

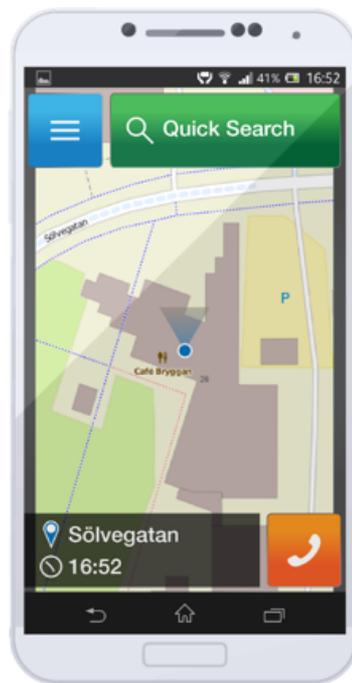
# NavMem UI Development

A New User Interface of Navigation App  
Evaluated by Persons with Stroke

*Petter Bergeling*

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*Division of Machine Design • Department of Design Science  
Faculty of Engineering LTH • Lund University • 2015*



LUND UNIVERSITY





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## **Preface**

This report is part of a degree project in Mechanical Engineering with Industrial Design that has been carried out in collaboration with the EU project NavMem as well as Certec within the Department of Design Sciences at Lund University.

First of all I would like to thank the supervisor of this project, Kirsten Rasmus-Gröhn, for guiding and supporting me through this process by being a sounding board rather than pointing fingers.

Furthermore, a big thank you to Allan Hedlund of the Swedish Stroke Association who has helped me understand and get in contact with the target group of this project.

Lastly, thanks to all the test participants for the feedback, laughs, coffee and pastry.

Lund, February 2015

Petter Bergeling



## **Abstract**

The elderly population within the European Union is growing where as the amount of caregivers is not. The objective of the NavMem project is to make older citizens more self-sufficient and confident specifically while traveling on foot. This could potentially lead to a more active and social life while decreasing the need of senior citizen care. With this objective in mind the NavMem consortium have up to this point created two separate beta-stage Android applications intended to aid and support the above mentioned target group.

The purpose of this thesis project has been to evaluate these applications as well as develop User Interface prototypes in order to improve the Usability and by extension the User Experience of the finalized product. The project was carried out using an iterative and user-centered methodology in order to ensure a final prototype in line with the needs of the target group. The Swedish Stroke Association assisted in putting together a group of test participants that were consulted throughout the project.

The project resulted in an assessment of the current applications as well as two prototypes, with the second one being a further development of the first. Decisions made while developing the prototypes are made based on input from the test participants as well as relevant theories within the field of User Interface. The last prototype displayed great improvement regarding Usability, compared to the current applications, as validated by the evaluation process performed.

To further ensure a successful final product field tests with larger portions of the target group would need to be conducted. This report however, aims to form the basis and guide the NavMem consortium in their future decision-making regarding the User Interface of the final product.

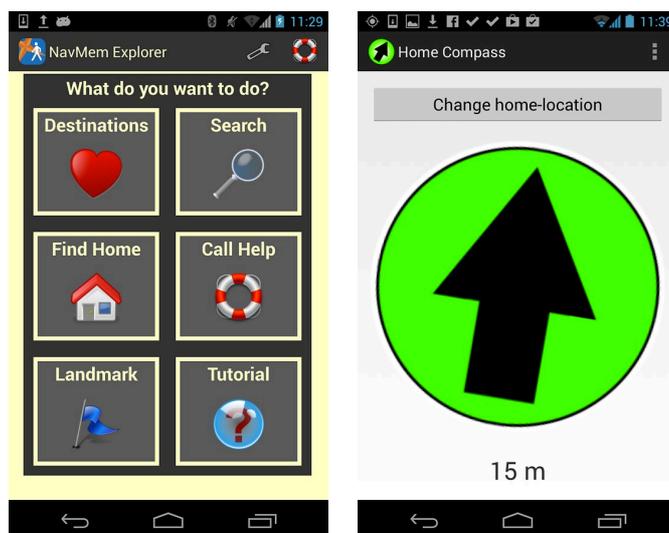
### **Keywords:**

User Interface, Usability, Design for Elderly, Prototyping, User-centered, User-driven, Iterative Design Process, EU project, NavMem, Navigation, Smartphones



## Sammanfattning

Syftet med detta projekt är att förstå problematiken med samt se möjligheterna i samspelet mellan äldre människor och ny teknik. Projektet kretsar kring användargränssnitt och dess användbarhet samt ämnar förstå hur dessa kan förbättras. Målgruppen kan ytterligare avgränsas till äldre människor med minnesnedsättning alternativt kognitiva nedsättningar till följd av stroke eller demens. Mer precist utmynnar denna rapport i en analys och användbarhetsundersökning av två existerande, men ännu inte färdigutvecklade, navigationsapplikationer till Androidtelefoner skapade av EU-projektet NavMem. Se figur 1 nedan för utdrag från dessa två applikationer kallade *NavMem Explorer* och *Hemkompassen*.



**Figur 1** De två existerande Android-applikationerna NavMem Explorer samt Hemkompassen.

Med grund i dessa två applikationer har prototyper för ett nytt användargränssnitt tagits fram, där *NavMem Explorer* och *Hemkompassen* slagits samman till en applikation. Dessa prototyper ämnar fungera som inspiration till användargränssnittet i den slutgiltiga produkten. Detta arbete har skett i samarbete med NavMem och i tät kontakt med målgruppen. Arbetet pågick i 20 veckor.

Inledningsvis genomfördes en kunskapsinhämtning av för projektet relevant material och teori såsom befintliga användarundersökningar genomförda av NavMem-projektet, teori inom användargränssnitt, interaktionsdesign samt design för äldre. En sedan tidigare upprättad kontakt mellan Lunds Universitet och Svenska Strokeförbundet bidrog till att skapa ett kontaktnät som i förlängningen skapade en användargrupp på åtta personer för detta projekt.

Denna användargrupp bidrog till att analysera användbarheten hos de redan existerande applikationerna samt bidrog med åsikter gynnsamma för utvecklingen av de prototyper som sedan skapades. Resultaten från analysen av de redan existerande applikationerna påvisade tydliga brister hos framförallt den ena applikationen, *NavMem Explorer*. I Tabell 1 nedan visas ett utdrag från användbarhetsundersökningen av *NavMem Explorer*.

**Tabell 1** Utdrag från användbarhetsundersökning av *NavMem Explorer* med fem deltagare

Karaktäristika	Poäng* (fem deltagare)	Medelvärde av poäng
Överskådlig	1, 1, 3, 4, 4	2,6
Enkel	2, 2, 2, 4, 4	2,8
Tydlig	3, 3, 1, 4, 4	3,0
Uppmuntrande	1, 1, 1, 2, 2	1,4

\*) 1: Instämmer inte alls 5: Instämmer till fullo

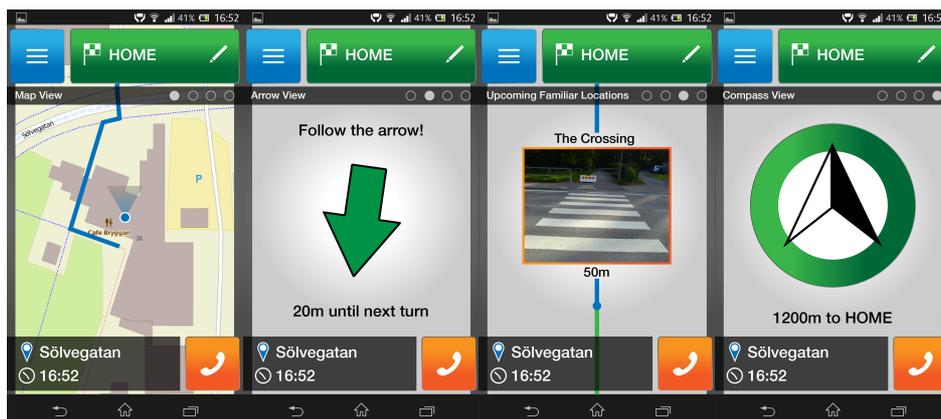
Under projektet användes en användarcentrerad och iterativ arbetsgång vilket genererade två prototyper, *Prototyp 1* och *Prototyp 2*. *Prototyp 2* är en vidareutveckling av *Prototyp 1*. Analysen av de redan existerande applikationerna låg till grund för skapandet av *Prototyp 1*. Vidare låg utvärderingen av *Prototyp 1* till grund för utvecklingen av *Prototyp 2*. Slutligen har det även utförts en utvärdering av *Prototyp 2* som kan användas för fortsatt utveckling av applikationen utanför detta examensarbete. Se Tabell 2 nedan för ett utdrag från användbarhetsundersökningen av *Prototyp 2*.

**Tabell 2** Utdrag från användbarhetsundersökning av *Prototyp 2* med fem deltagare

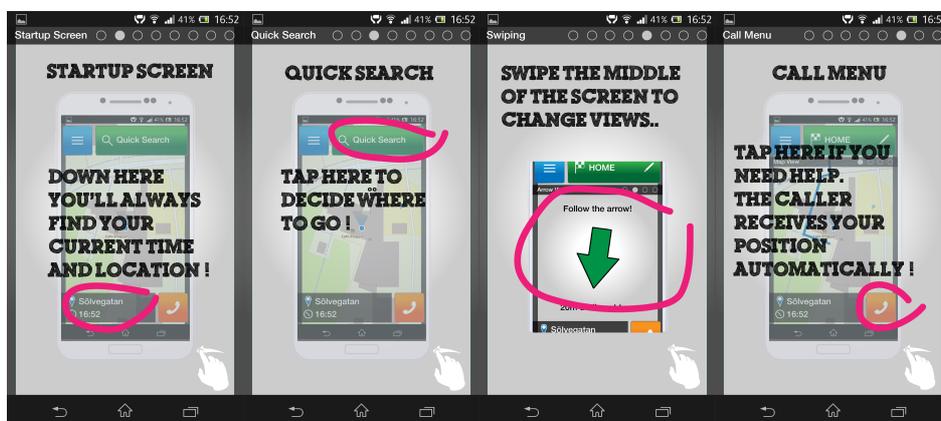
Karaktäristika	Poäng* (fem deltagare)	Medelvärde av poäng
Överskådlig	4, 3, 4, 4, 4	3,8
Enkel	4, 4, 5, 4, 5	4,4
Tydlig	5, 5, 4, 4, 4	4,4
Uppmuntrande	-, -, 4, 3, 4	3,7

\*) 1: Instämmer inte alls 5: Instämmer till fullo

Flera förbättringspunkter hos de initiala applikationerna har identifierats under arbetets gång och validerats genom användbarhetsundersökningar av ovan nämnda prototyper. Slutresultatet av projektet består av *Prototyp 2* med tillhörande instruerande hjälpaavsnitt. Se Fig. 2 samt Fig. 3 nedan för utdrag från *Prototyp 2* respektive det instruerande hjälpaavsnittet.



Figur 2 Utdrag från den slutgiltiga prototypen.



Figur 3 Utdrag från tillhörande hjälpaavsnitt.



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# 1 Introduction

*The opening chapter of this report will provide a short background of the reason for carrying out this master thesis project. It will introduce you to the NavMem consortium and define differences between their purpose and the purpose of this thesis. The aim as well as the scope and limitations of the project will be determined.*

## 1.1 Background

The elderly population of the European Union is continuously growing and will continue to do so for the foreseeable future. Meanwhile the funding towards welfare and more specifically senior citizen care is not - in fact, in many countries it is decreasing [1]. This situation is worrying and the obvious action would be to somehow provide more professional caretakers. However, there is another way of looking at it. Maybe we could provide some sort of aid that would help elderly people become more self-sufficient? In this case self-sufficiency should not imply or amount to loneliness. This is of much importance. On the contrary the aid should encourage physical and social activities while insuring safety.

The scenario above is the main idea behind the EU project NavMem. The NavMem consortium consists of seven partners one of whom is Lund University and more specifically Certec within the Department of Design Sciences. Certec has been the closest supervisor of this thesis.

The aim of NavMem is to create a system that provides orientation and navigation support to reduce the fear of getting lost while traveling on foot. This is an ongoing project that when this thesis was started consisted of two different beta-stage Android applications; NavMem Explorer and the Home Compass.

The target group is people with age related memory decline, mild cognitive impairments and other cognitive impairments that occur with diseases such as stroke, brain injuries or early stages of dementia. All of the above have negative impact on the ability to navigate and orientate. For more information about the NavMem project see Section 2.2 or visit their webpage stated in [2].

## 1.2 Brief

The objective of this master thesis is to, in close contact with above mentioned target group as well as the NavMem consortium, review the current beta-stage applications as well as create new User Interface (UI) prototypes that will help increase the

*usability* of the final product. Furthermore the aim is to combine the two above-mentioned applications into a single one.

The contents of this report will elucidate the outcome of the final prototype and help the NavMem consortium in their future decision-making concerning the application(s).

### **1.3 Scope and limitations**

The purpose of the prototyping is to develop the UI of the applications and not its functions, such as GPS-driven maps and search engines. However, any input received during meetings with the primary target group, regarding the functions of the current applications, will be forwarded to the NavMem consortium in Chapter 4.

The target group of the NavMem project is somewhat wider than the target group consulted during this thesis. The reason being that the Lund University has focused their user studies on people affected by stroke. However, results from user studies conducted by the NavMem consortium with the remaining part of the target group will be available through reports. These reports will have part in the making of the final prototype that aims to satisfy the entire target group of NavMem.

## 2 Background and User Interface Design

*This chapter will further investigate the target group and also present the NavMem consortium and the current state of their two beta-stage applications. Relevant theories concerning designing for elderly as well as theories regarding UI will be described.*

### 2.1 The primary users

The primary users are people with milder cognitive impairments that result in difficulties to orientate and memory loss. Old age, diseases such as dementia and stroke as well as brain injuries can cause cognitive impairments of this kind. Below, some of these causes are described, for more detailed information see [3].

#### 2.1.1 Users with dementia

Dementia is a syndrome that causes a progressive decline of cognitive functioning and mainly occurs among elderly. It has a wide array of symptoms that largely differs from case to case. However, in early stages, loss of short-term memory and difficulties performing everyday tasks are common [3]. In addition to memory loss, people with dementia can have difficulties to structure and schematically plan their living as well to orientate, even in familiar territory [4].

In Sweden, almost half of the people diagnosed with dementia still live at home and out of them, one half live alone [5]. The number of people diagnosed with dementia still living at home will dramatically rise within 15 years [3].

#### 2.1.2 Users affected by stroke

Stroke is caused by clot obstruction or rupture in a blood vessel that prevents the blood from reaching the brain. In Sweden stroke is one of the most frequent causes of disability or death. Roughly equal numbers of men and women get strokes and the average age of the affected is 75 years. Due to the impact stroke has on the brain dementia can result from it [3]. However, more commonly it can lead to hemiparesis and aphasia.

