

The design goal was created based on the insights from the previous chapters. It will be used as a guide during the ideation and conceptualization phase. Later in the process, the final design will be evaluated on its applicability to the design goal.

The design goal is as follows:

Develop a solution that **supports** people with **early to middle-stage dementia** to **maintain** an **active lifestyle** by enabling them to **navigate** to **frequent** and **infrequently** visited outdoor places.
Safe, **independent** & with **confidence**.

Support

Most products for people with dementia try to take all the tasks away from the person with dementia. However, here the challenge is to create a product that gives the person with dementia ownership over their life. The person with dementia will take the system along on their travels, where it will be able to offer support when there is a need for help.

Early to middle-stage dementia

People with early to middle-stage dementia were chosen as the target group because these people mostly live at home. Moreover, people within these stages would be most helped with a solution that enables them to keep their autonomy while living independently.

Maintain

Being able to carry out the activities that are part of your everyday life is very important for people with dementia, especially because dementia can make people feel like everything in their lives is changing. Participating in activities helps people feel valuable and allows them to remain active in society.

Active lifestyle

An active lifestyle's meaning can differ a lot from person to person. Within this design goal, an active lifestyle is defined as a lifestyle that requires a person with dementia during the week to participate in at least three activities outside their home environment.

Navigate

Current wayfinding products do not offer navigation guidance that suits the needs of people with dementia. Within this project, the goal was to go beyond tracking the users' whereabouts. To give people with dementia all the tools they need to navigate their outdoor surroundings without the help of other people.

Frequent and infrequently

Frequent places are places people with dementia regularly visit, like the

meeting center, a choir they are part of, or the supermarket. These places are part of their routine and are essential in their daily lives.

Infrequent places are places that are visited irregularly. Examples of infrequent places are a friend who lives in the same city, a cemetery, or a garden center. These places are often seen as meaningful by the person with dementia. However, due to the infrequency of the visits to these places, they are often the destinations that become impossible to reach individually.

Safe

Feeling safe while independently visiting places is the most important emotion people with dementia mentioned during the explorative research. The feeling of safety is needed for people to relax and enjoy the journey. Moreover, the safety of people with dementia, when they go outside alone is one of the biggest concerns of their caregivers. Caregivers fear that the person with dementia will fall or hurt themselves, become a crime victim, experience hypothermia, and get lost without the ability to find them (in time).

Independent

Independence is an integral part of the design challenge. People with dementia are often seen as people who need help with everything in their lives. They are stripped of their independence and autonomy to guarantee their safety. However, the ability to individually carry out tasks helps people with dementia feel valuable and strengthens their sense of worth. Therefore, the solution strives to bring independence in the lives of people with dementia as much as possible.

Confidence

People with dementia can feel insecure about their wayfinding capabilities due to the impact of the disease. That is why the goal is to empower people with dementia to feel confident by encouraging and reassuring them while on the road. While simultaneously helping caregivers gain confidence in the wayfinding abilities of the person with dementia.

6.2 Target group

Based on the results from the explorative research, the target group could be narrowed down further into two groups; a group that is identified as nesters and a group that is identified as adventurers.

Nesters

People in this group have no need or wish to visit places independently. They stick to the routine places they know and only visit unfamiliar places in the presence of their caregiver.

Adventurers

People in this group either experience the need to visit places independently because their caregiver is unable to be there all the time, or they have a strong wish to stay active and be independent.

Figure 13: Division within the target group early to middle-stage dementia.

Adventurers need to visit places independently, making it more urgent for them to have a device that aids them in this challenge. In contrast, nesters need a stimulant that shows them the need to visit more places independently. Nesters are set in the way they do things. Their dependency on familiarity makes them less prone to search for a device that can help them explore. Therefore, if nesters were to use a navigation device, they would use it to get reassurance while traveling to frequently visited places. Four personas were created based on the findings of the explorative research to show the diversity of the two groups.

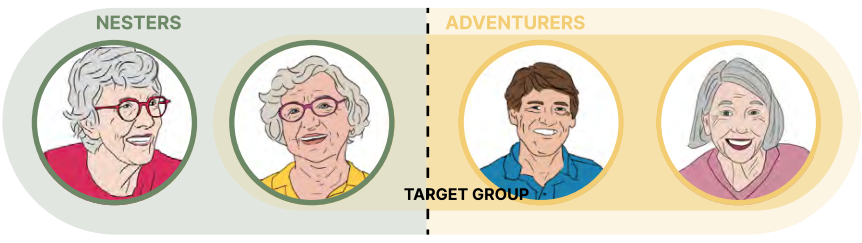


Figure 14: Overview of the persona's

Nesters

Two personas were developed for the nesters group. The personas differ in age, support system, and mobility capabilities.

Gijsje's persona represents an extreme category within the group of nesters. She is part of the category that rarely goes outside on its own. People within this category are often not stimulated by their families to visit places independently because of concerns for their loved one's safety. Another outstanding factor found in the exploratory research is that this group does not have the need to explore and do new things. The reason behind this can be related to their age and their contentment with their current situation. People explained that with age, they become more satisfied with the usual way of life, and their adventurous spirit decreases. However, an increase in passiveness because of dementia also plays a role here. For this persona, a navigation device is less needed because they rarely go outside independently and are helped by others with groceries, meals, and transportation to the meeting center.

Gijsje would be helped with a product that increases her safety on the street. Examples of devices that would increase the safety of this category would be traffic warnings when nearing dangerous points or fall prevention devices.

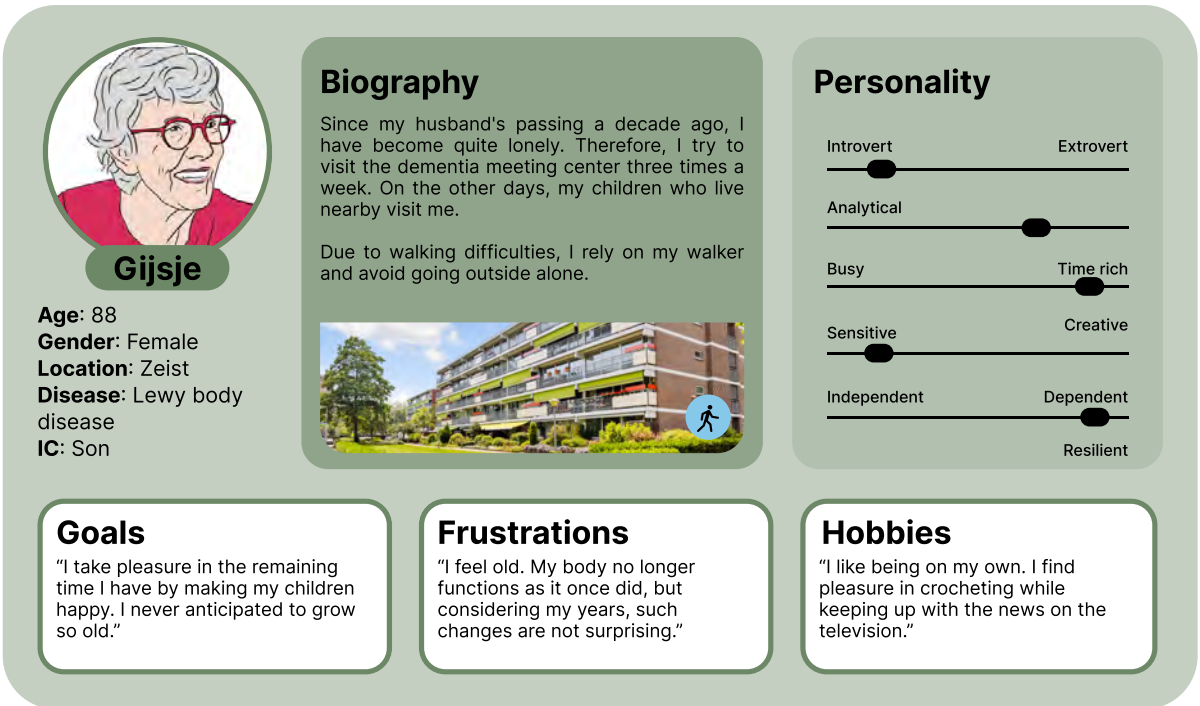


Figure 15: Extreme persona Gijsje from the nesters group.

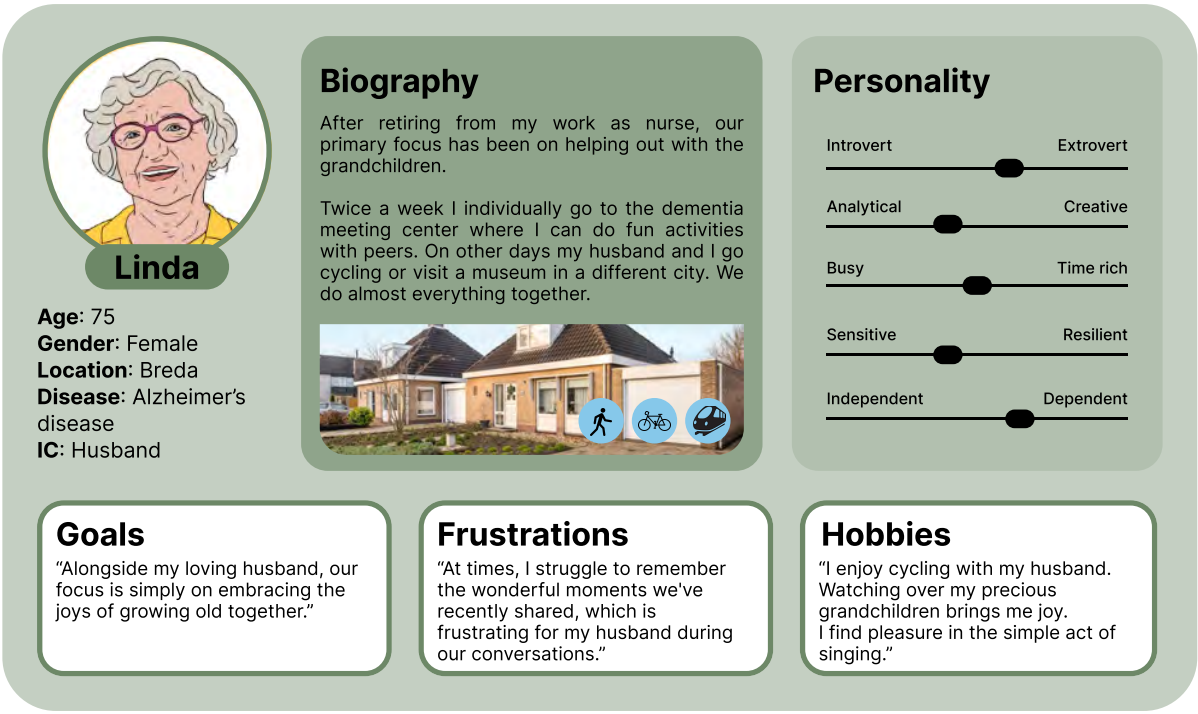


Figure 16: Moderate persona Linda from the nesters group

Linda's persona represents a more moderate person within this group. She is younger and can still use a variety of transportation options. However, since her caregiver is always present, she does not need to go to places individually. Furthermore, she does not wish to visit new places independently because she can always ask her husband to accompany her.

