GPS TECHNOLOGY TO AID THE BLIND AND
PARTIALLY SIGHTED IN COPENHAGEN,
DENMARK

An Interactive Qualifying Project Report
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Abstract:

This project, jointly sponsored in Copenhagen by the Danish Association of the Blind (DBS) and the Euman Company, assessed the feasibility of using Euman’s LifePilot GPS technology for blind and partially sighted individuals. After conducting literature research as well as surveys and focus groups, the team concluded that there is a potential for Euman technology, currently being developed, and an overall need for navigational aids, and recommended a variety of features for a GPS based device that would prove useful in the visually impaired community.
Executive Summary:

This project, jointly sponsored in Copenhagen by the Danish Association of the Blind and the Euman Company, assessed the feasibility of integrating the LifePilot GPS technology (produced by Euman) into the blind and partially sighted community.

Project Statement:

There are over forty-five million blind and partially sighted people worldwide that face everyday challenges living with such a disability presents (Up to 45 Million Blind People Globally - and Growing, 2007). This project explored current technology, specifically the Lifepilot GPS devices, as a promising aid for both support and encouragement to the blind and partially sighted as they strive for an independent life. The project focused on identifying the features that should be included in such a device in order to make it better adapted for the visually impaired community.

The following study was broken down into multiple parts. First, there was extensive background research into what technology currently exists on the worldwide market for the visually impaired and what studies have already been conducted in this area. Next, surveys were written and submitted to members of the Danish Association of the Blind to gauge a basic understanding of the desire and need for GPS technology. In addition the project team visited several institutions for the blind, and underwent blindness sensitivity training. After the surveys proved a general interest in GPS devices, two focus groups were held in order to get more in-depth data. Three of the volunteers were able to test the software on a simple route pre-designed by the project team and with way points identified in Danish and pre-recorded on the server to be activated as the GPS swept across them. The participants gave their feedback on the various way points
although more often than not during the trails the GPS positioning was inaccurate or the
pre-corded messages failed to play (a software problem that was fixed after the focus
group sessions were held).

The survey and focus groups proved to be very successful tools in determining
how GPS technology can best benefit blind and partially sighted individuals. A myriad of
suggestions came from the focus groups but tended to coalesce around the following
assertions: on demand information (via a push of a button) on location, street lights, etc.;
a special route with all bus stops and information about them listed; the buttons on the
device should be noticeably separated.
Extensive testing by the project team revealed widespread deficiencies in the current software on the Lifepilot cell phones. Specifically, the main server proved to be erratic and undependable, and the linkage between GPS way points and audio descriptions often proved faulty. So difficult were the technology issues that the project team could only conduct one actual test with visually impaired participants (in which the participants were only able to test the route from the DBS to the 2\textsuperscript{nd} turn location). Those tests revealed further problems: the necessarily inaccurate identifications via the GPS system, great difficulty using the closely spaced and tiny buttons and lack of speech recognition software. However, there remained several features of the technology that blind and partially sighted users favored and hoped could be extended and modified. For example, the ability to record their own voice messages, the fact that the audio can be replayed and the capability to share the routes via the internet, and messages can be replayed again and again so as to overcome outside noise. Moreover, in the very last days of the project, the software was dramatically improved, although the structured imprecision of non-military GPS remains an insurmountable impasse.

Through this study, it can be seen that GPS technology, specifically Lifepilot, has potential to help many blind and partially sighted individuals. Issues with the software will need to be worked out and the devices themselves will need to be better adapted for visually impaired (i.e. voice recognition software, large button sizes, etc). Furthermore through the course of research and focus group discussion the project team learned of several other innovations that might prove useful both to the sponsoring agencies and to blind and partially sighted community in Denmark such as Radio Frequency Identification (RFID) technology.
It is recommended that both groups look into (RFID) technology as an aid for the blind and partially sighted. Perhaps, a combination of GPS and RFID technology could be successful in the future. The GPS would allow the user to navigate to a general area (i.e. a specific train station) and the RFID would allow for more accuracy for immediate surroundings (i.e. a doorway inside the train station).