### 2.1.3 Users with mild cognitive impairment

For many years, MCI (mild cognitive impairment) is a diagnosis that has been used in clinical research when a diagnosis of dementia is not valid but there is still some sign of dementia-related symptoms. One third of individuals diagnosed with MCI will over time (i.e., a few years), develop a dementia disease while a third will not and the rest will still be classified as in a border zone. Persons who develop MCI due to a stroke mainly suffer from deficits in attention, short-time memory loss and language problems. Orientation of time also becomes more difficult [3].

### 2.1.4 Elderly Users

Difficulties to orientate and navigate are common among elderly without significant cognitive impairment as well. Insecurities about carrying out everyday tasks such as shopping for food are also common. It is also important to consider other conditions coming out of old age, such as impaired vision, when designing a UI for elderly users.

Among physiological changes that happen because of ageing, reduced vision and hearing are some of the most common. The reduction in vision can happen to for instance the near vision, the field of view or contrast and color sensitivity [6]. Further, reaction time, attention span and working memory can be negatively affected by old age [7].

## 2.2 NavMem

NavMem was started on the 1st of October in 2012 and consists of seven partners from four European countries. See Tab. 2-1 below for declaration of the partners of the consortium.

**Table 2-1** The seven partners of the NavMem consortium [2]

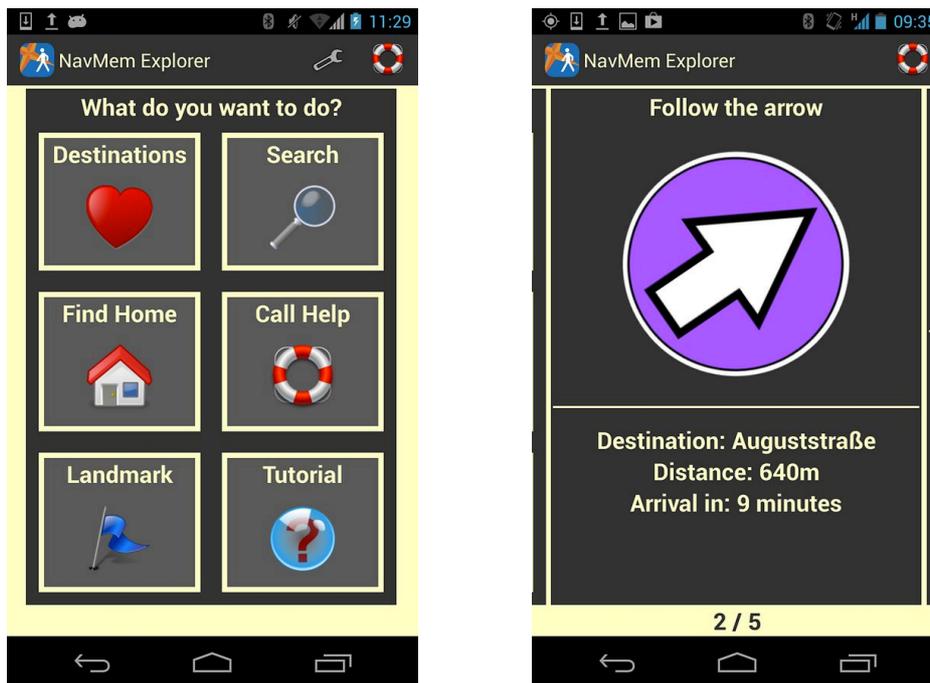
OFFIS – Institute for Information Technology	Germany
Siemens AG	Germany
Swedish Stroke Association	Sweden
Lund University	Sweden
Astando AB	Sweden
Roessing Research and Development	The Netherlands
Navex	Great Britain

Through their user studies NavMem have compiled several user needs relevant to the UI such as large icons, suitable naming of functions and appropriate color schemes. See Appendix A for a full list of the user needs stated by NavMem.

## 2.3 Current state of the beta-stage applications

### 2.3.1 NavMem Explorer

The aim of the NavMem Explorer is to fully satisfy the needs of the users with a broad variation of functions and navigation guidance. It provides the ability to search for and select any given destination. See Fig. 2-1 below for two screenshots of the NavMem Explorer.



**Figure 2-1** Start screen (left) and arrow navigation (right) of NavMem Explorer

#### 2.3.1.1 Functions

The functions within the NavMem Explorer allows the users to

- Search for any destination and receive navigational guidance (Search)
- Save visited destinations thereby making them quickly available to select, and receive guidance to, next time (Destinations)
- Save and thereby quickly receive guidance to their home position (Find Home)
- Call for help and at the same time provide the receiver of the call with their position via e-mail (Call Help)
- Save *Landmarks* that will support orientation (see definition below) (Landmark)

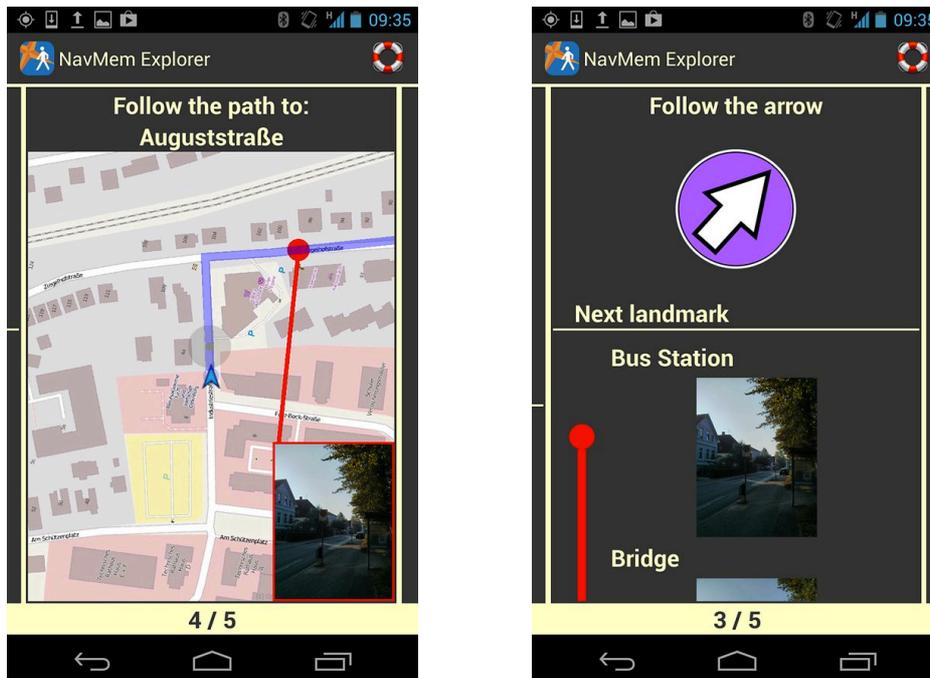
## 2 Background and User Interface Design

Landmarks are locations that are familiar to the user, such as a church or a crossing. These locations are different from destinations, in the way that they are solely used as support in reaching the final destination.

### 2.3.1.2 Guidance and Routing

There are four different screens available while being guided to a destination. These are

- *Map View*, where the users position on the map is shown as well as the beginning of the route to the destination, see Fig. 2-2 below
- *Arrow View*, where an arrow shows the direction, see Fig. 2-1 (right) above
- *Arrow and Landmark View*, where the arrow is combined with information about upcoming landmarks, see Fig. 2-2 below
- *Map Overview*, where the full route is shown on the screen



**Figure 2-2** Map view (left) and Arrow and Landmark view (right)

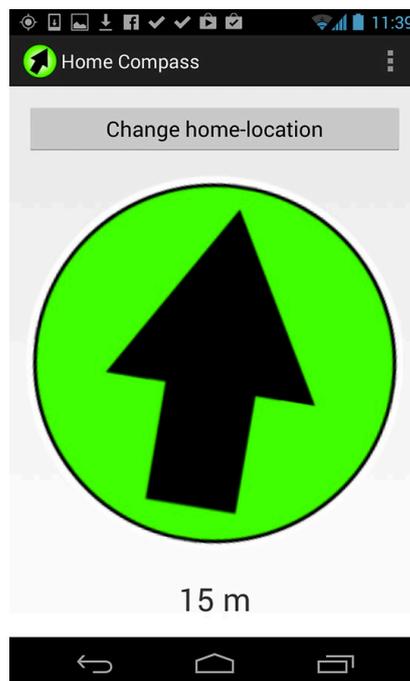
### 2.3.1.3 User Interface and Wireframe

The NavMem Explorer uses a Springboard Navigation Pattern, presenting most of the functions, as the start screen. When activating a destination four additional screens,

consisting of the different navigational aids, becomes available to the user. Swiping performs navigating between these as well as the start screen.

### 2.3.2 Home Compass

The aim of the Home Compass is solely to guide the user to their home, see Fig. 2-3 below. The guidance is provided by the use of a compass that shows the direction and remaining distance. The user has the ability to change their home-location whenever they wish.



**Figure 2-3** The Home Compass

## 2.4 User Interface Design and Terminology

### 2.4.1 Navigation Patterns

Today, there are a limited number of structural patterns used for navigation within a UI on mobile applications. These patterns have to be considered when developing new UI simply because they are established and most users have a distinct feeling how things should work. These patterns are usually categorized into *Persistent Primary Navigation Patterns*, *Transient Primary Navigation Patterns* and *Secondary Navigation Patterns* [8].

The primary patterns, i.e., *Persistent Primary Navigation* and *Transient Primary Navigation*, are used for primary navigation, which means navigating from one

category, i.e., group of features, to another. Persistent meaning that all your options are visible while transient means that some options have to be revealed with a tap or a gesture [8].

The secondary navigation patterns decide how you navigate within a category and include swiping and scrolling maneuvers. Below some of the more common patterns are explained. [8]

### 2.4.1.1 Springboard Navigation

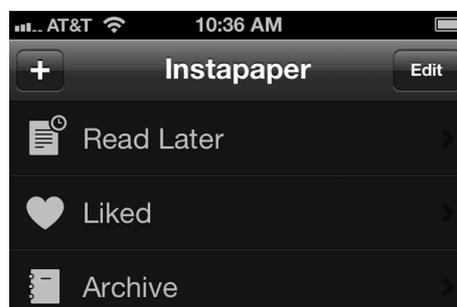
The Springboard pattern, also known as a Launchpad, is a very common choice when designing UI. It is recognizable by the grid-like placement of menus, for instance 3x3 set of icons as seen in Fig. 2-4 below. One of the concerns with this type of pattern is that all the options are flattened down to same level of importance [8].



**Figure 2-4** An example of Springboard Navigation [9]

### 2.4.1.2 List Menu

The List Menu pattern resembles the Springboard pattern since each list item is a launch point leading deeper into the application. However, this option usually leaves more room for text and less for icons [8]. See Fig. 2-5 below for an illustration of the List Menu pattern.



**Figure 2-5** An example of a List Menu [10]

### 2.4.1.3 Toggle Menu

The Toggle Menu is either an inlay or an overlay menu that appears on top of the current content on the screen while activated [8].

### 2.4.1.4 Page Swiping

Swiping is considered a Secondary Navigation Pattern that is usually used to navigate within the same level of the application. Page locators are usually used to indicate it [8]. From the study in [11], swiping was proven to be a fully functional way of interacting with a mobile application even for elderly.

### 2.4.1.5 Anti-Patterns

Anti-Patterns are what UI designers call interface mistakes where an element indicates more than one thing or does not sufficiently indicate anything. Simply put, things that make the user confused [8].

## 2.4.2 Donald Norman's Principles

When designing a product, certain principles should be held in mind. These principles assure the products usability and improve the User Experience. In [12, pp. 1-33], Donald Norman writes about these principles and based on his text a short description of them is written below.

- Visibility*      A product should visually exhibit how it is supposed to be used. Displaying the components of the product will help the users grasp its entire functionality.
- Affordance*      Affordance describes the ability of an object to imply its own proper usage. It has great importance when designing UI. Graphic buttons need to look like actual buttons in order for users to understand their intended use.
- Mapping*        The relationship between *Controls* and *Effects*. Clicking on a particular interface element (control) should produce the expected effect.
- Feedback*        When users perform an action they want feedback telling them the product is answering.

### 2.4.3 Colors

Colors are a great way of sorting information within an application [13]. There are certain colors that should not be combined and the contrast between background and foreground needs to be kept in mind. Colors that are opposite of each other on the *Color Wheel* are considered to be complementary colors meaning that when they are paired up next to each other they create the strongest possible contrast. See Fig. 2-6 showing a *Color Wheel* on the next page. The strongest possible contrast is usually not pleasing to the eye and should therefore be avoided when creating UI. There are some basic techniques for combining colors including triadic and tetrad color schemes. More information can be found in [14].

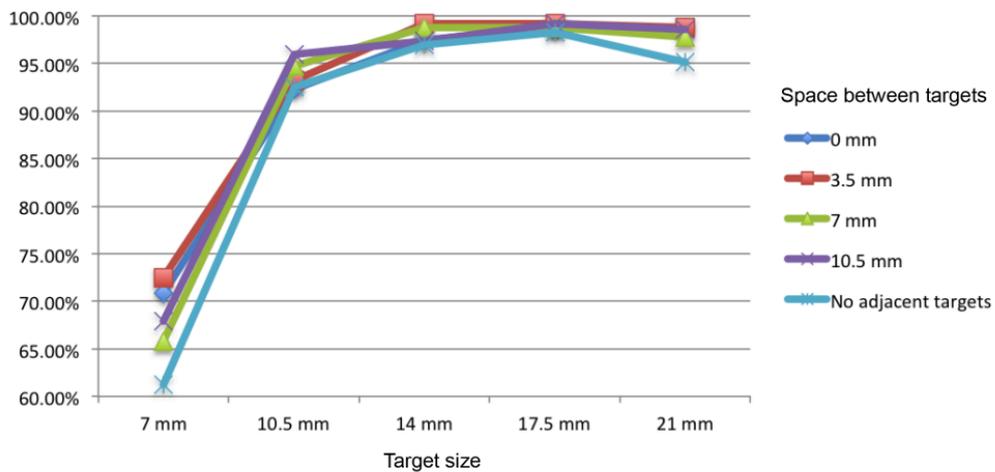


**Figure 2-6** Color wheel [15]

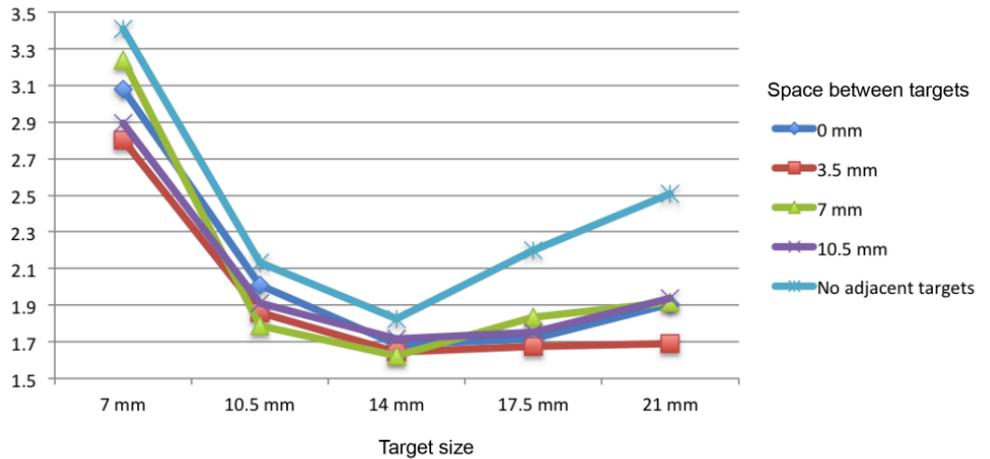
#### 2.4.4 Button Sizes and Spacing

When designing UI for elderly considering the target size of buttons is crucial. In [16] a study was performed to determine the necessary size of, as well as spacing between, targets (i.e., buttons) when designing UI for elderly on touch screen devices. Certain Tap and Swipe Games were created and the results are shown below in Chart 2-1, Chart 2-2 and Chart 2-3.