Linda would be helped with a navigation device that reassures her that she can always find her home wherever she is. Such a navigation device will help her feel more at ease and prevent stressful situations if she feels disoriented when traveling to frequently visited places. Moreover, a product that allows her to visit frequent places will offer help when she can no longer rely as heavily on her partner. In cases if, for example, her partner catches the flu or starts to experience mobility issues himself.

Adventurers

Two personas were developed for the adventurers group. The personas differ in age, support system, acceptance of the disease. People within this group are often of a younger age than in the nester group.

Mark represents a moderate version of the adventurers group. He wants to be more independent because of the need to help his family. Since he is relatively young, his caregiver still has to work part-time, making it impossible for Mark to depend on her entirely. During the explorative research, it was found that people that get dementia at a younger age (50-65) are more focused on doing everything they can to keep their lives as it has been. It is harder for them to accept that they cannot do certain activities because of the disease. This lack of acceptance could result from the busy lifestyle in which they were involved. However, it could also come from the idea that accepting the disease means accepting their life prognosis with dementia. In the case of this persona, he knows that over time his disease will worsen, and he will become a significant burden to his family.

That is why Mark would be helped with a product that allows him to navigate to frequent and infrequently visited places for as long as possible. In Mark's case, he is highly motivated to learn to use a device that could help him alleviate the burden on his family and allows him to live at home for as long as possible.

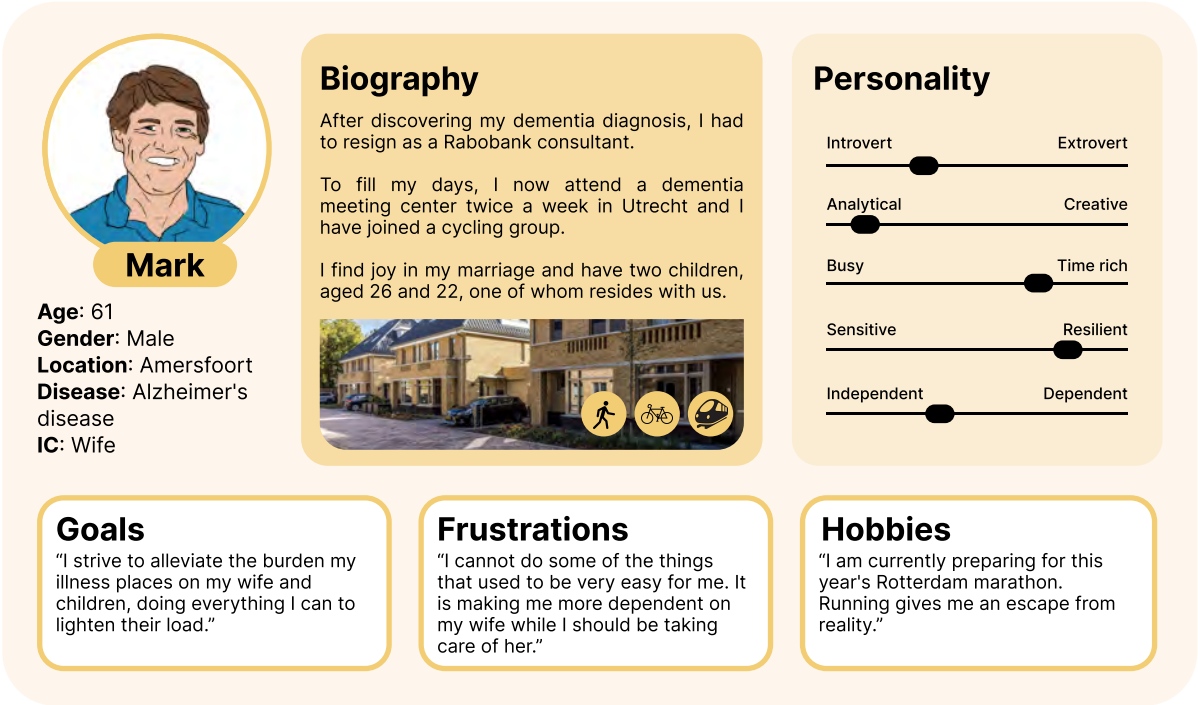


Figure 17: Persona from the adventurers group

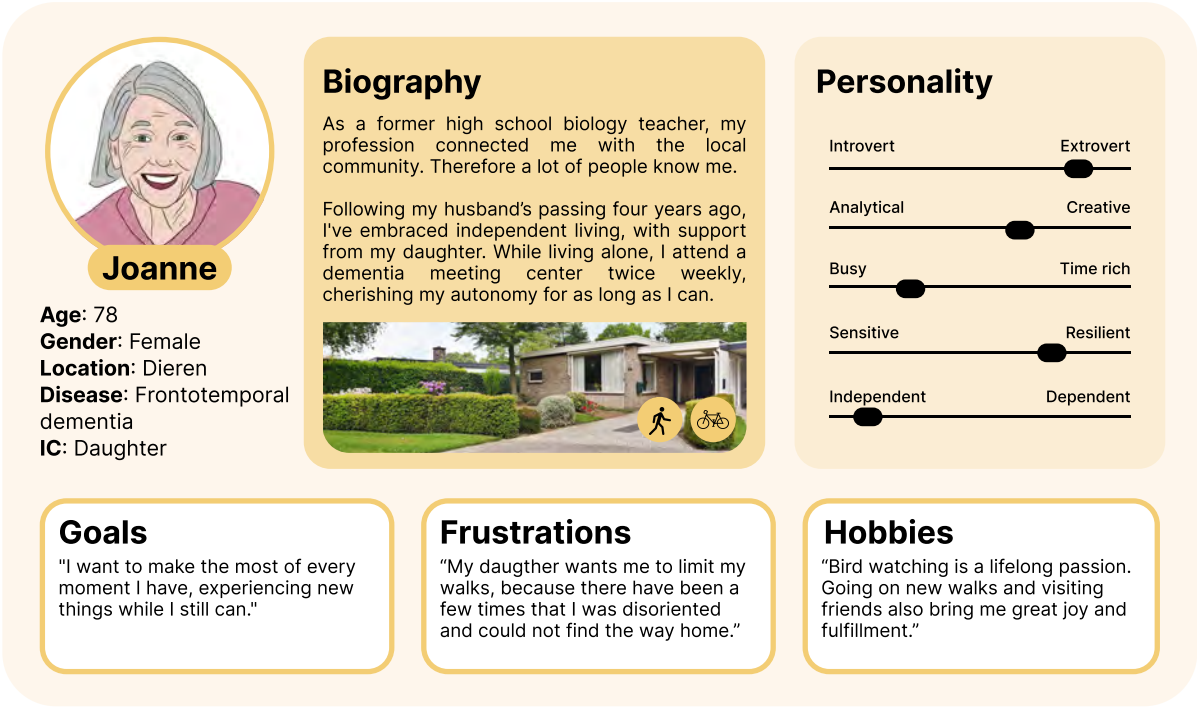


Figure 18: Extreme persona from the adventurers group

Joanne is an extreme persona within the group of adventurers. She has the wish and needs to be able to visit places independently. To alleviate the burden on her daughter, she wants to do daily tasks (like grocery shopping) by herself. Furthermore, Joanne has an adventurous spirit. She likes to explore new places and loves walking. Even the disease has not been able to change her love for the outdoors. Caregivers for a person like Joanne are put in a difficult situation. They do not want to restrict their loved one's freedom, and they also do not want to harm their loved one's safety.

A product that always shows the way home would give Joanne more freedom without feeling restricted. Moreover, this product should also be able to alert her daughter when something is wrong with Joanne. This alert system will make the daughter more aware of her mother's safety.

Defined target group

Based on insights about what kind of navigation device the different personas will need, it is decided that the adventurers will be the primary target group for this project. Due to their need to navigate independently, adventurers will be more motivated to buy and use a product that can help them with wayfinding, even if this product requires training. Moreover, this group will also use the device to travel to frequently and infrequently visited places.

Linda's persona can eventually also be swayed by a navigation device designed for the adventurers. However, she will probably only purchase the device if something happens to her caregiver.

6.3 Design opportunities

With the results of the explorative research, a user journey and an envisioned user journey (Appendix D) were made to analyze the current wayfinding process of people with dementia and identify three design opportunities. These design opportunities will be used during the ideation phase as a starting point.

1 Route-making

People with dementia depend on their caregivers to learn routes to infrequently and frequently visited places due to the complexity of the current navigation systems. Most people with dementia do not know the address of their destination, which makes it impossible for them to use existing