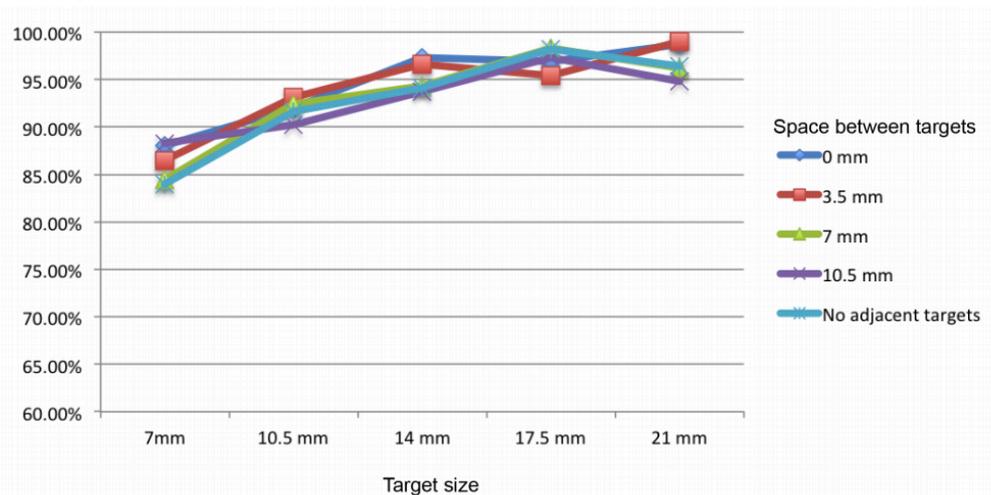
**Chart 2-1** Mean accuracy rates for the Tap Game according to target size and spacing size between targets [16]



**Chart 2-2** Mean task completion times [s] for the Tap Game according to target size and spacing size between targets [16]



**Chart 2-3** Mean accuracy rates for the Swipe Game according to target size and spacing size between targets [16]



The results states that a target size of 14 mm leads to the shortest completion times as well as a very high accuracy rate when tapping. The spacing between the targets is concluded to make less difference. Swiping targets on the other hand appears to be more functional the bigger the target area [16].

#### 2.4.5 Usability and User Experience

*Usability* defines the ability of a product to enable the user to perform certain intended tasks [17]. The usability of a product is often determined by observations

## 2 Background and User Interface Design

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and can quite easily be turned into metrics (i.e., the first task was completed by the user while the second was not). When determining the usability of a product there are five attributes usually considered

- Easy to learn
- Efficient to use
- Easy to remember
- Few errors
- Pleasant to use

[18]

User Experience however, measures the users attitude towards a product making it harder to determine. In [17] User Experience is determined to include three defining characteristics

- A user is involved
- The user is interacting with a product, system or really anything with an interface
- The users' experience is of interest and observable and measurable

Further a number of different courses of action to measure the User Experience are presented. All these different courses of action serve to measure the users' satisfaction of the product and help the designer to determine whether things are heading in the right direction. The study concludes that during an iterative process there are three possible outcomes when evaluating the User Experience [17]

- The new version tests better than the current product
- The new version tests worse than the current product
- No difference between the current product and the new product is apparent

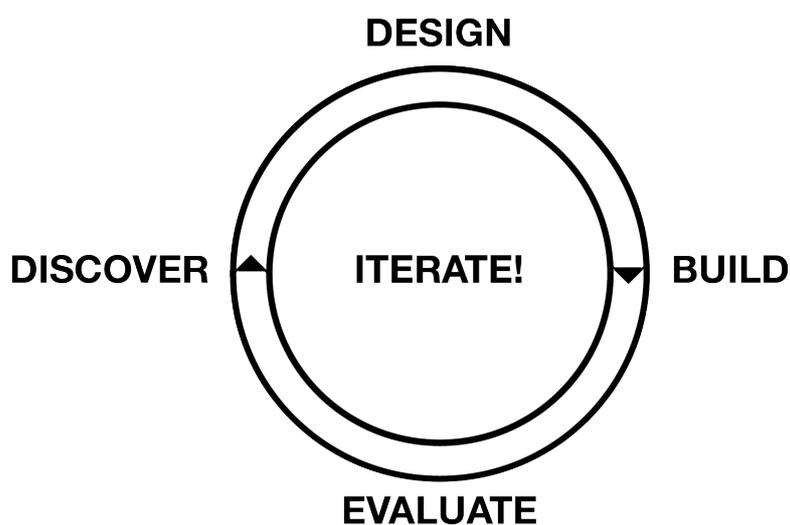
### 3 Methods

*This chapter will describe the methods used to carry out this master thesis project. Illustrations are included to clarify the order in which the steps of this project have taken place as well as to give an overview of the workflow. The project plan will also be visualized.*

#### 3.1 Approach

The main objective when performing this study was to conduct a user-centered design process. To insure a final prototype in line with the users needs, the process was iterative with a number of reconciliations with the target group. This kind of process and the importance of iterating when designing UI are further described in [19].

The method consisted of four different stages; discover, design, build and evaluate, see Fig. 3-1 below. The users were involved throughout the cycle. However, the involvement intensified during the discovery phases as well as during evaluations. The above-mentioned stages each contain several activities that are described on the following page.



**Figure 3-1** The iterative design process.

### 3.1.1 Discover

#### 3.1.1.1 NavMem User Studies

Previous to the start of this project, the NavMem consortium has performed substantial user studies [3]. These reports were a solid starting point of the discovery phase. The information from these studies was categorized and the material relevant to UI design noted, see Appendix A.

#### 3.1.1.2 Literature Studies

Literature studies of information regarding the field of UI and Design for Elderly were carried out in order to grasp the subject.

#### 3.1.1.3 Review of the Current Applications

In addition to these reports seven potential users were contacted via the pre-existent relationship between Lund University and the Swedish Stroke Association. Meetings were set up and during these the current beta-stage applications were presented and a proper introduction with walkthroughs and opening interviews conducted, see Appendix B.1 for pre-test protocol and chapter 4 for further information. Reconciliations with these users took place continuously throughout the project. During these, interviews were carried out using half-structured interviews, See Appendix B.2.

Thorough observations were carried out where methods comparable to the *Talk-Aloud* concept were used. Talk-aloud is a concept where the users are encouraged to be vocal while using the applications and thereby providing information about positive and negative aspects of them [20]. The testing of the beta-stage applications were concluded with a post-test interview, see Appendix B.3.

#### 3.1.1.4 Benchmarking

Existent mobile applications intended for elderly as well as navigation support applications were studied. The results of these studies will not be further described in this report. However, sources of inspiration will be mentioned in the presentation of the prototypes.

### 3.1.2 Design

Since the meetings with the target group were carried out throughout the project the design phase is somewhat difficult to describe. It was the process and the decisions made continuously that led up to the building of the prototypes. These decisions were heavily influenced by the user-input received along the way. Conversations with the users and visualizations of ideas led to minor decisions almost every day during the project timespan. This concept is sometimes referred to as *reflection in action* and is described further by Donald A. Schön in the book *Bringing Design to Software* [21].

However, on top of this progressive, day-to-day, decision-making process more hands-on methods led up to the embodiment of the ideas. These include sketching,

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see Appendix C, and the use of the *Card Sorting Method*, more information about this method can be found in [22]. Paper-based prototypes were created before creating each of the hi-fi (i.e., Android-based) prototypes.

### 3.1.3 Build

During the build-phase, prototyping-tools were used to realize the design concepts in order to make them available for evaluation by the target group. These include POP (Prototyping on Paper) and InvisionApp [23], [24]. All graphic elements were created in Adobe Illustrator.

### 3.1.4 Evaluate

While evaluating the prototypes a group of, in total, eight participants from the target group were presented with them and asked to perform common tasks related to navigation. This list of tasks further intended to make the user explore the entire wireframe of the prototypes. This was observed and documented, see Appendix D. Interviews were conducted and a scoring procedure was carried out in order to make the results comparable to previous prototypes as well as the current beta-stage applications. The categories within the scoring procedure were heavily influenced by five attributes often associated with *usability* [18], described in in Chapter 2. The evaluation process was qualitative rather than quantitative which meant that the group of participants was somewhat small (in this case eight users) but the interviews and observations thorough.

In the evaluation of the second and final prototype an in depth interview was conducted with the test participants. These interviews sought to further discuss the changes and decisions made during this project.

Additionally the first prototype was presented to, and evaluated by, parts of the NavMem consortium at the NavMem mid term review meeting in Oldenburg, Germany. The second and final prototype was demonstrated and evaluated during a meeting with NavMem members from Lund University and the Swedish Stroke Association.

### 3.2 Project plan

The Project Plan, see Fig. 3-2 below, is visualized and the iterative nature of the project clarified.

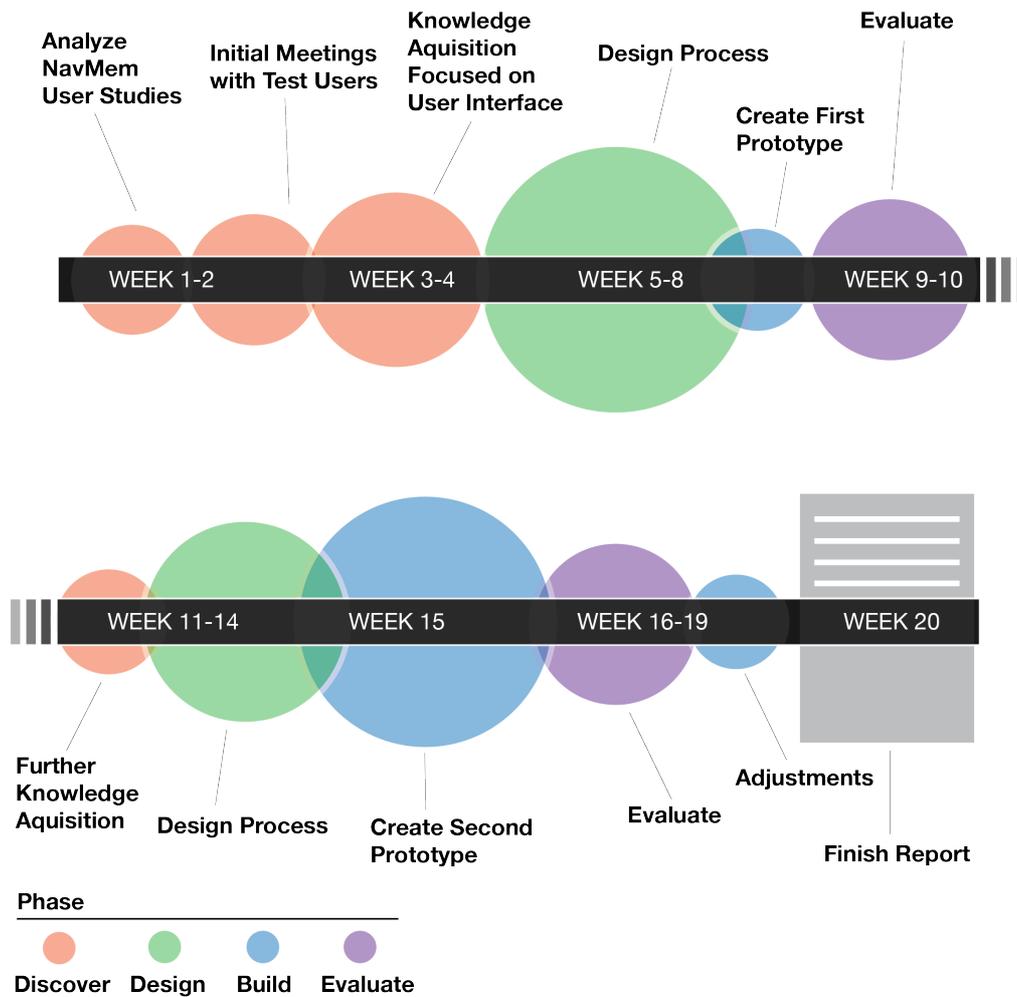


Figure 3-2. Project Plan.

## 4 Review of the Current Applications

*This chapter will describe and summarize the activities performed to review the current beta-stage applications. The results will be presented and analyzed.*

### 4.1 Test Setup and Procedure

The NavMem Explorer and the Home Compass were tested by, in total, 7 persons contacted through the Swedish Stroke Association. All of them were part of the target group while, however, only four had suffered a stroke. Their age ranged between 48 and 81 and the gender distribution was balanced. See Tab. 4-1 below for a list of the participants.

**Table 6-1** Test Participants

Participant	Affected by Stroke	Year of birth
A	Yes	1938
B	No (Spouse)	1933
C	Yes	1966
D	No (Spouse)	1943
E	Yes	1943
F	Yes	1949
G	No (Spouse)	1950

The test was carried out during a period of eight weeks by the Lund University part of the NavMem consortium, a member from the Swedish Stroke Association and the author of this thesis. The participants were asked to subjectively assess their motor abilities, navigational skills, vision as well as hearing. Inquiries were made about their previous use and experience of mobile phones and GPS devices. For interview protocol used see Appendix B.1.

Out of the four participants affected by stroke, one reported that the stroke had solely affected finer motor skills, such as writing. The remaining three reported no problems with their motor abilities. Two of the participants reported minor hearing impairments and two participants reported somewhat reduced vision.

The use of mobile phones was common. However, only three owned smartphones. Four participants had used GPS devices at some point to navigate in cars but never just for walking.

To initiate the test, the participants were provided with a smartphone or provided with the applications on their own smartphone. They were asked to use the applications as much as possible in their everyday life during a period of eight weeks. This meant that the testing was performed in an outdoor setting. During this eight-week period, the test was carried out as follows,

1. Startup meeting at the participants' home
  - a. Pre-test demographic interview and consent form, see Appendix B.1
  - b. Additional pre-test questions, such as previous experience of mobile phones, see Appendix B.1
  - c. Handing out phones and informing users of other practicalities
  - d. Introduction to the use of smart phones if needed
  - e. Carrying out a walkthrough of the applications in the participants' nearby outdoors environment
  - f. Helping users to store phone numbers for *emergency contacts* including the contact information of the test leaders
2. Intermediate contact
  - a. Test leaders kept in contact with the participants via phone or physical visits. The number of reconciliations depended on the need of the participant
  - b. An intermediate interview was carried out, see appendix B.2
3. Post-test meeting
  - a. A qualitative interview, see Appendix B.3 was carried out.

#### **4.2 Results – NavMem Explorer**

Through logging software, the usage of the NavMem Explorer could be recorded and the participants were also asked about their usage during the test period. The frequency of the usage during the period differed between the participants but in general they did not use the applications in any further extent outside the above stated meetings.

The test participants did not explicitly provide much positive feedback regarding the NavMem Explorer. The key functions were not presented in a suitable way to the user group, which made it hard to use the more advanced application NavMem Explorer in comparison to the Home Compass. However, one user pointed out that the home function in NavMem Explorer worked well.

In the early stages of the test period, some preliminary concerns were noted

- The Search Function is difficult to use and understand
- There is no information of where you are when the application starts
- Everything needs to be made easier

When asked about difficulties in using the application throughout the test period, the participants reported an array of problems. These can be found in Appendix E.

### **4.3 Results - Home Compass**

The Home Compass was generally used more seldom than the NavMem Explorer. The participants found it quite easy to use, but experienced issues with setting the *Home Position*.

### **4.4 Assessment of the results**

#### **4.4.1 NavMem Explorer**

Due to the fact that many users experienced severe difficulties while using the NavMem Explorer a large portion of the assessment below discusses the recognized issues. Some of the questions in the test-protocols were left unanswered since large parts of these meetings were spent discussing these major concerns. This was a deliberate choice by the interviewers and interviewees since there were some time constraints to consider. The following assessment was made based on the feedback received.

The primary users did not fully trust the application. This was probably the biggest concern. Further, they had issues grasping the contents and separating the functions, which took the "fun" out of using the application. Possibly, the similar appearance of the five different screens could be a reason for the problems with the separation of function. However, the swiping between these screens worked well.

Instructions and walkthroughs of the application clearly have not been thorough enough by the test leaders. In-depth training should not be needed, however, all participants lacked a manual or instructive content to refresh their memory. Many of the test participants would prefer such material in writing and pictures (traditional manual).

Regarding technical issues the routing needs to be looked at as well as the accuracy of the compass. The *Landmark* function also needs to be re-designed. The users had a hard time grasping the concept and were confused by it. The participants have suggested re-naming, but it is not certain that it will resolve the confusion.

The smartphone keyboard is too small considering the primary target group. More advanced functions such as the *Free Search* need to be simplified. In conclusion, the list of suggestions received from the test participants should be reviewed carefully, and every suggestion considered. For instance, the issue of compass disturbance in the case of using walkers and electrical wheel chairs needs to be considered since it is not unusual for persons with MCI to also experience difficulties walking.

#### **4.4.2 Home Compass**

The Home Compass application works relatively well. Obviously it contains fewer functions that make it easier for the participants to comprehend. One thing that needs to be looked at is how to simplify the setting and changing of the *Home position*.



## 5 The Design Phase

*This chapter will briefly describe the activities performed during the design phase but most importantly declare the decisions made going forward to the prototype building. A design phase was carried out before building the First Prototype as well as before building the Second Prototype. This is a summary of both. It should be clarified that certain feedback stated in the previous chapter regarding issues with programming was not relevant to the User Interface of the application and thereby not considered when conducting the design phase.*

As mentioned in Chapter 3 the Design Phase is the process of decision-making leading up to the prototype building. These decisions have been made mainly through recognizing issues with the current beta-stage applications and trying to find a way to solve these. The meetings with the users have played great part in the decisions made as well as the knowledge gathered through the literature studies.

The design phase is however a typical case of trial and error. Therefore the iterative nature of this project is crucial. Throughout this project a number of decisions have been made that will be visualized in the following chapters showing the prototypes. These decisions are stated and substantiated in this chapter.

### 5.1 Separating the primary and secondary users

Continuously throughout the project it has become apparent that there needs to be a differentiation between primary and secondary users, primary meaning the person using the application (i.e., caretaker) and secondary meaning the person(s) providing and setting up the application (i.e., caregiver(s)). It seems unlikely that a person with the impairments stated in the target group would download and learn the application on their own. This does not mean that the application is unusable but simply that there need to be reasonable expectations, and that there are certain additional factors to consider, when designing the UI.

### 5.2 Separating the functions

There are a number of functions included in the NavMem Explorer and the Home Compass. The purpose of this project is not to alter these functions but to present them in a manner easier to apprehend keeping the users mind. The separating of primary and secondary users needs to be transmitted to the sorting of these functions. In order to do this the *Card Sorting* method was used [20]. All of the functions included in the NavMem Explorer as well as the Home Compass were written down

on individual notes. Further, by studying the obtained knowledge about the primary target group they were determined to be able to perform the following actions:

- Select a pre-programmed destination, including Home position, and receive navigational guidance
- Apprehend at least one type of navigational guidance
- Perform a call to a pre-saved contact when necessary

Obviously parts of the primary target group are able to perform more demanding tasks but the aim of the NavMem project is to oblige a wide target group meaning that there needs to be a low threshold. Accordingly, the following actions were left to the secondary target group:

- Save and Name Locations, including Home location (preferably adding a photograph)
- Save and Name Contacts (preferably adding a photograph)
- Perform a free search of destinations
- Change settings and thereby customizing the application with the primary user in mind

### 5.3 Avoid the Springboard Menu

During the meetings with the primary target group it became apparent that there was an issue with the Springboard Menu setup in NavMem Explorer. This Navigation Pattern resembles the visual appearance of the Launchpad on most smartphones, especially if they are prepared with a *Launcher* intended for elderly users, see Fig. 5-1 below. This at times created confusion of whether the user was operating within the application or rather still seeing the menu of the phone.



**Figure 5-1** The Necta Launcher [25]

#### **5.4 Introduce More Color**

Many of the users had issues separating the functions of NavMem Explorer. This can be explained by the use of the flat Springboard Navigation Pattern but also by the lack of color-coding. Even though some studies, for instance the NavMem User Studies, claim that the use of colors should be minimized the decision to at least examine the opportunities was made.

#### **5.5 Revamp the Start Screen**

When Launching the NavMem Explorer there is no way of seeing your current location without choosing a destination and thereby starting the routing. This might not be a major concern if you imagine that the users always starts the routing before leaving the front door, but what if the user suddenly becomes disoriented while already outside? This has to be considered a reasonable event given the target group. In other words the Start Screen of the application needs to visualize and preferable spell out the location of the user without them having to take any action. Further the NavMem User Studies state that losing track of time is common within the target group [3]. The decision to include the current time along with the current location was made. Obviously the time is visualized in the upper right corner of a Android phone but the font is too small and thereby not comprehensible to large parts of the target group.

#### **5.6 Quick Access to Important Functions**

In the NavMem user studies it is stated that important functions need to be easily accessed. Through meetings with the target group the ability to call for help (and thereby providing the user's current location) is established as one of the most important functions. On top of that the ability to choose a destination is obviously the main function of the application. These functions are therefore decided to be easily and quickly accessed through the Start Screen.

#### **5.7 Merge the Destinations and Landmarks Concept**

The meetings with the target group discovered that there was some confusion regarding the concept of *Landmarks*. The differentiation between destinations and landmarks was (in the final prototype) removed. Other saved destinations that the user passes along the way to the active destination would however be visualized.

#### **5.8 Saving Destinations**

In the NavMem Explorer the ability to save a destination is only available while arriving at the actual destination. The decision to provide, mainly the secondary users, with the ability to save destinations from any location is made. This would enable the secondary users to quickly pre-program the application to fit the primary user's needs, for instance by saving important locations usually visited (the grocery store, the health center etc.). This function was perceived to be essential to the development of the application and therefore predicted to be part of the final product. Hence the

visualization and presenting of the function was decided to be a part of the UI of the prototypes.

### **5.9 Swiping**

The concept of swiping was kept. All participants of the field trials understood the concept of swiping well and had no problems using it.

## 6 Prototype 1

*This chapter presents the first prototype created. The User Interface is described and the evaluation of the prototype presented.*

### 6.1 Building Tools

The first prototype, Prototype 1, was created with *POP (Prototyping on Paper)*, which is a prototyping tool used to turn a collection of sketches into an interactive UI mockup [23].

Initially the graphics were hand-drawn sketches however in its final form the first prototype was, due to efficiency, built with graphics created in *Adobe Illustrator*. These were imported to *POP* and tied together using the functions provided by program.

### 6.2 User Interface

#### 6.2.1 Wireframe

During the design phase a lot of time was spent separating and grouping functions thereby creating a hierarchy within the application. Especially functions that will be used by the primary target group were separated from functions directed to the secondary target group. The full screen compilation of this prototype can be found in Appendix F.

Functions intended for use by the primary target group include choosing destination, finding home and performing a call. These functions are all located in the bottom of the screen. In the upper right corner the ability to add and save new locations and phone contacts is represented by a plus symbol. These functions are mainly intended for usage by caregivers (i.e., the secondary target group). The upper left corner contains the Main Menu including different settings and the ability to log on or off which are all part of the NavMem Explorer functions.

#### 6.2.2 Start Screen

The start screen instantly shows the current time along with the current location of the user. There are two views available to the user, Map and Compass view, see Fig. 6-1 on the following page. Switching between these was performed either by a swiping motion or by selecting the desired view close to the top of the screen.

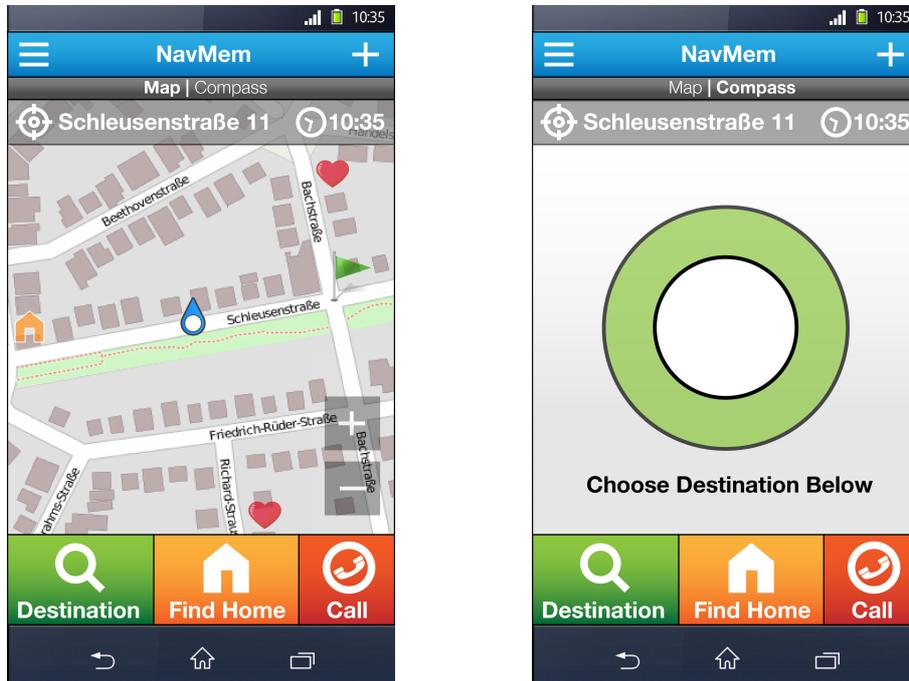


Figure 6-1 Start Screen Map (left) and Start Screen Compass (right)

### 6.2.3 Color Coding

The different functions and menus are color-coded using a tetrad color scheme; blue, green, orange and red. See Fig. 6-2 below for the tetrad color scheme used.

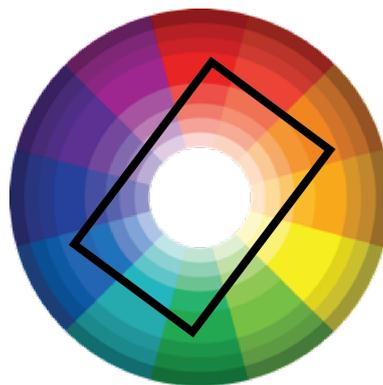
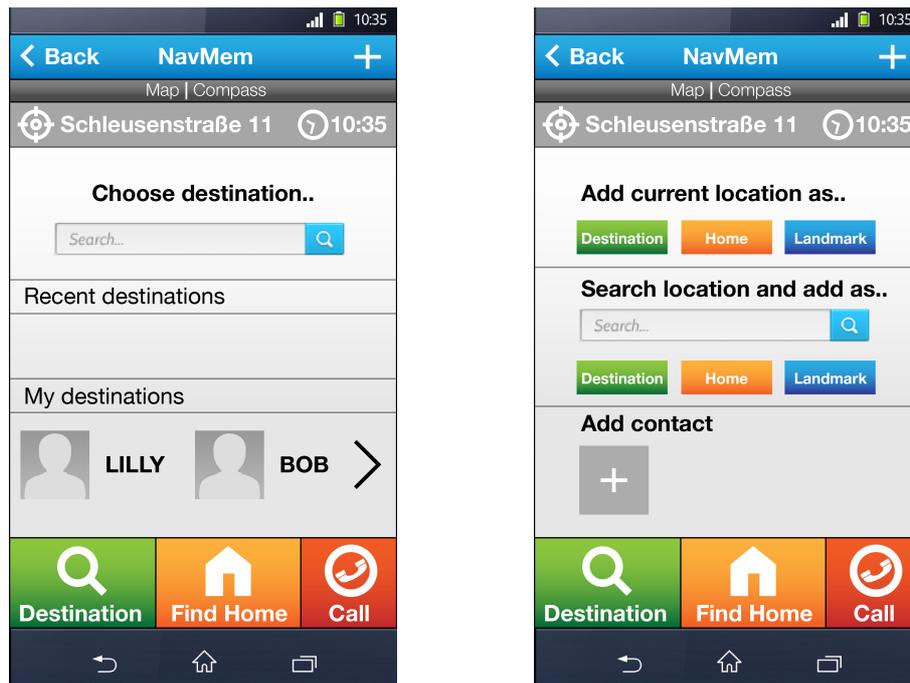


Figure 6-2 The Tetrad Color Scheme Used

### 6.2.4 Buttons and Menus

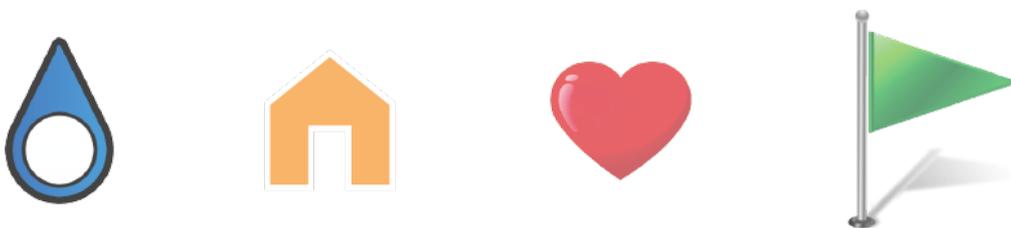
Buttons intended for the primary target group are labeled with both icons and text. All menus are Toggle Menus meaning they appear on top of the map or compass view. Clicking the Back-button that appears in the upper left corner regardless which menu is active performs returning from these menus, see Fig. 6-3 below.