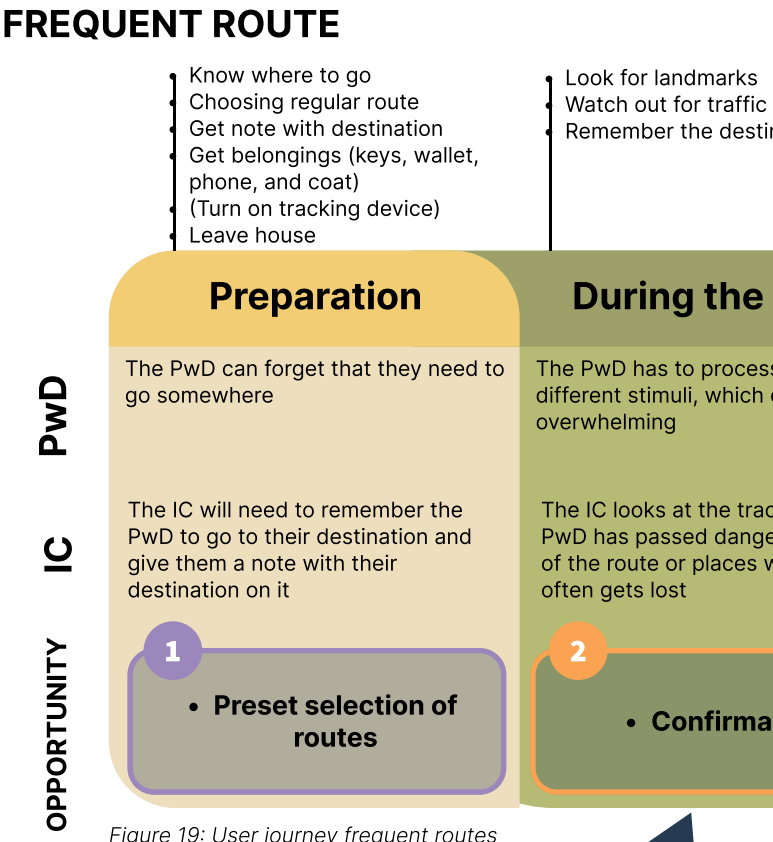


Figure 19: User journey frequent routes

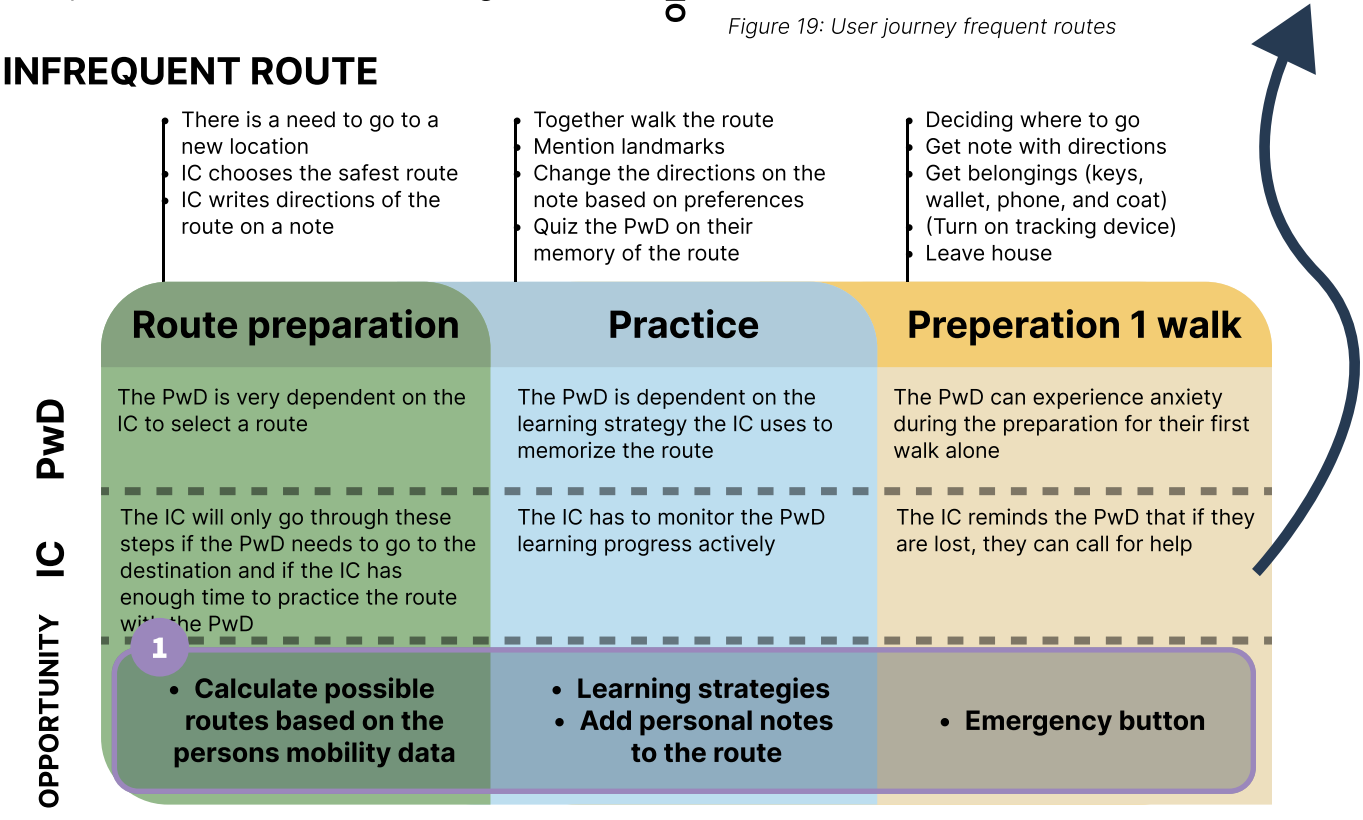
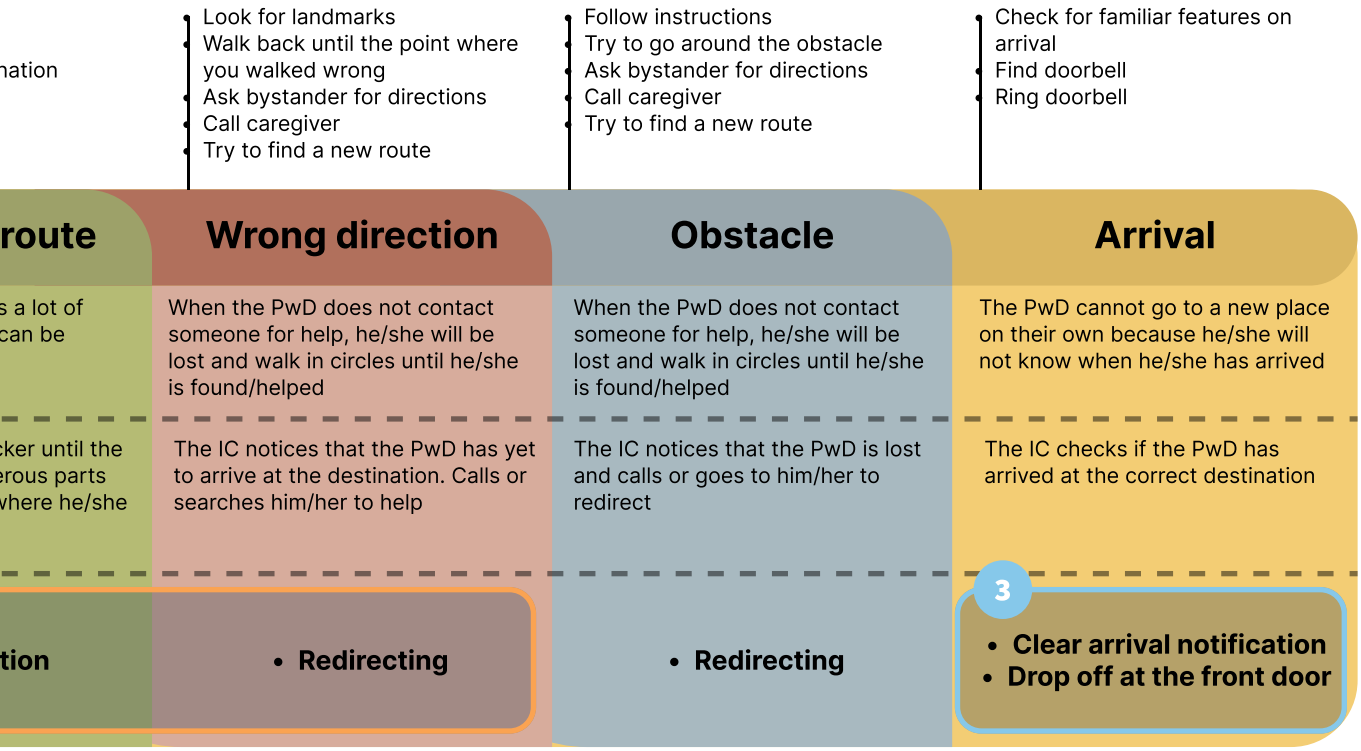


Figure 20: User journey infrequent routes



navigation devices. Moreover, the process for the caregiver to set up a route is quite complicated because the route that is, for example, suggested by google maps is often not a route that suits the needs of someone with dementia since they will need routes that are safe, easy to remember and incorporate familiar landmarks. Therefore, there are many opportunities within route-making to improve the current situation for the person with dementia and their caregiver.

2 Confirmation

People with dementia try to be very aware of their surroundings. They use landmarks as triggers for their memory to keep track of their progress. However, when traveling longer distances or using routes that are not familiar, relying on landmarks can be difficult. Additionally, due to dementia, it is harder to rely on your memory. That is why there is an opportunity for a wayfinding tool to aid people with dementia in getting confirmation that they are going in the correct direction. Besides needing people with dementia to get confirmation, caregivers also need reassurance that their loved one is traveling safely.

3 Arrival assistance

When going to a location, people with dementia often search for specific cues that will tell them that they have arrived at their destination. These cues range from a house number to an architectural feature. Current navigation devices do not help people in their search for these cues and will only tell them that they have arrived at their destination. Furthermore, navigation devices like google maps stop their guidance once they have arrived at the correct GPS location. However, people with dementia also need help with the steps needed to navigate within a location.

For example, when visiting an apartment complex, you first have to ring the bell at the front door of the apartment complex, push the button for the elevator, step out of the elevator on the right floor, walk to the right side of the gallery, and press the doorbell on the front door of the apartment. These steps require a level of information processing that people with dementia lack. Therefore designing arrival assistance that guides reaching and recognizing the destination will help people with dementia to visit places independently.

6.4 Design requirements

Design requirements were extracted from the findings of the literature and explorative research. These design requirements were then prioritized with the MoSCoW method (Brush, 2023). The design requirements will be used throughout the project to sample ideas and concepts.

MUST HAVE

- enable the person with dementia to independently navigate
- be understandable by people with early to mid-stage dementia
- require as few actions as possible for the navigation to work
- be able to use when walking
- stimulate the person with dementia to use their skills and thinking
- be adjustable for the usage of frequent and infrequent routes
- give constant confirmation of the route progress when in use
- provide a notification when the person with dementia has arrived at their destination
- use multiple sensory ways of giving navigation cues
- be easily carried around
- be integrated in the products that people with dementia bring with them when they go outside
- provide selective tracking information
- optimize the interface when it is raining or dark
- show address information of the destination at all times
- have materials that make the product look professional
- have a discrete design

SHOULD HAVE

- be able to use when cycling
- provide a sense of pride

WILL NOT HAVE

- include navigation cues to use public transport
- include navigation cues for driving
- provide 24/7 tracking

COULD HAVE

- give updates about the decline in wayfinding abilities of the person with dementia
- stimulate the person with dementia to become more active

PART 7

Conceptualization

7. Conceptualization

This chapter includes an overview of the different ideation activities that were done to come up with three concepts. The three concepts were evaluated with people from Tover and someone with dementia. Their views on the concepts contribute to the selection and evolvement of the final concept.

7.1 Ideation activities

The ideation activities consist of a three-day design sprint and individual brainstorm. The individual brainstorming helped combine the insights from the design sprint and find three distinguishable concepts.

Design sprint

The researcher organized a design sprint with a colleague from Tover to use the different perspectives of people within Tover to find solutions for the design goal. The Design Sprint existed out of three days with seven people and followed the Design Sprint method as provided by Google (Google, n.d.). Figure 21 shows an overview of the activities throughout these three days.

The first day's goal was to understand the problem and define How Might We questions that captured different aspects of the design challenge. The design goals defined in Chapter 6.3 were the starting point of this first day. During the second day, we wanted to generate many ideas that solved the design challenges. Lastly, the third day's goal was to decide which concepts held the most potential. The outcome of the design sprint is nine concepts which can be viewed in Appendix E.