**Figure 6-3** Destination Menu (left) and Add Location/Contact Menu (right)

### 6.2.5 Map Icons

The prototype contains four different Map Icons as shown in Fig. 6-4 below.



**Figure 6-4** Magnifications of the Map Icons

All icons except the Current Location Icon are clickable. If clicked they show further information about the destination and offers the ability to be guided there, see Fig. 6-5 below. The primary reason for having these Map Icons is to create a feeling of security. While using the application they give the user a feeling of being in a familiar environment.

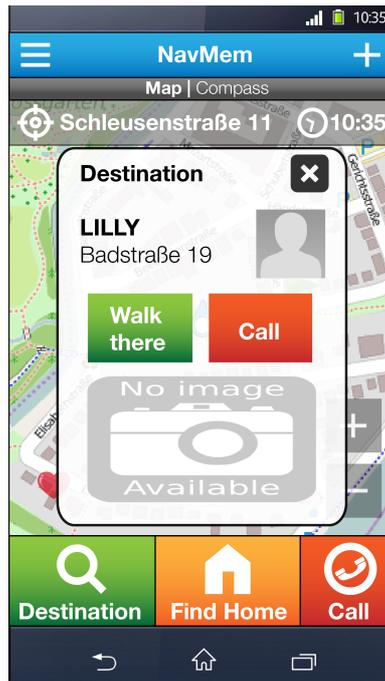


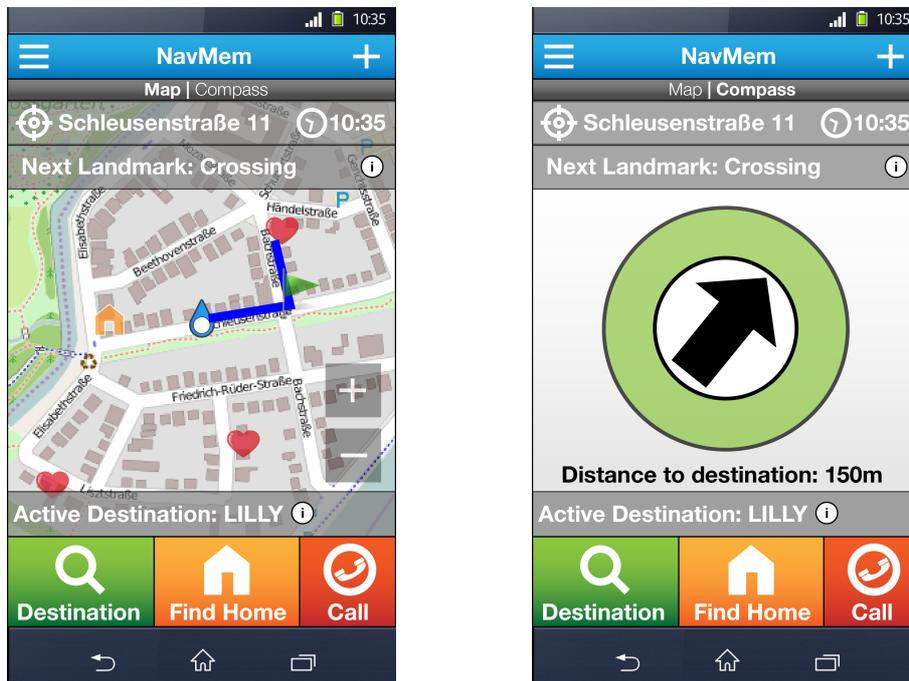
Figure 6-5 Pop-Up Menu

### 6.2.6 Routing

When a destination has been chosen, in this case “LILLY”, the Map View appears with a blue line guiding the user to its destination. The Compass View can also be chosen which instead shows an arrow telling the distance and direction (as the crows fly) to the destination, see Fig. 6-6 on the following page. The Compass View is highly inspired by the current *Home Compass* application.

The active destination also appears as a text field, which is placed on top of the lower row of buttons. The next Landmark that will be passed on the way there is shown just below the Map/Compass view toggle.

These are both clickable and give information about the location and how far you have left to get there as well as the current duration of your walk. If you want to abort your destination you click the active destination field and choose “End Destination”.



**Figure 6-6** Active Destination on Map (left) and on Compass (right)

### 6.3 Credits

Font used within the prototype – Helvetica Neue.

### 6.4 Evaluation

During the evaluation a Samsung Galaxy S5 prepared with the *Necta Launcher* was used [26].

#### 6.4.1 NavMem Midterm Review

This prototype was exhibited during the NavMem midterm review on October 15 2014 and feedback was collected, see Fig. 6-7 on the following page for a photograph of the participants. To summarize there was some confusion about what is clickable. Further the sizes of the photographs next to the contacts in the Call Menu were perceived as too small and the font perceived as all through somewhat small. On the other hand the prototype was perceived as more fun and encouraging and the idea to merge NavMem Explorer and the Home Compass was positively received.



**Figure 6-7** The NavMem Midterm Review

#### 6.4.2 User Maneuvering Test with Target Group (Observation)

During the evaluation a list of tasks were set to explore the entire wireframe of the prototype. These were read, one-by-one, to the users who performed them to the best of their ability. The concept of *Talk-Aloud* was used during the observation to collect further feedback [20]. The full list of tasks can be found in Appendix D. The maneuvering test as well as the following scoring procedure was conducted with five participants from the target group. See Tab. 6.1 below for a short description of the participants.

**Table 6-1** Test Participants in the Observation and Scoring procedures

Participant	Affected by Stroke	Year of birth
A	Yes	1938
B	No (Spouse)	1933
C	Yes	1966
D	No (Spouse)	1943
E	Yes	1943

During the observation some of the participants were unable, or hesitant while, performing the following tasks

- Locate your HOME on the map
- Change to "Compass View"
- Change back to the "Map View"
- Abort the routing "Home".
- Find information about your current location (street name etc.)
- Find information about upcoming landmarks

#### 6.4.3 Target Group Scoring

While performing the first evaluation with the target group the decision was made to compare Prototype 1 with solely the NavMem Explorer. The reason being that they both intend to contain more features than the Home Compass and therefore are more comparable. As concluded in Chapter 4 the Home Compass also already was widely well received by the target group.

During the evaluation, in order to determine the Usability and User Experience of the UI, four attributes were used to describe the NavMem Explorer and the First Prototype. These descriptions are heavily influenced by the attributes stated in [17]. However, the phrasing of the attributes was changed to make them easier to apprehend by the test participants and the *few errors* attribute was investigated by conducting an observation.

The users answered on a scale from 1 to 5 how well they agreed with the statement. Results are shown in in Tab. 6-2 through Tab. 6-5. Further they were asked to give an overall rating of the UI, in attempt to examine the User Experience, see Tab. 6-3 and 6-5.

**Table 6-2** Collected Scoring of the *NavMem Explorer* UI

Characteristics	Score* (Participants A-E)	Mean of Score
Easy to grasp	1, 1, 3, 4, 4	2,6
Easy to use	2, 2, 2, 4, 4	2,8
Self-explanatory	3, 3, 1, 4, 4	3,0
Encouraging	1, 1, 1, 2, 2	1,4

\*) 1: Fully disagree 5: Fully agree

**Table 6-3** Overall Rating of the *NavMem Explorer* UI (1 to 5)

Overall Rating	2, 2, 2, 3, 3	2,4
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**Table 6-4** Collected Scoring of *Prototype 1*

Characteristics	Score* (Participants C-E)	Mean of Score
Easy to grasp	4, 4, 4	4,0
Easy to use	4, 4, 4	4,0
Self-explanatory	4, 4, 4	4,0
Encouraging	4, 3, 3	3,3

\*) 1: Fully disagree 5: Fully agree

**Table 6-5** Overall Rating of the *Prototype 1* UI (1 to 5)

Overall Rating	4, 4, 3	3,7
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## 6.5 Collected assessment and analysis

The first prototype was intentionally filled with a lot of features, probably too many to be able to provide a pleasing *Usability*. The reason behind this was to be able to evaluate which features to keep and which to lose.

Another issue related to the amount of features was the font being too small and the UI appearing cluttered. The menus intended for the primary target group were placed in the bottom of the screen. Since this application is intended for use on Android phones this is not the best idea as the Android Standard Menu (bottom of the screen) sits right below them. The Map Icons were seldom used during the evaluation tests and were not visible enough. Feedback regarding a battery-life feature was received but ultimately considered a question for the programmers.

The scoring procedure was carried out in order to examine whether the project was moving in the right direction or not. It should be stated that the conversations and time spent with the users create a firmer basis of this perception and that the scoring procedure was mainly created to make the grade of satisfaction experienced by the users measurable. This in extension created the opportunity to compare the User Experience of the NavMem Explorer, Prototype 1 and later on Prototype 2.

As seen in Tab. 6-3 and Tab. 6-4 the test participants find that the UI of Prototype 1 is an improvement compared to the NavMem Explorer. However, only three participants were able to take part in the scoring process of the prototype. Therefore the results of the scoring procedure should be seen as an indication, rather than a fact, that the process is moving in the right direction. The results from the maneuvering test (observations) have created a perception of what needs to further investigated and developed.

## 7 Prototype 2

*This chapter presents the second and final prototype created. The User Interface is described and the evaluation of the prototype presented. A concept of a help section within the application is introduced.*

During the evaluation a Sony Xperia Z1 was used. The application *Eniro Navigation* [27] has served as inspiration to parts of the UI and deserves mentioning.

### 7.1 Building Tools

The Second Prototype was created using InvisionApp. It is a powerful tool for building application prototypes used by several market leading companies [24]. The graphic elements were once again created with Adobe Illustrator.

### 7.2 User Interface

#### 7.2.1 Wireframe

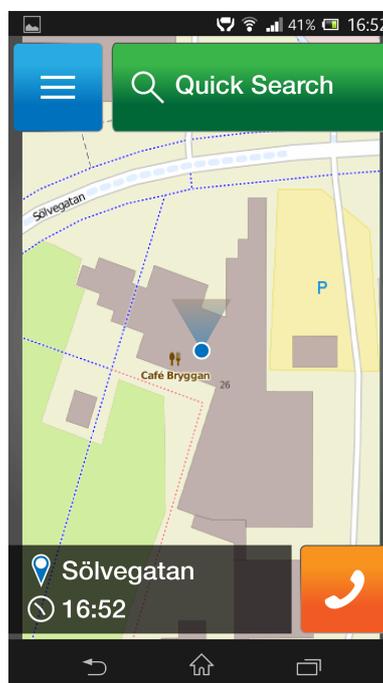
A lot of the sorting of functions and hierarchy of the prototype was kept from the First Prototype. Efforts were made too reduce the amount of information yet still satisfy the needs of the target group. A compilation of screens in Prototype 2 is provided in Appendix F. A *Splash Screen* was created instead of using the classic Menu Bar in the top of the screen see Fig. 7-1 on the following page. This means more space for actual functions instead of promoting the name of the application. A *Splash Screen* is the screen seen by the user while the application is loading upon start-up.



**Figure 7-1** Splash Screen

### 7.2.2 Start Screen

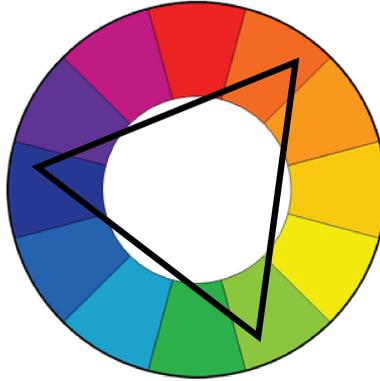
The Start Screen consists of solely the Map View see Fig. 7-2 below. Information about the current time and location are visible in the bottom left corner.



**Figure 7-2** Start Screen

### 7.2.3 Color Coding

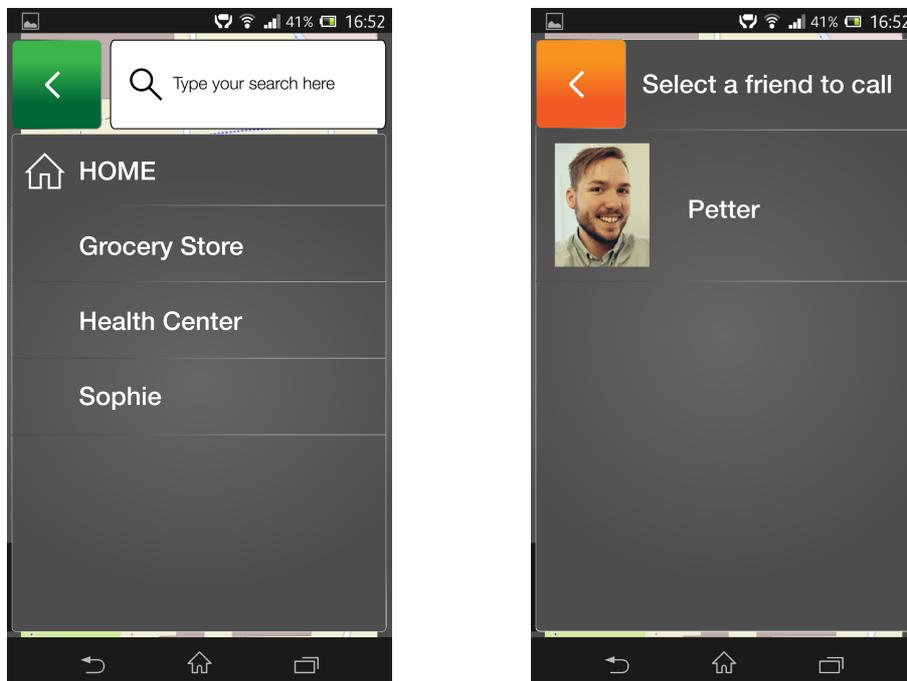
The idea of color-coding is used in this prototype as well. However a triadic, instead of tetrad, color scheme is used, see Fig. 7-3 below.



**Figure 7-3** Triadic Color Scheme

### 7.2.4 Buttons and Menus

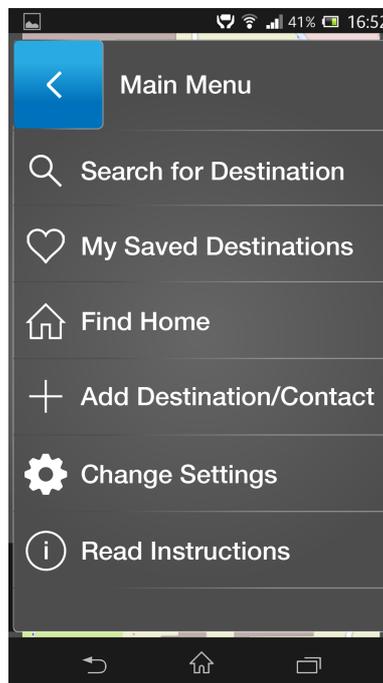
There are only three buttons on the Start Screen. Two of these are specifically intended for the primary target group; Quick Search and the Call Menu. See Fig. 7-4 below for visualization of their content.



**Figure 7-4** Quick Search Menu (left) and Call Menu (right)

The third button located in the upper left corner, the Main Menu, contains somewhat more advanced features such as; Adding Destinations, Adding Contacts and Settings. This menu is mainly intended for secondary users who can set up saved destinations and save contacts for the elderly user to access simply through the Start Screen.

The Main Menu is a List Menu that allows lots of space for both descriptive icons and text. It has a dark background compared to the navigation views that help separating the menus from the Start Screen. All menus are built this way however in the Call Menu the icons are replaced with memory supportive photographs. The Main Menu is shown in Fig. 7-5 below.



**Figure 7-5** Main Menu

### 7.2.5 Map Icons

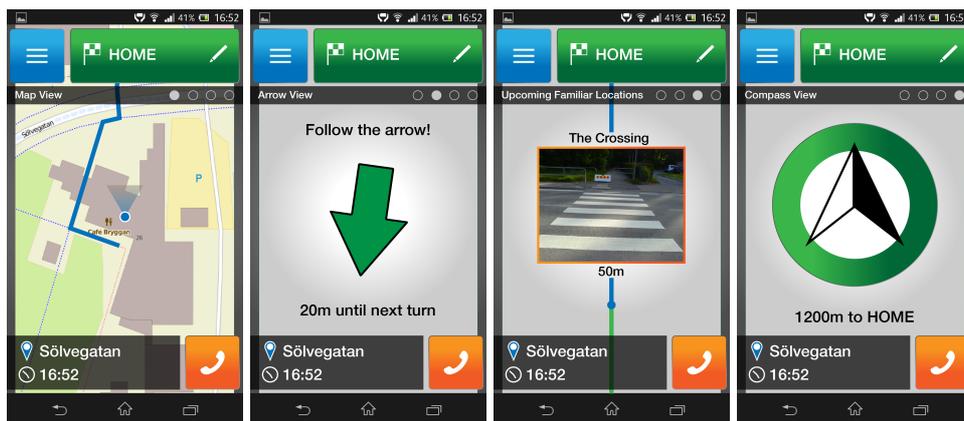
The Map Icons were essentially deleted except for the Location Marker that has been re-worked, see Fig. 7-6 on the following page. The previous *Location Markers* were small and it was hard to make out which direction you were facing.



**Figure 7-6** Location Marker of the Prototype 1 (left) and Prototype 2 (right)

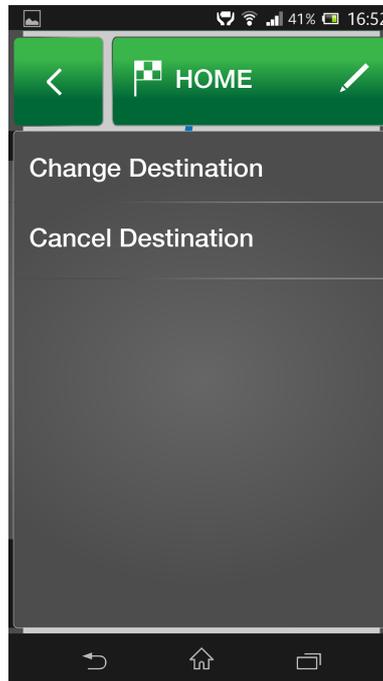
### 7.2.6 Routing

When a destination is chosen and the routing is activated there are four different views to change between, see Fig. 7-7 below. The amount of active screens and which of the screens that should be active can however be changed in the upper left corner menu. This will enable caretakers (i.e., secondary users) to customize the application to suit the specific needs of the user.



**Figure 7-7** The four available views (types of guidance) in Prototype 2

When a destination is activated it is visualized with its name and an accompanying icon on the green button in the upper right corner. On the right side of the button there is an icon indicating that the chosen destinations can be changed or cancelled if so desired, see Fig. 7-8 on the following page.



**Figure 7-8** Changing and cancelling a destination

### **7.2.7 Font and Button Sizes**

The font sizes of the prototype are equivalent with 14 points for all text except the swipe indicator bar that has 12 points and all the buttons share the height of 14mm while having different lengths. If the UI is used on a smaller screen all buttons should maintain the height of 14 mm while the size of the guidance views is reduced.

### **7.2.8 Instructive Help Section**

During the meetings with the target group several participants asked for instructive content. Most of them stated that they would like a “real” paper manual. The instructive content created within this project is however a help section created to fit within the application. This creates lots of challenges regarding screen space. The Help Section is therefore created as an introductory to the application and mainly intended for the secondary users. This information can be forwarded to the primary users with more efficient practical instructions. The Help Section could also be used in marketing – offering a preview of the app to the possible buyers. As stated in Chapter 5 the Help Section is intended for secondary users, which explains the visual appearance of it, see Fig. 7-9 on the following page.



Figure 7-9 First Screen of the Help Section

The concept of swiping is introduced right away as well as the swiping indicators in the top of the screen. In the following screens the main features, functions and selling points are explained see Fig. 7-10 below.

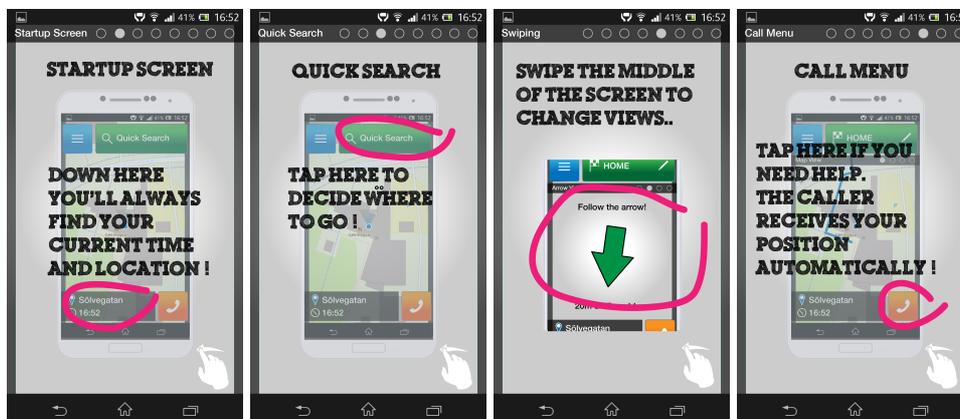


Figure 7-10 Collection of screens in the Help Section

### 7.3 Credits

The swiping and clicking gesture icon within the *Help Section* used are not my own design. It is free to use but should be considered recreating in a finalized product [28]. The same applies to the font within the *Help Section* [29]. The font used in the rest of the UI is Helvetica Neue.

## 7.4 Evaluation

### 7.4.1 Lund University NavMem Meeting

During a meeting with four participants from the Lund University and one member from the Swedish Stroke Association, all part of the NavMem project, Prototype 2 was demonstrated.

The prototype was well received and especially so by the member of the SSA. There was however some things pointed out that could be further investigated in the future,

- Naming of the Quick Search Menu. Could there be a better name for it? Possibly *Choose Destination*.
- The Call Menu icon could be even clearer, maybe with a red border around it.
- Could the Main Menu (the blue button), intended for secondary users, be hidden possibly within the Main Menu of the android OS?
- The algorithms used to sort saved destinations within the Quick Search Menu needs to be carefully programmed.

Further it was discussed whether there could still be a possibility to choose whether a destination is saved as a “Main Destination” in comparison to a location that is only intended to provide visual guidance to the User. If not, the saved destinations list could become too cluttered. Possibly the users could, when saving a destination, choose whether it should be a “Via Point” or a “Destination”.

### 7.4.2 User Maneuvering Test with Target Group (observation)

Once again a list of tasks were set up to explore the entire wireframe of this prototype. This list of tasks can be found in Appendix D. During this evaluation the tasks were separated between primary and secondary users. Five participants from the target group were observed while maneuvering the tasks intended for primary users while three were observed maneuvering tasks intended for the secondary users.

All tasks were completed, however, two of them with hesitation from one participant. These include changing between guidance views for the first time and cancelling a chosen destination (primary users). After receiving short instructions the user was able to perform these tasks without problem.

### 7.4.3 Target Group Scoring

The scoring procedure was conducted in the same manner as with the previous prototype and the NavMem Explorer. The test participants and results are shown on the next page in Tab. 7-1 through 7-3. Participants A and B are the same that took part in the evaluation of the previous prototype.

**Table 7-1** Test Participants in the Observation and Scoring procedures

Participant	Affected by Stroke	Year of birth
A	Yes	1938
B	No (Spouse)	1933
F	Yes	1949
G	No (Spouse)	1950
H	Yes	1955

**Table 7-2** Collected scoring of the *Prototype 2* UI

Characteristics	Score* (Participants A,B,F-H)	Mean of Score
Easy to grasp	4, 3, 4, 4, 4	3,8
Easy to use	4, 4, 5, 4, 5	4,4
Self-explanatory	5, 5, 4, 4, 4	4,4
Encouraging	-, -, 4, 3, 4	3,7

\*) 1: Fully disagree 5: Fully agree

Two of the test participants did not understand the concept of whether the UI was perceived as encouraging or not and therefore did not want to rate that specific characteristic.

**Table 7-3** Overall rating of the *Prototype 2* UI (1 to 5)

Overall Rating	4, 4, 4, 4, 4	4,0
----------------	---------------	-----

#### 7.4.4 Interviews with the Target Group

During the evaluation of this second and final prototype in depth interviews were conducted with all participants. They were open interviews that discussed the changes made to the UI.

All participants were pleased by the separating of functions derived from the separating of primary and secondary users. Many of them expressed that this is the only way to actually make this application usable. The decision to depart from the Springboard Menu setup of the start screen was also well received.

Regarding the use of color, one of the participants made an interesting comment. He perceived that almost all of his, especially female, friends played the popular game called *Candy Crush Saga*. Since he himself was very sympathetic to idea of color use

he argued that one thing that may attract his friends to this game is the heavy use of colors. Colors by themselves create feelings and therefore make applications more fun and encouraging interacting with [30].

While further discussing the revamped Start Screen some comments were made, just as in the NavMem meeting mentioned above, about whether “Quick Search” is the most appropriate naming of that function. However no suggestions were made of how to efficiently rename the feature.

Notes were made that especially one participant felt that an auditory guidance (instructive voice) needs to be added to the application. This is however not an area that will be developed in this project.

Further, the same participant argued that the project in itself might be useless since users either are healthy enough to use ordinary navigation applications or too impaired to be helped by any such application. However, the aim of this project has never the less been to help create the best possible UI to provide a useful application.

### **7.5 Collected assessment and analysis**

From the evaluation process it is safe to state that *Prototype 2* is an improvement in comparison to *Prototype 1* as well as the *NavMem Explorer*. The use of scoring, observations and interviews created a triangulation within the evaluation process that further validated this perception.

However, there still are points of improvement, which will be further discussed in the following chapters. Most importantly the decisions made during the design phases has been proved to improve the usability of the application meaning that further development of the UI should be based on these decisions.

## 8 Discussion

*This chapter discusses and evaluates the aim, methods and results of this project.*

It has been challenging working with a target group that is unaccustomed to current new technology, in some cases even skeptical to it. However it is the challenge that made this project developmental. The designer was equally foreign to the target group as the technology was to them.

The involvement of the users, as stated in the introduction, is critical to the outcome of the final prototype. Even though the users have played great part in especially the discovering and evaluating phases they could have been more involved in the design phase of this project. Conducting a user-centered process is however time consuming and some tradeoffs had to be made to meet the timeline of the project plan.

The reconciliations with the users have been of a qualitative nature. All in all eight primary and secondary users were part of this project. The main reason of focusing on qualitative studies is that there is a substantial threshold to overcome before the users become familiar with the project. Conducting surveys would have been hard for many reasons, and getting relevant feedback on the UI of a specific product probably even harder. It has been a pleasure to get to know the test participants and while still keeping a professional attitude towards them a substantial basis in the success of the project was to gain their trust and make them feel comfortable expressing their opinions and experiences. The fact that the test participants were aware that the author of this thesis also was the creator of the prototypes they were evaluating is worth mentioning. This could potentially have led to a deceptive results, however, the feeling through the project has rather been, as stated above, that the close relationships with the participants led to more honest feedback.

The group of participants partly changed between the different evaluation phases. This needs to be kept in mind while viewing the scoring of the different UIs. However, this report states that the scoring results are mainly used as indication and the most valuable feedback has been gathered through conversations with the test participants.

The iterative nature of the project was absolutely necessary since it is hard for the primary target group to express “This is what it should look like!” when they are not fully familiar with the technology involved. It is much more productive to present a prototype and ask them what is working well and what is not. Analyzing feedback from these studies then provides a good sense of how to proceed. This project

managed to create two hi-fi prototypes. To fully guarantee a pleasurable User Experience more prototypes should be tested, in fact, the more the merrier.

A critical part of this project has been separating the primary users from the secondary and ultimately separating and sorting the functions of the application in the same way. It has become obvious that this application will not be fully usable without the help of caretakers. Further on, when developing a business plan of the finalized product, this should be considered. Perhaps it is not the primary users that should be approached when marketing this application but the secondary or tertiary (i.e., health facilities, nursing homes etc.) users.

A well-know fact within the field of design is that “Attractive things work better”. Without stating that the final prototype is “attractive” in every ones eyes it has become evident that this fact is equally important when designing for elderly. Attractive UI makes the experience more fun and rewarding for the user. This project has established that the current appearance and functionality of the NavMem Explorer is insufficiently encouraging to the target group. The frustration of the users while using the applications needs to be overcome. The much useful functions of the application are clouded by an insufficient presentation of them. On top of UI some flaws within the programming aspect of the applications have also been identified.

The principles of Donald Norman are stated in the Background Chapter and have played part in the design phases. However, in reflection it is mainly the principles of *Visibility* and *Affordance* that are visually apparent in the final prototype. Hence, further development should be carried out regarding *Mapping* and especially *Feedback*.

Further, regarding the Final Prototype there are a few things that should be discussed, one being whether the ability to perform a free search should be available in the Quick Search Menu at all. The answer to this question probably lies within the future business plan. Removing this option would probably narrow down the target group but might reduce the risk of errors for the remaining part of it. Also the naming of that particular function should be revisited.

All in all the aim of this project has been met and hopefully this report will contribute positively in finalizing a successful Android-based navigation application. The project has managed to conduct a user-driven process rather than a tech-driven, which should provide a greater understanding of the intended users.

## 9 Conclusions and recommendations

*This chapter states the conclusions made during the project as well as recommendations for future development of the application.*

The purpose of the NavMem project is to simplify and enrich the lives of the target group. However, the current visual appearance of, as well as some technical issues with, the application instead leads to user frustration and confusion. With that being said it is far from impossible to make the final product usable and more importantly useful to the users. The UI of the application needs to play part in helping the users overcome their anxiety towards modern technology. The necessary functions need to be susceptible to the users while still not exhausting their minds. This is a challenge since the target group differs widely in their preferences of guiding aids.

The user-input received during this project concludes that there are issues with the UI of, especially one of the, current applications. Further it validates that the prototypes built have taken important steps in improving the Usability of the application.

It is recommended to retain the differentiation between primary and secondary users moving forward. Further this is believed to be the key in finalizing a successful product. The developers need to realize that the primary target group can perform some actions within the application while others are simply too demanding, regardless the presentation.