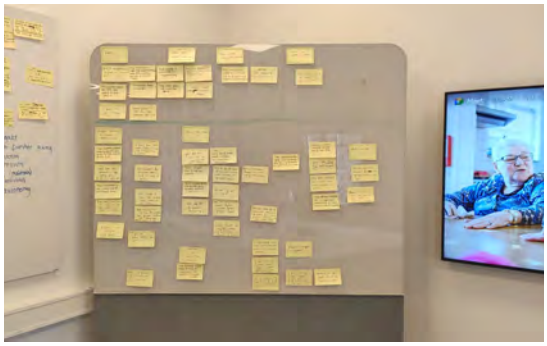


Figure 22: Clustered risks

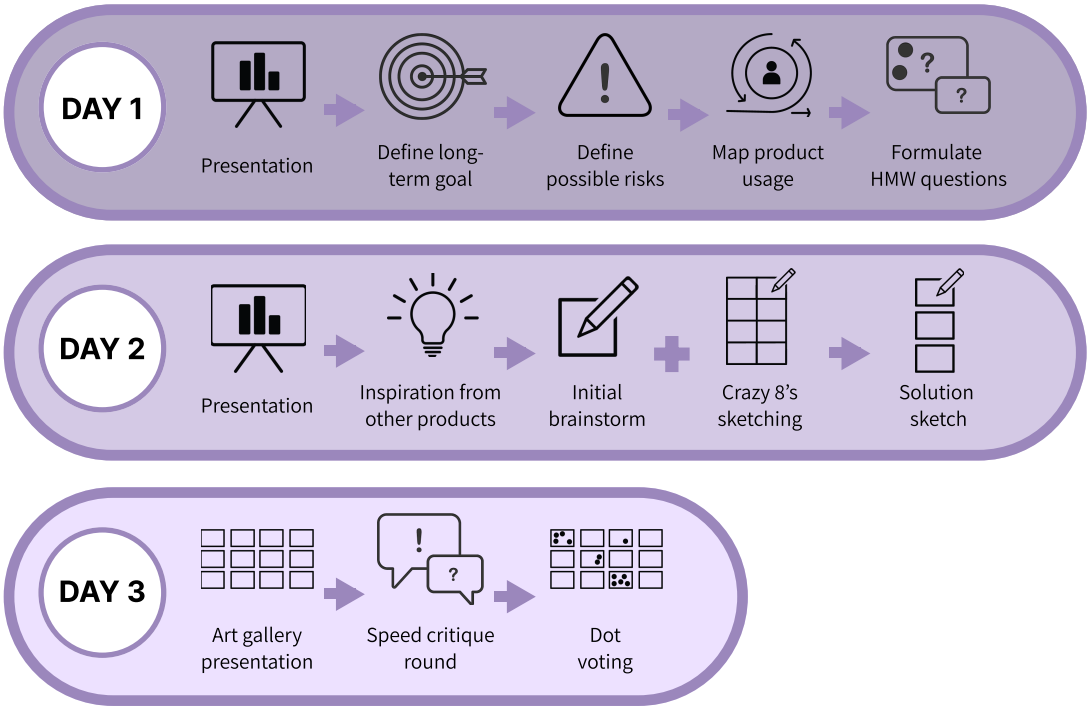


Figure 21: Design Sprint activity overview

Individual brainstorm

All the insights from the Design Sprint were grouped and analyzed. The concepts were put on the timeline of the envisioned user journey, which showed that the ideas from the Design Sprint focused most on route-making and confirmation cues. Only a few concepts explored solutions for obstacles, going in the wrong direction, and arrival assistance. That is why the researcher did a separate brainstorm on these topics with the flower association method.

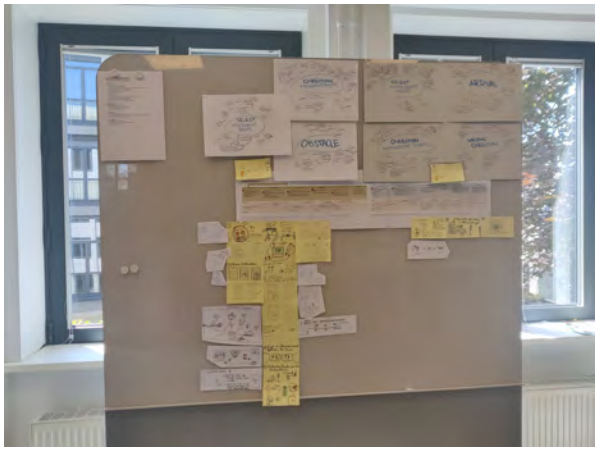


Figure 23: Grouped results of the Design Sprint and flower association activity

7.2 Concepts

Three concepts were created based on the input from the Design Sprint and the individual brainstorming. For the three concepts, different ways to give navigation cues to the person with dementia were selected. Using different ways of navigation helped create a clear distinction between the concepts, making it easier for people to evaluate them. Some concepts are similar to the products shown in Chapter 4.2 but were chosen as part of the final three concepts because of their popularity during the Design Sprint.

Concept 1: Orientation based navigation

The concept uses the direction of a line to show where the person with dementia needs to go. Only showing the user's orientation relative to their destination allows the user freedom to choose their path while subtly guiding them to their destination. The dots on the screen give an indication about the distance between the user and its destination.

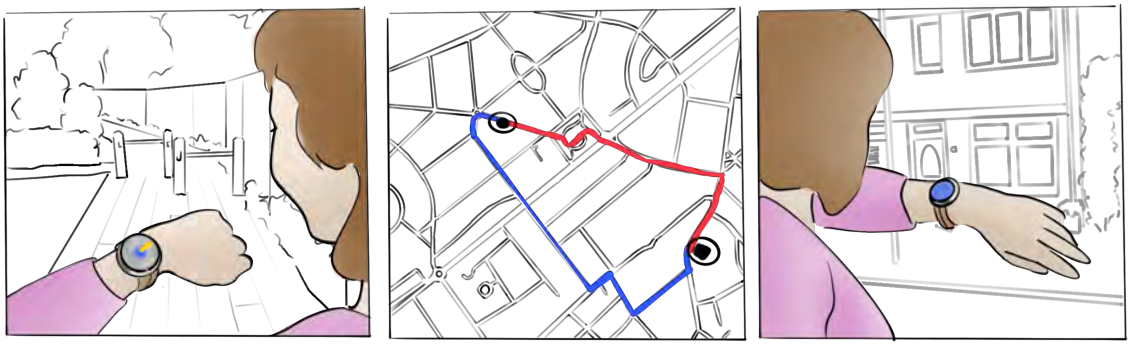


Figure 24: Concept overview

Figure 24 shows how the woman sees that she needs to go right. However, at the moment, there is no possibility for her to go right, so she has to keep walking straight ahead until she can make a right turn.

Once the person with dementia has reached his/her destination, the wearable will turn blue and start vibrating, informing the wearer that he/she has arrived.

Concept 2: Landmark-based navigation

The navigation device shows the direction of the route by displaying a yellow arrow when the yellow button is pressed. When the orange button is pressed, landmarks in the image are highlighted in the color orange to help people find them in real life. The home button can be pressed if the person with dementia wants to go home. The navigation cues will then bring them home.

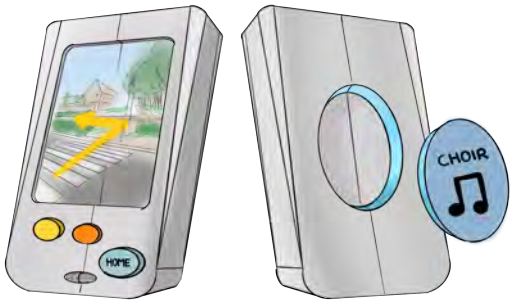


Figure 25: Concept overview

The caregiver plays an essential role in this concept. Before the navigation device can be used, the caregiver has to select and upload a route onto a token. The token will then always give the directions that are part of the route the caregiver has uploaded. Once the tokens are connected to a route, they can be used by the person with dementia to activate the navigation cues on the device independently.

The tokens are stored on a map of the city that hangs in the hall of the user. Here the tokens function as a physical reminder of the locations that the person with dementia can independently visit. Before going outside, the person with dementia can take a token from the map and place it in the device. Once placed in the device, the navigation cues will immediately start and take the person with dementia to the location connected to that specific token.

The token will give specific instructions about how to get inside the location when the person with dementia has reached their destination. The instructions vary per destination and can be personalized.

Concept 3: Conversation based navigation

An audio player walks the person with dementia through the route by explaining directions with the voice of one of their loved ones. The system uses personal navigation cues combined with a familiar voice, making the system feel reassuring and comfortable.

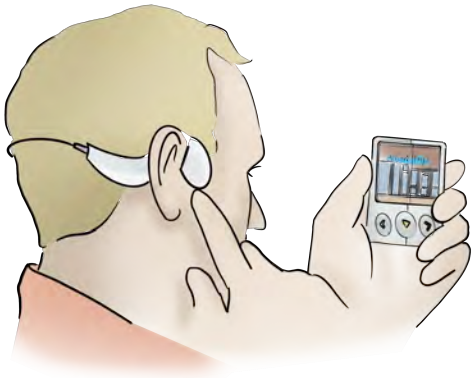


Figure 26: Concept overview

As shown in Figure 26, the person with dementia and their caregiver must first walk the route while they bring the navigation device. On the walk, they need to let the navigation device track their GPS location and record their conversation. Crucial is that the caregiver asks the person with dementia about the landmarks they use for wayfinding along the route. The system will connect the landmarks to the specific GPS location of the landmark and save it as an important navigation cue.

When leaving home, the person with dementia has to shuffle to the correct route and click play for the navigation to start working. Once play is pressed, the navigation device will keep track of the user's GPS location and give navigation cues about their exact location.

Once the person with dementia has reached their destination, the audio player will show a repeat backward button, which allows them to get audio cues that bring them back to the location from which they came.

7.3 Concept selection

The three concepts were evaluated to understand the perspectives from the user and developer side. Feedback was needed from both parties to make improvements to the concepts regarding the business potential and ability to meet the needs of the user.

Evaluation process

The concepts were evaluated by:

- The Head of Research & Design, the Co-founder & Chief Product Officer, and a UX designer
- A 74-year-old woman with vascular dementia who still lives at home

The evaluation included an explanation of the context, a walkthrough of the concepts (using the concept sketches), a discussion per concept, and a comparison between the concepts.

Concept review results

Figure 27 shows an overview of the results from the evaluation with the experts and a person with dementia. The key results in comparing the concepts are discussed more elaborately below.

The woman with dementia mentioned that all three concepts could be preferred by someone depending on their characteristics and their stage within the dementia process. She preferred landmark-based navigation because she is a very visual person. However, conversation-based navigation could be more suited if you are visually impaired.

The orientation-based navigation was the most challenging concept to understand. This concept offers an abstract way of navigation which can be difficult for people with dementia to learn. Moreover, it was mentioned that not getting clear and direct instructions on where to go could make the person with dementia feel unsure about whether they are walking in the right direction. The experts liked the concept's simplicity and the freedom that it gives to the user. However, they mentioned that the interface needed to be more intuitive.