Another area of potential improvement that has not been studied in this project is the use of auditory guidance and feedback. This feature has been requested by parts of the test participants and should be looked into. The algorithms used to remember and rank previously chosen destinations should be further developed and the use of keyboard input by the primary target group minimized.

The font use should be revisited and was intentionally not investigated in this project since it commonly is one of the last things decided during User Interface development (text is separated from the graphic elements and therefore easy to change).

The navigation patterns within the application need to be carefully chosen. The use of Springboard Navigation should be avoided because of its similarity to most menus of smartphones. Further the users current position as well as the current time should be clearly visible while using the application.

Additional hands-on testing of future prototypes need to be conducted with a wider spectrum of users included in the target group. The use of color should be further

## 9 Conclusions and Recommendations

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investigated and additional color schemes could be provided to the users to best satisfy their individual needs.

Further, non-UI related problems such as the issue of not being able to save destinations (i.e., locations) without actually visiting them needs to be resolved as well as technical issues with routing and compass instability.





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## Appendix A: NavMems' User Needs Relevant to User Interface

The User Needs stated below are extracted from [4].

- Keys and screen need to be large enough
- Several input modalities should be included (audio hints can help for reduced vision)
- Slide-out keyboards should be avoided
- Program and command naming should be carefully considered and in accordance with the users' mental models
- Provide large, clear and bright screens
- Provide large buttons
- Provide the possibility to zoom in on small text
- Provide clear confirmation of target capture (i.e., button press, visited link). The user should not be expected to detect small changes
- Older users should not be expected to double click because of slower hand movements
- A single, consistently placed button for returning to the home state should be included
- Graphics should be relevant and not for decoration. No animation should be present.
- Images should have alt tags
- Icons should be simple and meaningful and also labeled (with a large enough font)
- Clear navigation should be provided
- Tapping often preferred to drag and drop
- Provide current location in the interface
- Clearly show which tasks are active
- Important features should be available directly via a labeled button and not via menu navigation
- Avoid pull down menus
- Do not have very deep hierarchy and group information into meaningful categories
- Important information should be highlighted
- Information should be concentrated mainly in the center
- Provide ample time to read information

## Appendix A: NavMems' User Needs Relevant to User Interface

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- Reduce the demand on working memory by supporting recognition rather than recall and provide fewer choices to the user
- Main navigation always the same and critical functions should not disappear
- Colors should be used conservatively
- Blue green tones should be avoided
- Background screens should not be pure white or change rapidly in brightness between screens. Also, a high contrast between the foreground and background should exist
- Avoid moving text
- Avoid fancy font types
- An online help should be provided
- Error message should be simple and easy to follow
- Minimize the number of steps
- Limit the amount of information

## Appendix B: Test Protocols

### B.1 Pre-Test Protocol

PRE-test protocol, participant: \_\_\_\_\_

Pre-test date	
Interviewer	
APPs to use	
Phone	
Launcher	
Care personnel	
Family	

#### Demographic information

##### A. Basic information

1. Gender: |  | Male |  | Female

2. Year of birth: \_\_\_\_\_

##### B. Hearing, vision and mobility

1. Please rate your visual ability (with the best possible correction for your glasses):

|  | Full vision

|  | Minor vision problems

|  | Moderate vision problems

|  | Severe vision problems, with some residual vision

|  | Blind

Please provide detail if relevant to test:

---

2. Are you color blind: |  | Yes |  | No

Appendix B: Test Protocols

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3. Please rate your hearing:

|  | Full hearing

|  | Minor hearing problems

|  | Moderate hearing problems

|  | Severe hearing problems, with some residual hearing

|  | Deaf

Please provide detail if relevant to test:

---

4. Please rate your motor abilities:

|  | Fully mobile

|  | Minor motor problems

|  | Moderate motor problems

|  | Severe motor problems

Please provide detail if relevant to the test:

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5. Dominant hand: |  | Left |  | Right

6. Do you experience any navigation related problems? How does that affect your life and your ability to carry out daily activities?

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C. Experience of mobile phones

1. Do you own (and use) a mobile phone? |  | Yes |  | No

2. Which kind of phone?  Feature phone (with traditional buttons)  Smart phone

3. Model and brand of phone? Ask participant to show the phone. \_\_\_\_\_

D. Mobile maps/GPS experience

1. Have you ever used a GPS device or a GPS app on a mobile phone?  Yes  No

2. If yes, how often have you used it? \_\_\_\_\_

3. If yes, for what purpose have you used a GPS app/device? \_\_\_\_\_

E. Sense of direction

1. Please rate your sense of direction.

Excellent (I always know where I am and where I am heading)

Reasonable (I know where I am & where to go most of the time, but I get lost occasionally)

Poor (I find it hard to know where I am and where I am heading – I often get lost)

None (I get lost very easily and need help when navigating)

**B.2 Intermediate Test Protocol**

Intermediate test protocol, participant: \_\_\_\_\_

APP (circle appropriate)	NavMem Explorer / Home Compass
Interviewer	
Week:	
Date:	

1. Have you used the app the last week?  Yes  No  I don't remember

2. How **many times** and **how long**?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Appendix B: Test Protocols

3. Have you experienced any problems? What were they and how did you resolve them?

---

---

---

4. Have you seen any direct benefits with the app this week? Please describe.

---

---

---

5. Have you come up with any suggestions for improvements?

---

---

---

6. Rate how satisfied you are with the app this week from 1-10 (1: very dissatisfied, 10: very satisfied)

1 ----- 2 ----- 3 ----- 4 ----- 5 ----- 6 ----- 7 ----- 8 ----- 9 ----- 10

**B.3 Post-Test Protocol**

POST-test protocol, participant: \_\_\_\_\_

APP (circle appropriate)	NavMem Explorer / Home Compass
Post-test date	
Interviewer	

1. Have you used the app the last week?  Yes  No  I don't remember

2. How **many times** and **how long**?

---

---

---

---

3. Have you experienced any problems? What were they and how did you resolve them?

---

---

---

---

4. Have you seen any direct benefits with the app this week? Please describe.

---

---

---

---

5. Have you come up with any suggestions for improvements?

---

---

---

---

6. Rate how satisfied you are with the app this week from 1-5 (1: very dissatisfied, 5: very satisfied)

1 -----2 -----3 -----4 -----5

7. Has the app helped you to do things you want or need to do? If yes, please explain:

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8. Has the app prevented you from doing things you want or need to do? If yes, please explain:

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9. Rate how secure you feel doing errands outside (such as going to the store or visiting a friend) **without** the app (1: very insecure, 2: insecure, 3: neither, 4: secure, 5: very secure)

1 -----2 -----3 -----4 -----5

10. Rate how secure you feel doing errands outside (such as going to the store or visiting a friend) **with** the app (1: very insecure, 2: insecure, 3: neither, 4: secure, 5: very secure)

1 -----2 -----3 -----4 -----5

Appendix B: Test Protocols

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11. Rate how likely it would be that you would recommend the app to a friend (1: I would strongly advise against using it, 2: I would advise against using it, 3: I would neither encourage nor advise against, 4: I would recommend using it 5: I would strongly recommend them using it)

1 -----2 -----3 -----4 -----5

12. If you would not recommend it now, what possible changes would change your recommendation? Please prioritize the changes you would like to see.

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---

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X. User acceptance form





## Appendix D: Observations

### D.1 Prototype 1

*Is the task completed? Yes/No/with hesitation. 5 participants.*

1. Zoom out map (one step).

5 Yes. Annotation: 4 persons both pinched and used the +/- buttons, 1 person solely pinched.

2. Can you make out YOUR position on the map?

5 Yes.

3. Can you locate your HOME on the map?

2 Yes, 2 No, 1 with hesitation.

4. Can you identify your saved destinations on the map?

4 Yes, 1 No.

---

5. Ask the application to find HOME.

5 out of 5 completed the task without hesitation

6. Change to "compass view".

2 Yes, 3 No. Annotation: The font used is too small. All users preferred swiping.

7. Change back to the "map view".

4 Yes, 1 No. Annotation: All users preferred swiping.

8. Abort the routing "Home".

1 Yes, 4 No.

---

9. Ask the application to guide you to "LILLY".

5 Yes.

10. Can you find the call menu? Open it.

## Appendix D: Observations

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5 Yes.

11. Return to the "map view".

5 Yes. Annotation: Lower back-button (Android Standard Menu) often used.

---

12. Can you find information about your current location? (Street name etc.)

3 Yes, 2 No. Annotation: Improve the icon.

13. Can you find information about upcoming landmarks?

3 Yes, 2 No. Annotation: Font is somewhat small. Does not look clickable.

14. Can you find more information about your destination, in this case LILLY?

4 Yes, 1 No.

### **D.2 Prototype 2**

*Is the task completed? Yes/No/with hesitation. 5 participants.*

#### **Primary user tasks (five participants)**

1. Can you make out YOUR location on the map?

5 Yes.

2. What is the name of the address (street name)?

5 Yes.

3. What time is it?

5 Yes.

---

5. Ask the application to find home.

5 Yes.

6. Change to "arrow view".

4 Yes, 1 with hesitation.

7. Change to "familiar locations view".

5 Yes.

8. Change to "compass view".

5 Yes.

-----  
9. Abort the routing home.

4 Yes, 1 with hesitation.

10. Call a friend.

5 Yes.

11. Leave the Call Menu.

5 Yes.

**Secondary User tasks (three participants)**

1. Perform a “free search” of a destination.

3 Yes.

2. Add and save a location.

3 Yes.

3. Add and save a contact.

3 Yes.

-----  
5. Change the default choice of guidance.

2 Yes, 1 with hesitation.

6. Find and read instructions.

3 Yes.



## Appendix E: User Input of Current Applications

### E.1 NavMem Explorer

#### *Problems with compass accuracy*

- ”The arrow feels unreliable”
- ”It gives the wrong distances”
- ”Compass disturbance at bridge”
- ”Unstable compass”
- ”Calibration problems - phoned ULUND to get help”

#### *Problems with search and routing*

- ”Takes too long to get the route”
- ”Search function difficult to use and understand”
- ”Sometimes shows car routing”
- ”Car routing instead of walk paths and bike paths in neighborhood”
- ”Can't search for places, need to have address (cumbersome)”
- ”You could end up on the wrong side of a long house if the address is pointing there”

#### *Problems with interaction*

- ”Search function difficult to use and understand”
- ”Text too small”
- ”Buttons too small (keyboard)”
- ”Tried to add a landmark, "take a photo" (didn't work)”

#### *Other problems*

- ”It vibrates constantly”

## Appendix E: User Input of Current Applications

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### *Suggestions of improvements*

- ”Needs to become easy to use all over.”
- ”Not too many steps.”
- ”Should not need to work so hard to use it.”
- ”Needs to be matched better to the user group.”
- ”Needs an instruction book!”
- ”Bigger keyboard”
- ”Everything needs to be made easier”
- ”Pre-programmed places”
- ”Keyboard (larger and more clear)”
- ”Compare to the Eniro Mobile Application (step by step instructions and nice colors)”
- ”Spoken navigation information”
- ”Change label for landmark to milestone or similar. It needs to give the right understanding of what it is!”
- ”Needs to be possible to use with electric wheelchair and bike”
- ”Address suggestions need to be sensible - it should not propose names and places in an unpredictable manner.”
- ”Routing on walk paths and bike paths”
- ”Information about battery life - will it last until I reach my destination (and possibly home again)?”
- ”Extra battery?”

## **E.2 Home Compass**

### *Problems that occurred*

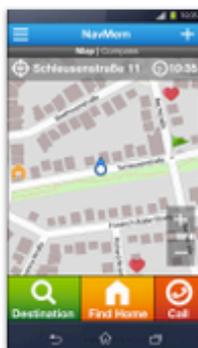
- ”Had the wrong home position saved.”

### *Suggestions of improvements*

- ”Simplify the home position setting!”