Regarding landmark-based navigation, image context information is essential to reassure a person with dementia that they are correctly following the route. Moreover, family involvement in creating the route was seen as a pro by the woman with dementia and the experts.

The conversation-based navigation was positively rated due to the ability to operate the device without using your hands. Hand-free navigation enables the person with dementia to focus on their surroundings. However, the person with dementia mentioned that the device's sounds could distract her,

CONCEPT REVIEW E xperts Person with D ementia	 **Orientation-based navigation**	 **Landmark-based navigation**	 **Conversation-based navigation**
Intuitiveness	E The interface needs to be more intuitive D Difficult to understand how the product works D Abstract way of navigation D The lack of clear directions would lead to doubt and insecurity	D Very visual, which makes it easy to understand D The orange button is confusing. Only use the yellow button D The instructions to enter your destination are very helpful	E The interface needs to be more intuitive D Searching for the right route is difficult (whereas in the landmark concept, it is very simple) D Just listening is very easy
Safety		D I would not use this on the bike because it would distract me too much	E People will not be distracted by a screen while using the product E Hand-free navigation D Danger of being distracted by the sound D Other people could potentially hear where you are going
Context	D No information about the route between your current location and your destination D The system does not give you the fastest route D The system provides no ETA (important for scheduling breaks)	D Images give reassurance D The context that is provided by the map will not be helpful for me. I will not be able to understand the distances and relations D Street names help me with wayfinding	D Ability to select personal landmarks is important
Use throughout the disease progress		D Understanding visuals is something that will probably continue to work because it is something we do all the time	D Understanding audio instructions is something that will probably continue to work because it is something we do all the time
Family involvement		E The family helps build the map and the network of routes with you E The family will feel safer about the use of the product because of their involvement in setting up the routes D Easy way of letting the family know where you are that does not restrict your feeling of freedom	
Reminiscence		E The map can function as a reminiscence object	
General	E The concepts lack magic. They are not 'prikkelend'. D Products need to be used during the beginning process of someone with dementia because this helps them get used to working with it.		

Figure 27: Overview feedback concept review

which could be annoying and lead to dangerous situations. Moreover, she mentioned feeling less safe if others could hear where she was going.

Overall when discussing the interaction needed to select the route, landmark-based navigation was chosen as the easiest way to complete the action. The physical aspect of the tokens was preferred over pressing a button with the name of the location on it because putting a token in the device felt more deliberate. Furthermore, the tokens on the map give a visual overview of all the options, which is better than what the conversation-based navigation interface provides.

Concept choice

The feedback from the concept evaluation provided rich information about the pros and cons of all three concepts. Additionally to the concept evaluation, a Harris profile scored the concepts on aspects of the design requirements.

Based on the Harris profile and the results from the evaluation, it was chosen to move forward with the concept of landmark-based navigation. This way of navigating provides the most complete directions due to the context information shown in the images.

However, making the navigation device a separate device would be expensive. Therefore, it was decided to create a mobile application with landmark-based navigation. Using the mobile phone as a device for the navigation software is a more sustainable solution. Additionally, people always take their phones with them when they go outside, making it less probable that they forget to take the landmark-based application. Lastly, it is expected that the future generation of people with dementia will be more accustomed to the smartphone, making it a device they are already familiar with.

HARRIS PROFILE	Orientation-based navigation				Landmark-based navigation				Conversation-based navigation			
	--	-	+	++	--	-	+	++	--	-	+	++
Understandability												
Adjustability frequent & infrequent routes												
Confirmation route progress												
Destination recognition												
Discrete design												
Feasibility												
Costs												
Simplicity												

Figure 28: Harris profile

PART 8

Design

8. Design

The concept developed in the previous chapter is explained in more depth in the design chapter. It includes an overview of the different design components and an elaborate explanation of their functioning.

8.1 Proposed solution

The wayfinding system (Figure 29) enables people with early to middle-stage dementia to visit places independently. It uses three components: navigation cards, a navigation application, and the application to set up the routes.

The wayfinding system guides people with dementia to their preferred location if they insert a navigation card into their phone case. The navigation cards are preprogrammed with specific route information linked to a destination. Therefore, when the navigation card is placed into the phone case, it will connect to the phone using Near Field Communication (NFC) and immediately start the navigation application to provide directions to the destination of the navigation card.

The navigation uses real-life footage and projects an arrow on top of the footage to show the direction the person with dementia needs to go. The navigation is personalized by highlighting landmarks that are familiar to the person with dementia and provides audio cues to stimulate traffic awareness.

The caregiver's involvement is essential in setting up and personalizing the navigation. With their initial help, the person with dementia can gain more independence and walk around in their neighborhood with the reassurance that they can find their destination. A step-by-step overview in Appendix F shows the different steps in using the product.

Figure 29: Concept prototype in context environment

8.2 Design components

The proposed solution consists of three design components. These components play a different role within the user journey of the product. The person with dementia mainly uses the navigation cards and navigation application, whereas the caregiver uses the route selection application.

Navigation card

The navigation cards give people with dementia a tangible item that skips the steps of filling in an address to a destination due to its saved navigation settings. There are two types of navigation cards, the destination card that brings you from your home to a destination and the home card that brings you from a destination to your home.

Destination card

Destination cards can be used by people with dementia who want to learn the route to a specific destination, are unfamiliar with their outdoor environment (due to moving), or frequently experience moments of spatial disorientation. In all of these cases, the destination card can provide a feeling of reassurance and help people understand their outdoor environment.

The destination card holds information on its NFC chip that can open a specific navigation route on the mobile phone that the caregiver saved. Therefore, the navigation opened by the destination card will give wayfinding cues that include personal landmarks and instructions.

Figures 30 and 31: The phone case extension with inserted navigation card (top) and navigation cards with empty phone case extension (bottom).

Home card

Home cards are used by people who want to go outside without specifically being directed to a destination. This card reassures them they will always be able to find their home when they bring their home card and smartphone.

The home card holds the GPS coordinates of the home address and puts these coordinates as a destination

in the navigation app when connected to the smartphone. The app will then calculate the fastest route based on the current location of the person with dementia and guide him/her using its augmented reality features. In contrast to the destination cards, the route from the home card can not use personal landmarks specific to the route. However, the system can add landmarks used in other routes to its navigation cues if they match points on the route that leads them home.

Design of the navigation cards

The cards are designed to show the person with dementia the destination of the card. Several iterations, as shown in Figure 33, led to the final design of the navigation cards. The photo on the card and the address can be added to the card by the person with dementia or the caregiver, making it a card that can be reused for other destinations if needed. The destination information helps the person with dementia recognize their destination and is a continuous reminder of where the user is walking to. Thanks to their flat design, the navigation cards can easily be stored in flip covers of phones until the user wants to use the navigation by inserting the card in the phone case extension.

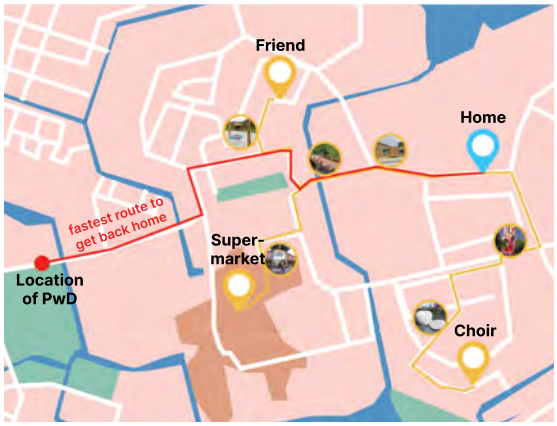


Figure 32: Overview of how landmarks from other routes can be added to the route created for the home card.

Design phone case extension

The silicon phone case extension has cutouts to show the most important information about the navigation card, what the card's destination is. When the card is not inserted in the extension, the words "Where am I going?" are visible. These words link to the words "I am going to..." that are visible on the navigation cards to show that the navigation card needs to be inserted in the extension.

Figure 33: Different iterations of the navigation card

Navigation app

After the navigation card has been inserted into the phone case, the navigation app will start up and give the directions of the route on the card. The interface of the navigation app only has essential features that people with dementia will need during their journey. These features are described below.

① Direction arrow

The yellow arrow on the screen always points toward where the user needs to walk. When making a turn, the arrow turns with the user.

It was chosen to make the arrow yellow because this color does not often occur in an urban environment making it distinguishable from the background. Additionally, yellow is viewed as an optimistic color that can boost confidence and increase joy, precisely the feelings that are aimed to stimulate when the navigation device is used (Braam 2023).

The arrow is a universal sign of direction used through the ages, making it an intuitive symbol (Follett, 2009).

Figure 35: Concept prototype in use

Figure 34: Interface navigation app

As an extra cue, instructions are shown on top of the arrow. These instructions give actionable tasks that help people with dementia undertake steps to follow the system's guidance even if they forget the meaning of the arrow.

② Street name

The name of the street the user is walking on is projected at the top of the screen. Seeing a street name can reassure people who use signs as part of their wayfinding strategy. The street names are placed in the corner of the screen, making them visible without distracting from the navigation cues.

③ Estimated Time of Arrival (ETA)

The ETA is presented in the navigation bar of the app. For people with dementia who still have a sense of time, knowing the ETA can be vital because it gives them information about how long they need to walk until they reach their destination. Seniors need this information to plan breaks on their walk.

④ Call button

The call button is a fallback option for when people are too disoriented or confused to understand the navigation and need extra help. With the navigation app active, the user has easy access to the option to call someone without closing the app. When the call button is pressed, the screen, shown in Figure 38, will pop up and present up to four possible people the person with dementia can call.

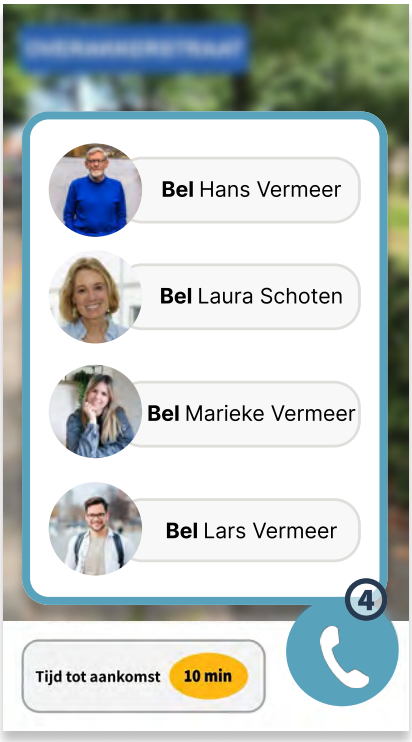


Figure 38: Interface call menu

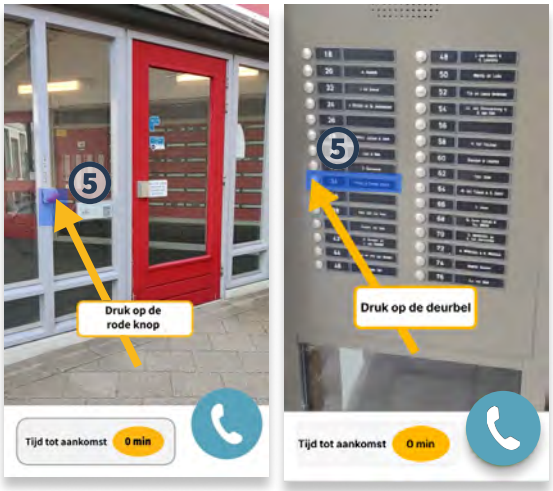


Figure 36 & 37: Examples of specific instructions

⑤ Specific instructions

The navigation cues guide the person with dementia until they have reached their destination, meaning it only stops after they are inside the correct room/ apartment of the house/building they intend to visit. For this to work, the caregiver saves specific navigation cues of the destination to the route. Figure 36 and 37 show examples of the instructions the navigation app gives based on the caregiver's information.

⑥ Landmarks

Landmarks are highlighted in the environment by a blue transparent box, as shown in Figures 39 and 40. These personal landmarks are highlighted in the interface to trigger moments of route awareness. The caregiver, together with the person with dementia, marks these specific landmarks as important for wayfinding while setting up the route. The system remembers the points and highlights them when the person with dementia individually walks the route. Some landmarks, like the outdoor fitness device in Figure 39,

are specific for the person with dementia and need to be manually categorized as landmarks, whereas other objects, like the fences in Figure 40, can be detected by the system as landmarks.

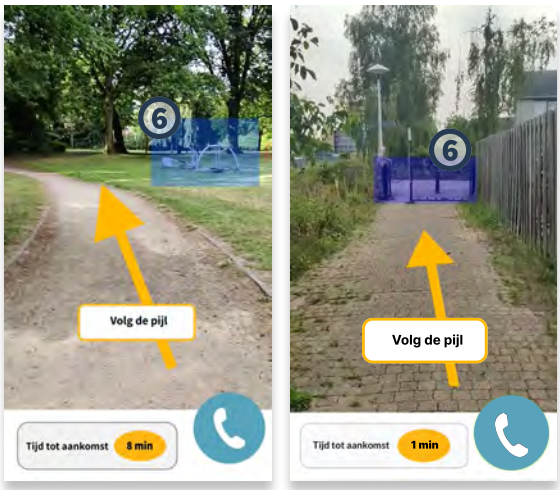


Figure 39 & 40: Examples of highlighted landmarks

⑦ Traffic awareness

Visual and audio warnings are added to the system at road crossings to stimulate traffic awareness. If the person with dementia is nearing a road crossing, the system will show a red screen with the words "Look out! You have to cross the road." (see Figure 41). At the same time the message is shown on the screen, the system will notify the user with the same warning through a voice message. The transparent red screen allows the user to still see which direction to go. However, it directs the user's focus to the traffic awareness warning.

⑧ Celebration

If the person with dementia can successfully navigate to their destination, a celebration screen will be shown. The celebration message tries to evoke a feeling of pride and stimulate the user to use the system more often.

Figure 41: Example of traffic awareness warning

Figure 42: Example of celebration page in the app

Wrong turn

The system will execute several actions when someone does not follow the directions of the navigation device. At first, it will redirect the person with dementia to a point on the original route. It is important that the person with dementia walks the route saved into the system because by always walking the same route, the person with dementia will eventually learn the route. An audio message that tells the user the first three navigation cues is used to grab the user's attention. However, suppose the person with dementia consistently neglects instructions. In that case, the navigation device will ask the user if they still want to go to the destination using an audio and visual message. If they answer "Yes," the navigation will continue directing them, but if they answer "No," the app will ask the user to take the inserted navigation card out of the phone case extension.

Obstacle

The system will detect a road closure or obstacle if the person with dementia encounters one of these. Similar to detecting everyday objects that are important for wayfinding, like fences or pedestrian crossings. Once detected, the system will redirect the user to a path that returns them to the original route. If the person with dementia does not understand the changed directions, he/she can always refer back to the fallback option and call someone for help.

Figure 43: Example of traffic awareness warning

Route selection app

The caregiver has an application where he/she can add and update personalized instructions to routes. Figure 44 shows the different steps the caregiver must follow to upload a new route to the system.

① The caregiver first has to fill in the starting and end point of the route for the system to gather the GPS data of the route.

②③④ The second step of setting up a route involves personalizing the navigation cues. The caregiver has to walk the route with the person with dementia and, while walking, film the route. Screens two, three, and four show instructions on how to correctly capture the route. During the route, the caregiver is instructed to ask the person with dementia questions about their surrounding to understand what objects their loved one uses for wayfinding.

⑤⑥ After capturing the route, the caregiver will watch the video and mark particular objects as landmarks or navigation cues. The caregiver can also add triggers that might help the person with dementia remember the landmark. Once marked, the system will save the cues and add them to the route. When the person with dementia independently walks the route, the system will highlight the cues and show the information that the caregiver has provided.

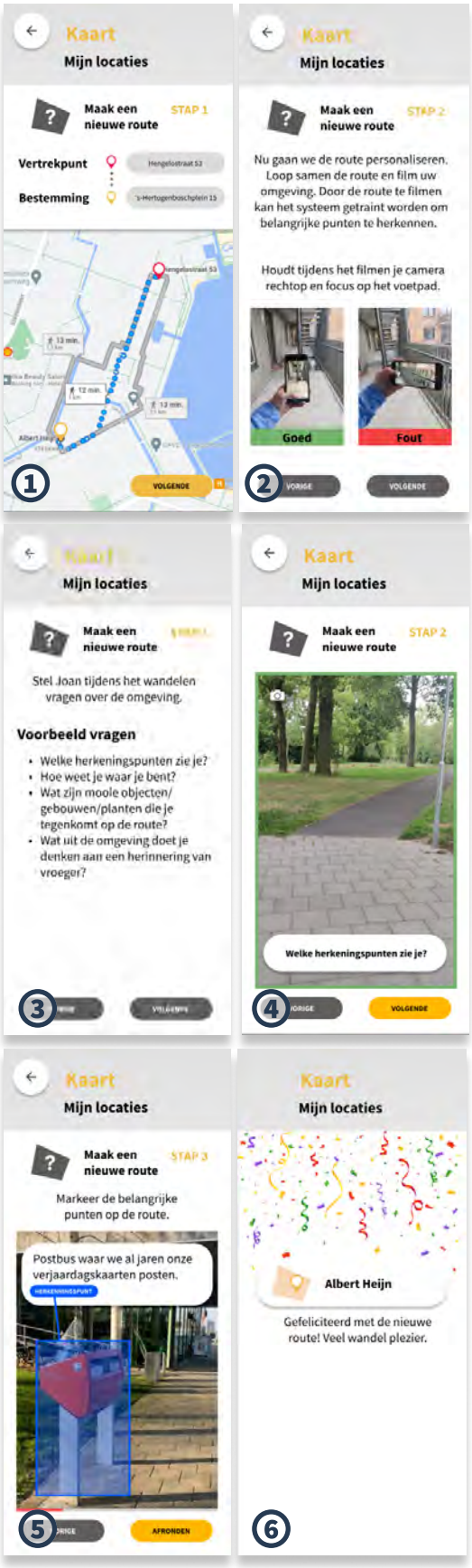


Figure 44: Wireframe for setting up a new route

8.3 Technology

Although the detailed technological development of the navigation application extends beyond the scope of this project, the key technologies of the solution and the feasibility have been explored. Most notably, NFC communication between card and application, AR to portray real-live navigation arrows, and image recognition to recognize landmarks.

NFC communication

NFC is a short-range wireless technology that uses magnetic field induction to communicate with devices (Android Authority). This technology requires no manual input to establish a connection; the NFC tag only needs to be held at a distance of up to 10 cm from an NFC reader, making it a simple interaction for people with dementia (Andriod Authority). Almost all smartphones on the market have NFC technology integrated and are, therefore, active NFC devices. An active NFC device can send and receive data, whereas passive NFC devices, like tags, can only send information.

This project uses NFC technology to startup the correct navigation route. The navigation card is a passive, and the smartphone is an active NFC device. The communication between the navigation card and the smartphone would work, as is shown in Figure 45. If the card is held near the mobile phone, the NFC reader in the mobile phone will discover the NFC tag in the card and read the information on the tag. NFC uses NFC Data Exchange Format (NDEF) to send messages to the NFC reader (Android Developers, n.d.). The system filters these NDEF messages to see if they have information that can be used. The system reads and carries out actions in the NFC tag according to the sequence defined in the NDEF message. The NFC reader will open the navigation application on the phone and start the navigation to the destination linked to the information on the tag. Subtasks in the NDEF message are to silence none essential apps already running on the phone, like games or news apps.

The NFC tag must be programmed before it can communicate the correct information to the smartphone. The Android app Tasker was used for the usability test to read and write actions on the NFC tag. Within this app, actions could be created that ranged from turning a setting on or off to opening an app and pressing play. The system had to read the NFC number before writing actions on it. Similar software like this app could be used to develop the route selection app.

Experiment

An experiment was conducted to test whether other NFC cards in the phone case would interfere with the NFC signal of the navigation card. With two

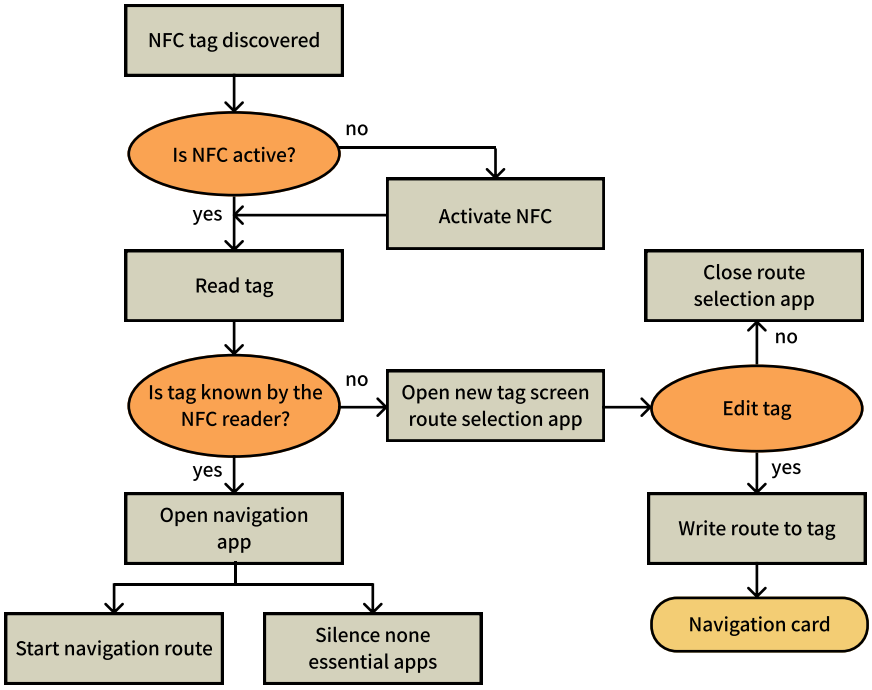


Figure 45: Flowchart communication NFC and smartphone

bankcards (with NFC chip) stacked on top of an NFC sticker, the tag could still open the app on the phone. However, the NFC could not connect to the phone with more than two cards stacked on it.