## Appendix F: Compilation of Screens

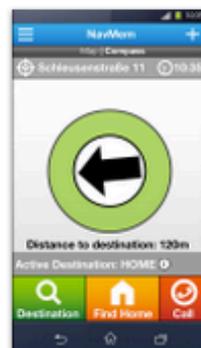
### F.1 Prototype 1



start\_map\_cl...  
#1



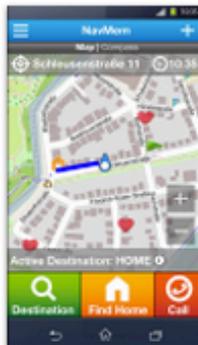
lilly\_compass...  
#2



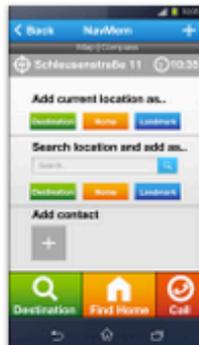
home\_compass  
#3



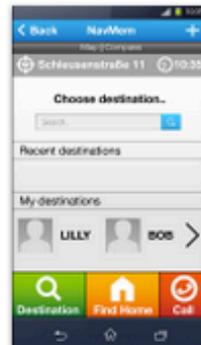
start\_compass  
#4



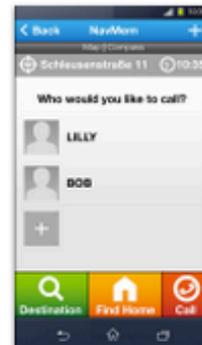
home\_map\_far  
#5



plusmenu  
#6

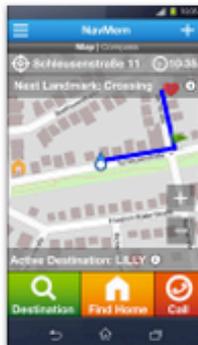


destination  
#7

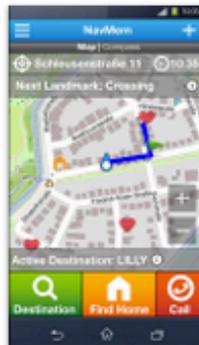


call  
#8

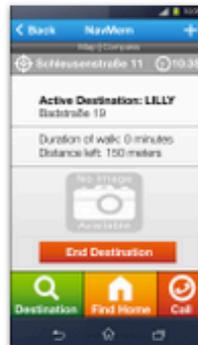
## Appendix F: Compilation of Screens



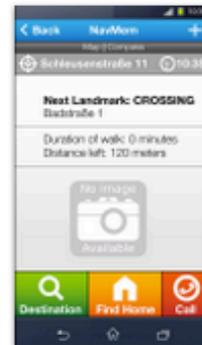
**lilly\_map\_close**  
#9



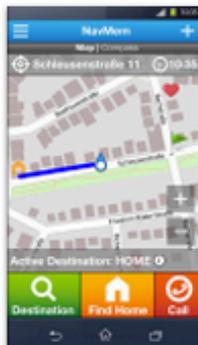
**lilly\_map\_far**  
#10



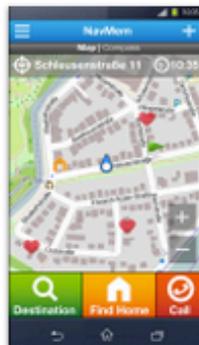
**destination\_in...**  
#11



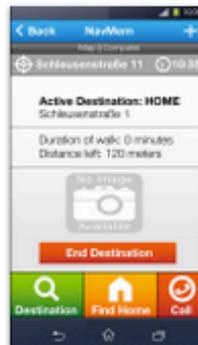
**landmark\_info**  
#12



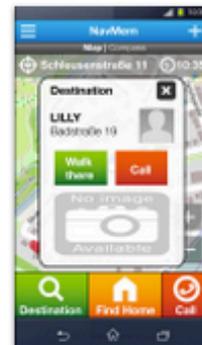
**home\_map\_cl...**  
#13



**start\_map\_far**  
#14

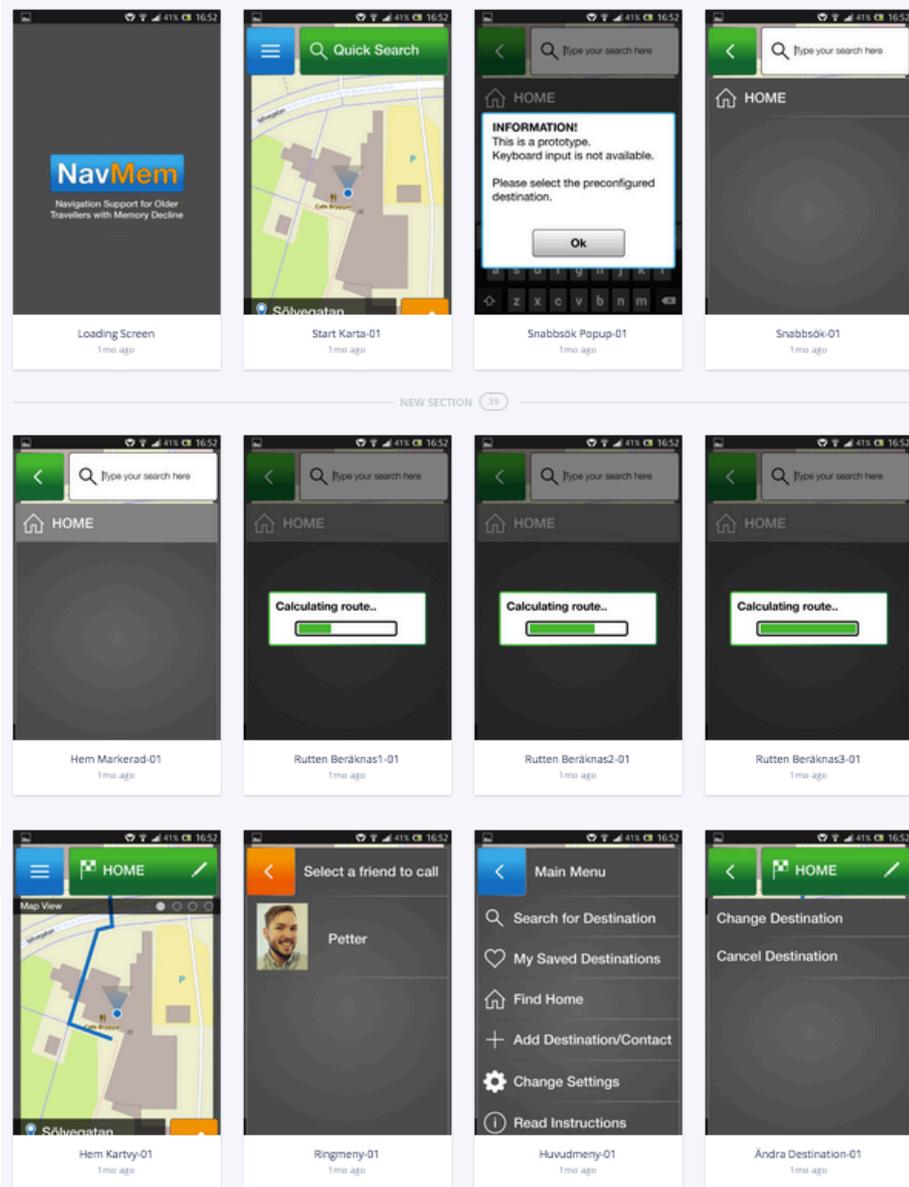


**home\_info**  
#15

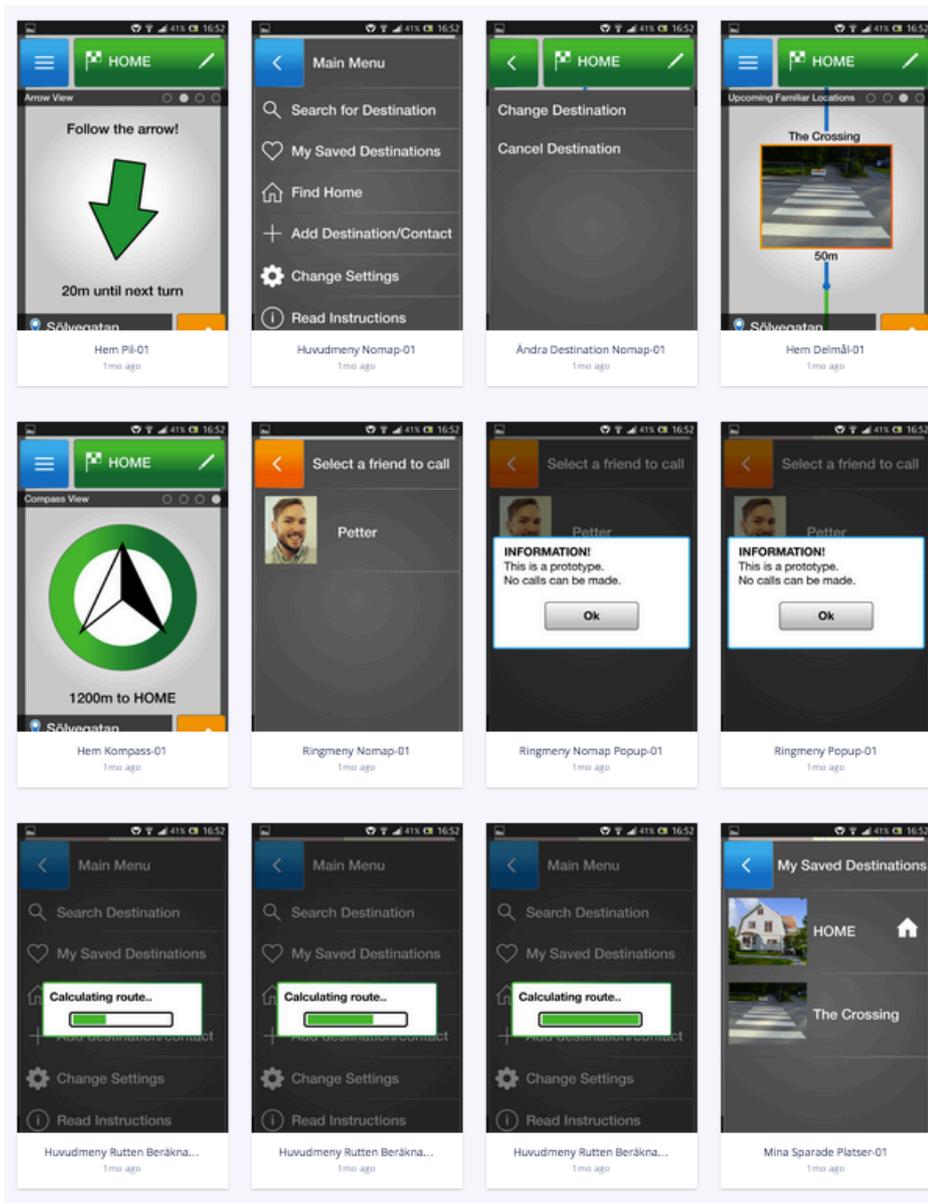


**lilly\_popup\_far**  
#16

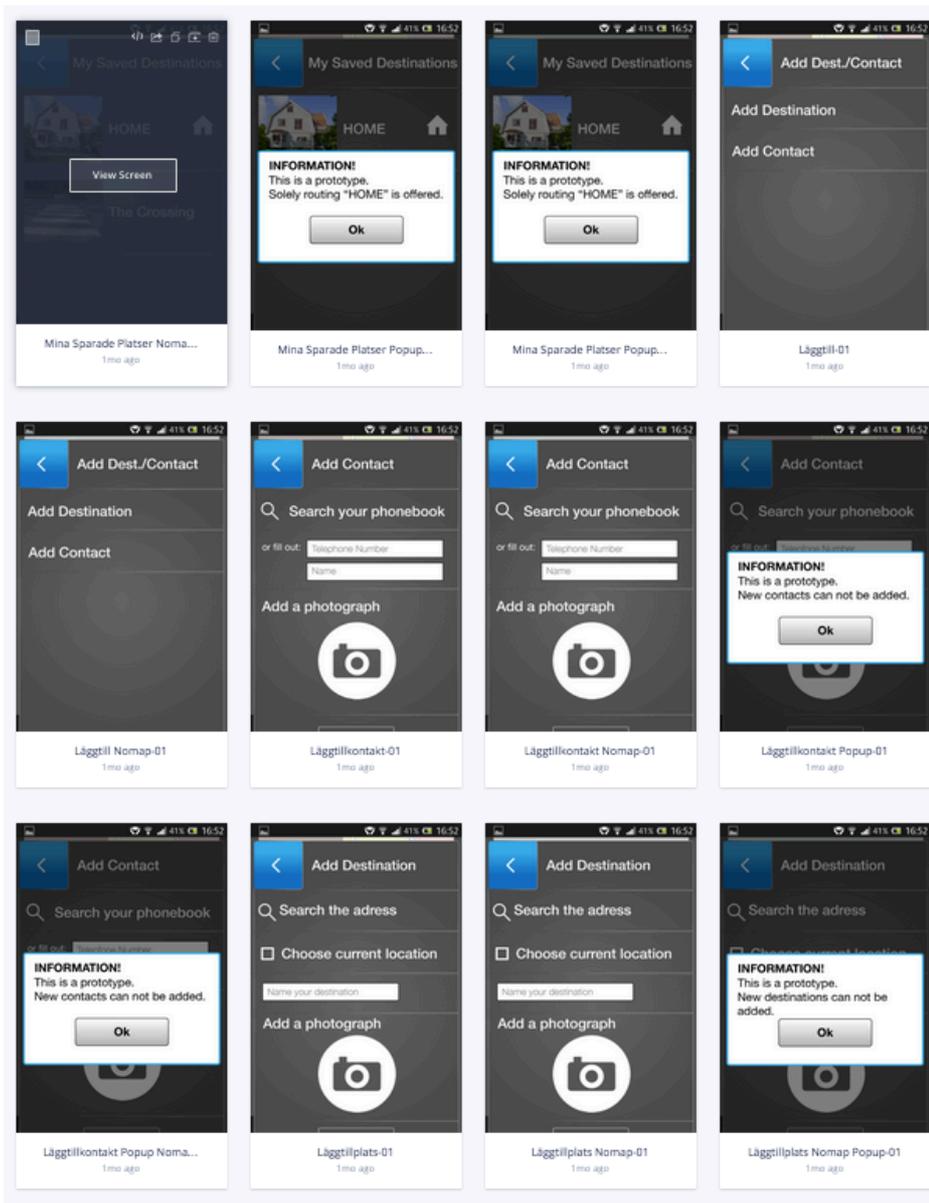
## F.2 Prototype 2



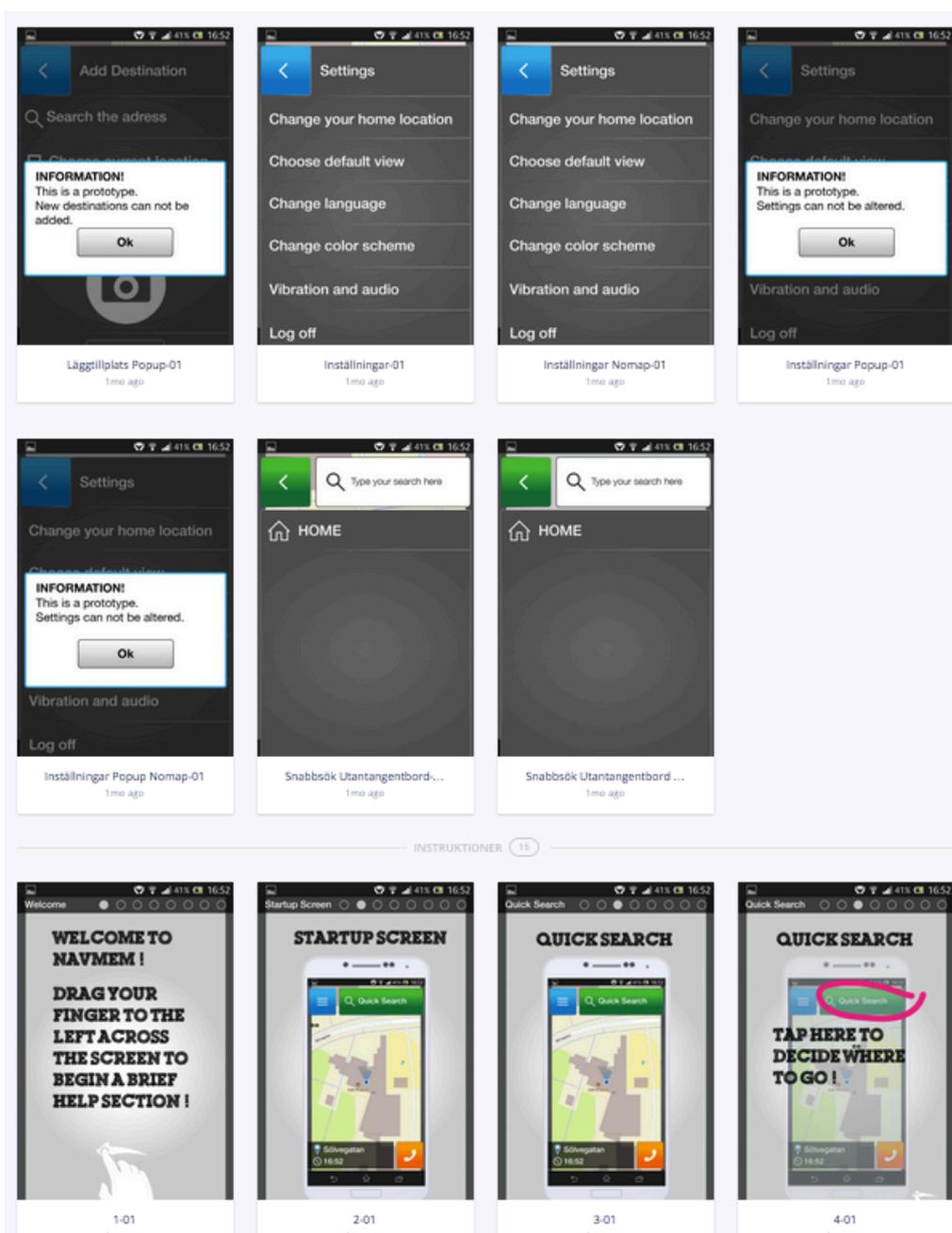
## Appendix F: Compilation of Screens



## Appendix F: Compilation of Screens



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