Figure 46: Experiment NFC interference

To overcome this problem, the phone case extension where the navigation card must be inserted is positioned on the phone's backside. This location is where the distance between the NFC tag in the navigation card and the NFC reader in the mobile phone is the smallest. Moreover, cards are used instead of NFC stickers in the proposed solution. NFC cards have a bigger antenna, the coil of wire within the NFC tag, which is better for harvesting energy (Seritag, 2023). Therefore, the NFC card can scan from a bigger distance.

Augmented Reality (AR) Navigation

The navigation app uses augmented reality to project navigation cues in the footage captured by the smartphone's camera. It combines GPS, digital navigation systems, motion recognition, and outdoor positioning software to create natural outdoor scenes and provide panoramic navigation (Yao et al., 2021). AR Navigation uses the smartphone's camera to capture the surroundings, a gyrosensor to sense angular velocity, an accelerometer to measure acceleration, and GPS to capture the smartphone's location (Yao et al., 2021). The data from all these sensors are filtered to reduce the data size. Additionally, some AR Navigation systems use Point Of Intrest (POI) data from online databases to gain more

information about the surroundings since this is geographical information about buildings put as such by people (Chung et al., 2016).

AR Navigation systems have been developed by companies like, Google Maps and Mercedes Benz to create a more immersed navigation experience (Andriod Planet, n.d.; Mercedes, n.d.). Although these navigation systems are developed for different target audiences, and their user interface is not useful for people with dementia, their development proves the technical feasibility of the wayfinding system proposed in Chapter 8.1.

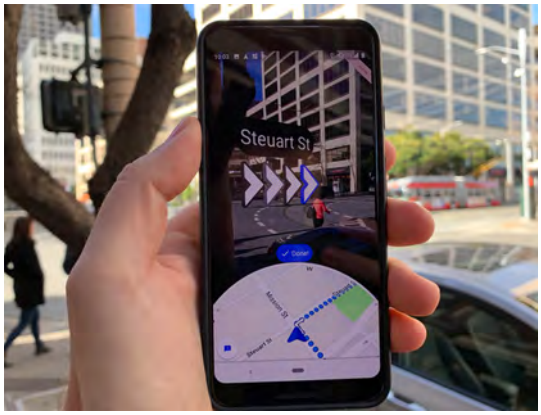


Figure 47: Google Live View (Android Planet, n.d.)

Image recognition with machine learning

A machine learning model would be trained by datasets to detect common landmarks, like poles, fences, pedestrian crossings, etc. The model classifies these images by exploiting image properties through the use of Neural Networks. Neural Networks are layers within the model that weigh input data and give a threshold numbers that help the model accurately categorize images. Through the use of Convolutional Neural Networks (CNNs) the model is able to label the objects as landmark and project a box around them (SuperAnnotate, n.d.). The landmark recognition is aided by GPS data, the gyroscopic sensors that indicate the orientation of a phone, and the input provided by caregivers. The app "knows" what landmarks to expect in what location. However, image recognition must help to ensure the instructions are placed right, for instance, by highlighting a traffic sign or pointing towards the door handle.

Technological viability

The key technologies required for the solution, NFC, AR, and image recognition, are feasible and proven. However, the proprietary development of AR and image recognition is complex and imposes a risk. For the development of both solutions, technological expertise and large volumes of data are required. Therefore, the preferred scenario for the development would be to partner with a solution provider by integrating existing image recognition engines in the wayfinding device.

Integrating these existing technologies in a wayfinding solution with a simple user interface for people with dementia and caregivers is technologically feasible.

PART 9

Validation

9. Validation

The proposed solution was validated through tests in which people with dementia and informal caregivers could experience the navigation system. The goal of the validation tests was to find out if the concept fulfilled the design goal. The user tests aim to show how users interact with the device. Through these tests strengths and weaknesses of the product are exposed, which helps the designer to improve the concept.

The research questions for this chapter are:

5. To what extend does the concept enable people with dementia to navigate to outdoor places?
    a. What are the experiences of people with dementia and informal caregivers using the device?
    b. Are people with dementia able to independently use the navigation device to visit outdoor places?
    c. How can the navigation be implemented into the current routine of people with dementia and their caregiver?

9.1 Test method

User tests in which the proposed solution was tested and discussed were held with 5 people with dementia and 2 caregivers. The user tests consisted of an introduction to the concept, A/B test for the map and the destination cards, and a usability test with the navigation prototype. In the cases where the caregiver was present, a cognitive review of the app for the caregiver was added to the test. A overview of the test plan can be found in Appendix G.

Two rounds of tests were held. The navigation prototype was tested during the first round with four people with dementia and two caregivers. Out of the seven participants, two people with dementia and their caregivers had participated in the interviews from the explorative research and therefore were familiar with the project. For those two couples, the test was held in their own homes. The other two people with dementia were part of the King Arthur Group. The test with them took place at a sports park in Utrecht, where members of the King Arthur Group regularly meet for activities.

Insights from the first round introduced some changes to the prototype. The effect of these changes was tested in the second round with an additional person with dementia who had also participated in the concept selection process. The test in the second round was held in the home of the participant.

Overall the tests took approximately 45 minutes.

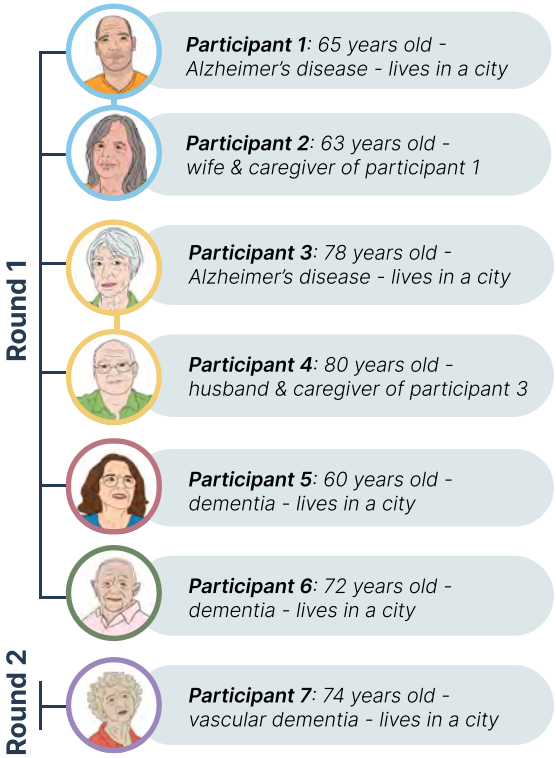


Figure 48: Overview of the characteristics of the user test participants.

A/B test

A comparison was made by the participants between a detailed and simplified version of a map on which the navigation cards could be stored. Additionally, a comparison was made card between flat and 3D navigation cards. Since the maps and navigation cards were physical, the participants could interact with them and explore the possibilities of the different versions.

Figure 49 & 50: Simplified map with 3D navigation cards (left) and detailed map with flat navigation cards (right).

Usability test

The usability test was an approximately 10-minute walk guided by the navigation system in the neighborhood of the test location. Videos of the walk were edited to show how the navigation system would work. An NFC-chip was attached to the navigation card and connected to the video, which made the video pop-up when placed on the backside of the mobile phone. The people with dementia were asked to hold the smartphone put the navigation card on the backside of the phone and follow the instructions of the navigation system. The participants were encouraged to think out loud and explain their thoughts when using the system. The researcher walked along with the participants and observed their behavior, only intervening when something went wrong. After the walk, the researcher asked the participants questions about the ease of use of the navigation system and how the participant would use it in their current lifestyle.

Cognitive walkthrough

The caregivers could test a mock-up version of the app to experience the steps to creating a route for the location cards. They were given specific tasks they had to carry out while the researcher noted their experiences and actions. After the walkthrough, questions were asked about the system's ease of use and the caregiver's willingness to invest time in setting up routes with such a system.

Figure 51 & 52: Overview of two of the five routes walked during the usability test

9.2 Validation results

The results from the user tests were summarized in different themes and supported with quotes from the participants. The results from Participant 1 of the usability test are not considered in this analysis. Despite the researcher's multiple efforts, the Participant seemed to misunderstand the tasks of this test, leading him to ignore the navigation prototype.

Understandability navigation cues

All participants were able to independently follow the cues from the navigation system to arrive at their destination. The researcher had to intervene once when Participant 5 was too distracted by explaining her thoughts about the device to the researcher that she missed a cue to go left. Only when the researcher asked whether they were still going the correct way did the participant notice the mistake.

The universal meaning of the arrow, in combination with the words "follow the arrow," was understood by all participants. Four out of the five people with dementia repeated the words aloud before following the direction of the arrow when they were asked to follow the navigation system's directions. Furthermore, two participants explained that they used their surroundings to check if they were following the directions given by the navigation system. Similarly, it was observed that almost all participants were continuously looking from the screen to their environment to check their progress. All participants liked the ability to get navigation cues that go further than the door of a building.

"Ah, the arrow points past the pole in the road so I have to go past the pole and then into that direction."
72 year old male with dementia

The translucent blue boxes highlighting important landmarks gave participants a focus point on the route. However, participant 7 mentioned that it would be better if the boxes were highlighted in a way that did not influence the object's visibility.

"It is easier to use than Google, because I don't have to fill in an address."
60 year old female with dementia

"The navigation is guiding me to the sidewalk, which helps with being safe."
72 year old male with dementia

Traffic awareness

It was confirmed that traffic awareness could be lower by people using the navigation system. Participant 6 had to be warned by the researcher when he wanted to cross the street without looking up from the system. Other situations like this did not occur. The quote of Participant 3 showed how she and another participant tried to

remember upcoming cues to focus more on the traffic. The prototype that Participant 7 used had a traffic warning (as shown in 8.3). She reacted positively to the visual and audio warnings. She even mentioned that the audio warning would be beneficial if she is tired. Even though she heard the warning six times on her 8-minute walk, she did not voice irritation toward the warning and reacted positively every time.

"Well, I can lower my arm until we reach that point. Then I can also see if traffic is coming."
78 year old female with dementia

Reassurance

Participants 3 and 7 mentioned that having a card that could always bring them home would reassure them when going outside independently. That would be the main reason for them to buy this device.

"These cards give me the freedom to just go into the woods and do my own thing. It creates a sense of calmness."
74 year old female with dementia

"When I have a blackout, I always get very nervous and insecure. Such a card would reassure me and make me calmer. I wish that the product already existed and worked. I need very few helping devices, but I really need a card like this."
74 year old female with dementia

Learning process

The caregivers mentioned that understanding and using the system will require practice. Especially the meaning of the navigation cards and their connection to the phone needs to be learned. Caregivers mentioned being willing to help their loved ones with this learning process even if they must commit their time to it.

"You have to understand that that token contains the route. You must be aware that you know how to grab your token if you get lost. It is not self-evident that someone knows this immediately, especially in a stressful situation."
80 year old caregiver

"I want to take those steps if it improves independence. But my husband has to learn how to use it. If he masters it, it will bring him a lot. Then it will be just a matter of putting the card in his wallet, and he can go his way."
63 year old caregiver

To learn and understand this device, people with dementia must start becoming familiar with it while they are still at the beginning of their dementia journey.

"When I held the app in my hands and saw the arrows, it was obvious what I had to do. And when you get closer to home, you recognize the road more."
78 year old female with dementia

"In a stressful situation, I still think about calling someone with my smartphone, so I should be able to do that (use the navigation system) too."
74 year old female with dementia

Carrying the mobile phone

During the test, most people held the mobile phone in their hands throughout the whole route. Only participants 3 and 5 stopped looking at the mobile phone when they knew where the navigation was directing them. Participants 3 and 7 stopped when they neared a crossroad and watched in which direction the arrow would turn. In comparison, the other participant followed the navigation without slowing down their walking pace. Figure 53 show the range of postures the participants had while carrying the mobile phone.

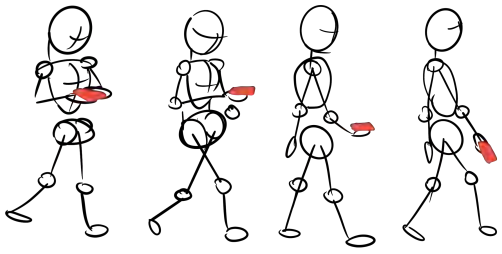


Figure 53: Postures observed during the usability test. (The red spots represent the smartphone.)

Carrying the navigation cards

All participants with dementia had a flip-cover phone case to store essential cards and personal information (like address, phone number, and birth date). Since the participants already have a flip cover, their preference went to the flat navigation card that could be stored in the flip cover. Participants also mentioned that carrying the cards in a cover felt safer because otherwise, they expected to lose them.

"The pictures on the tokens also help. It is good to put the names on there, too. That makes it even clearer."
63 year old caregiver

"I could easily incorporate this into my routine. I always take my cell phone with me now. I would just put the home card in my mobile case."
74 year old female with dementia

Context information on the map

The simplified and detailed map version did not give helpful information for people with dementia or their caregivers. Maps, in general, were seen as too abstract and complex to understand by people with dementia. Participant 2, however, mentioned that the connection between the navigation cards and their destinations could be easier to understand if they were added to a board with the week's agenda written on it. Because of this feedback, the map is not explained as a feature in Chapter 8.3 or used in the second round of the user test.

Use cases for the navigation device

Participants mentioned using the device to go to unfamiliar places like the stadion, theater, or cinema. Besides walking, Participants 1, 2, and 5 also expressed interest in using the device on their bicycles. Participants 6 and 7 mentioned public transportation as a use case that they would want to see incorporated into the device. Lastly, participant 2 explained the need for a night version of the navigation app that highlights key features that are less visible in the dark.

"I would use this for a lot of places. There are many places in Almere that I would like to visit."
65 year old male with dementia

9.3 Conclusion

5. **What are the experiences of people with dementia and their caregivers with the device?**

People with dementia find knowing you carry a navigation card with you reassuring. Through these cards, they can regain some of their freedom and independence. The ability of the device to give you navigation cues even when you are inside a building was seen by people with dementia and their caregivers as a great feature. Furthermore, the street names and personal landmarks gave people focus points while navigating.

a. Are people with dementia able to independently use the navigation device to visit outdoor places?

Yes, the findings of this test show that the participants could reach their destination without the help of a second party. The navigation cues on the navigation app are easy to understand, and the context that the video images provided helped participants keep track of where the navigation was directing them.

b. How can the navigation be implemented into the current routine of people with dementia and their caregiver?

People with dementia must get time to become familiar with and learn how to use the device. Therefore, they should be introduced to a device like this at the beginning of their dementia journey. Furthermore, with improvements that allow people with dementia to store the navigation cards on their phone cover, the concept can easily be integrated into their current routine. A possible opportunity for further integration is the ability to connect the cards to the user's agenda.

c. What do caregivers think of the route selection app?

Caregivers mentioned being willing to spend more time setting up the routes even if this does not directly saves time. However, the process needs to be easy to understand.

PART 10

Discussion

10. Discussion

Through researching the needs and requirements of people with dementia, a product was developed that aids people in wayfinding. This wayfinding device is validated with people with dementia and caregivers to show the extent to which it meets the project's goal.

10.1 Discussion

The aim of this project was to research the needs and requirements of people with dementia (and their caregivers) when they navigate their outdoor environment to develop a solution that enables them to visit outdoor places. Safe, independent and with confidence.

This project shows how people with dementia can be supported by a navigation device to visit places in their outdoor environment independently. The navigation device was developed through an iterative process that included literature studies, workshops, interviews, a design sprint, and user tests to find the most suited solution. Throughout the project, 19 people with dementia shared their experiences with the designer, which helped form the final design.

People with dementia experience problems with wayfinding due to symptoms of their disease. These difficulties can limit a person's ability to perform activities related to independent living and impact their emotional well-being. By enabling people with dementia to visit places independently, they will regain independence, relieve some of the burdens on the caregiver, and even reduce the growing costs of dementia on the healthcare system.

Current navigation devices are too complex and require too many steps making it impossible for people with dementia to use them. The products designed to help people with dementia in the outdoor environment only focus on tracking instead of enabling the person with dementia to navigate. That is why there is a need for a simple navigation device specifically designed for people with dementia that reassures them that they can navigate themselves to the correct location.

There is a clear opportunity here because, within this research, no competitor could be found with an effective navigation device for this target group. As highlighted in Table 5, the navigation device developed in this project proved to be more suited for the target group compared to devices with a similar goal.

Key features of the proposed solution are the context information provided by the AR navigation, the personalized landmarks, the intuitive navigation cues, and the limited actions needed to activate the navigation. The effectiveness of the navigation was proven during the concept's validation since all participants could independently follow the navigation.

Overall, the proposed solution provides people with dementia with a feeling of reassurance and freedom since it puts

them back in charge of their active lifestyle. People with dementia can, with the caregiver's help, get the support they need from this navigation device to independently visit places in their neighborhood.

					
		Homing compass	**Wearable haptic-feedback navigation**	**Automated wayfinding system**	**Proposed solution**
TEST CHARACTERISTICS	Amount of test participants	8	6	7	5
	Test participants that have dementia	✓	✓	✗	✓
DESIGN REQUIREMENTS	Understandable	✓	✓	✓	✓
	Minimal actions required	✓	✓	✗	✓
	Stimulating	✓	✗	✓	✓
	Adaptable	✗	✗	✓	✓
	Progress confirmation	✗	✗	✓	✓
	Arrival notification	✗	✓	✓	✓
	Multi-sensory	✗	✗	✗	✓
	Forgettability	✗	✓	✗	✓
	Portability	✓	✓	✓	✓

Table 5: Overview of product analysis scored against the design requirements.

10.2 Limitations

Looking back on the project, several limitations that influenced the proposed solution and its validation can be pointed out.

Throughout the project, a large number of people with dementia were involved. The researcher actively tried to get as much feedback as possible from this group. However, only two caregivers gave their input on the design. Caregivers play an essential role in the proposed solution and greatly influence the decision-making process of purchasing help devices for people with dementia. That is why it would have been beneficial if more caregivers would have participated in the research.

Similarly, case workers are important stakeholders in the dementia journey of people. They are the people who give information about living with the disease to people with dementia. Unfortunately, no case worker was involved in the project, so their perspective is missing.

The lack of involvement of caregivers could have altered the research findings during the explorative research. People with dementia often forget the context in which specific experiences have happened, which can paint a distorted picture. Therefore, it would have been helpful to have more caregivers present during the research activities so that they could add to or correct information given by their loved ones.

Some limitations can also be found within the final design's validation. The usability test in which people got to experience the navigation system existed out of approximately 10-minute walks. These walks were near familiar locations and did not involve complex or busy traffic situations. Therefore the insights from this validation can only give an impression of how people with dementia will experience using the navigation device.

10.3 Recommendations

The limitations identified in Chapter 10.2 can be overcome by taking note of the following recommendations.

Research

The validation of the concept executed in this project gives an impression of the user experiences; however, to get a more in-depth understanding of how the navigation system will be used in real life, a test should be conducted that studies at least twenty people with dementia and their caregivers using the device for over six months. This test will uncover many issues that will help the product evolve. A more extended testing period can also show interesting insights into how the product should adapt to the decline of the user's abilities. Furthermore, a more extended test period could show improvements in behavior and emotions. The current validation only showed how people responded to the navigation and how people thought that the concept would be able to improve their lives. Over a longer test period, participants can reflect on whether these expectations are met.

Additional research should be done on improving the learning process of understanding and using the device. The navigation and interaction with the navigation cards are kept as simple as possible to make them easier to understand and use. However, people with dementia will still need to become familiar with the system. This process of familiarizing should be analyzed, and improvements need to be made based on the results.

Development

The current prototype used Wizard of Oz methods to help the users experience the navigation system. However, a functional prototype is required to test the concept over a longer period. To create this prototype, further research and development are needed on the technological side of the product. Especially the communication between the different design components should be further developed. To speed up the development process, other companies that are further ahead with AR Navigation or digital navigation systems could be contacted to discuss possible collaboration. In that case, a focus should be placed on developing the navigation cards since they are a unique element that can add to existing navigation devices.

During the concept development, less emphasis was placed on creating the route selection app for the caregiver. This part of the proposed solution requires further research and development.

The participants mentioned that they would use the navigation app at night.

Currently, the UI of the navigation app is designed for daylight use. If a user test is going to be carried out for a long period, then a night mode should be developed. At night, personalized landmarks and other environmental cues that aid in wayfinding, like paths and nodes, must be made more visible.

Other use cases

The proposed solution is a navigation device that aids with walking; however, participants suggested using the device for public transport during the research. An extension of the current walking navigation could involve public transport since the context of public transport is similar to walking. Real life-footage with navigation assistance could be very helpful for people with dementia who want to travel further from their homes.

A navigation device for cycling was also mentioned several times. Cycling, however, requires a very different way of navigation. Cycling takes place in an environment that is quickly changing. In this context a navigation device can easily be distracting, leading to dangerous situations. Through this project, a need for a cycling navigation device was found. However, more research is needed to adapt the proposed solution to fit this use case.

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