One of the most important aspects of this study is that a majority of the data gathered was from blind and partially sighted individuals; the people who can benefit from this technology. By using their suggestions and adapting the GPS technology, a mutually beneficial product can be formed that can provide aid for the visually impaired on an everyday basis.
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1. Introduction

Close your eyes and imagine a world of darkness, loud noises, screeching tires and jumbled voices- would you be able to go to school? Visit a friend? Go to work? Many problems face the over forty-five million blind and partially sighted people worldwide (Up to 45 Million Blind People Globally - and Growing, 2007), as they struggle with the usage of public transportation, navigating around town and communicating with other people.

Each day the modern world is becoming more technologically driven and our civilization is moving towards personal-independence. Nowadays, you can find the nearest restaurant with a click of a button using GPS devices, and have a computer guide you to its exact location, without ever having been to the place or glanced at a map. Can this technology be designed to accommodate the various needs and concerns of the blind and partially sighted community? Lifepilot, by the Euman Company in Denmark is a GPS technology in a cell-phone like package that may be a promising solution.

The goal of this project is to investigate new possibilities and look at existing methods used to better orient the blind and partially sighted with regard to several aspects such as navigating the streets in Copenhagen, and taking a full advantage of the city’s cultural offerings. A specific focus will be on the usage and integration of GPS technology, such as the many devices that are currently being developed by company Euman, as a means to relay information while addressing special concerns for blind and partially sighted users. By conducting surveys, doing background research, and scrutinizing the current technologies that are or could be adapted for the blind and
partially sighted, the feasibility and benefits of integrating Lifepilot technology will be examined.

2. Background

This project is done in collaboration between the Danish Association of the Blind and Euman. Such a unique combination of sponsors allows us to address this topic from both the social/humanitarian side, as well as the technological, thus providing the opportunity to come up with a thorough solution for the issues concerned. This dual sponsorship gives us the chance to look at both the marketing of a technological device, such as the Lifepilot Trekker, and the social impact that it creates simultaneously, furthering our understanding of the inter-relationship of technology and human need and allowing us to suggest any necessary modifications right away – which is a very important advantage, for results from one research area have great consequences on the other.

2.1 Project Statement

There are over forty-five million blind and partially sighted people worldwide that face everyday challenges living with such a disability presents (Up to 45 Million Blind People Globally - and Growing, 2007). This project will explore current technology, specifically the Lifepilot GPS devices, as a promising aid for both support and encouragement to the blind and partially sighted as they strive for an independent life. It will focus on identifying the features that should be included in such a device, as well the feasibility of having that technology succeed in the market.
2.2 Addressing Issues Faced by the blind and partially sighted in Today’s Society

Today’s society puts a great emphasis on technological advances and discoveries. We are becoming a part of the “do it yourself” era, with individual express checkout lines at the grocery stores, personal instruction for furniture construction, and online features that allow you to pay your bills, shop, and plan out your vacation in the convenience of your own living room without having to interact with others. Such a progressive way of living that eliminates human contact as the middle step in accomplishing a task has been creating a gap between the sighted and visually impaired. Many times, those who live with such a disability rely on human contact as part of their daily routines; therefore, it establishes a dependence and inequality that needs to be addressed.

To lead an independent life, blind and partially sighted people often need to undergo training to learn adaptive techniques and essential skills (Getting Around, 2006). There are resources which provide a variety of programs and training lessons in order to help those who are blind and partially sighted in accomplishing everyday tasks. The website for the Texas School for the Blind and Visually Impaired, for example, offers an extensive curriculum to develop skills in an assortment of fields ranging from physical education, recreation and leisure, career and communication and orientation and mobility.

2.3 Orientation and Mobility

Perhaps one of the most difficult challenges facing the blind and partially sighted on a daily basis is getting around in their environment. Aids that many of us take for granted, such as markings on the road to indicate the crosswalk, lights to inform us when it is safe to cross, maps that layout the schedules and routes of buses and trains, and signs
that communicate our location as well as advertise what’s ahead, are not a possible resource for the blind and partially sighted, making everyday transportation very challenging.

James R. Marston and Reginal Glledge in *Removing Functional Barriers: Public Transit and the Blind and Vision Impaired* state that, “People with disabilities live in a transformed space. Obstacles and barriers are multiplied and expanded. Gutters can become chasms, streets become treacherous paths and stairs may be impossible to use.” Such inability to move freely using a well integrated system like public transportation can affect both the personal life and careers of those who are blind or visually impaired. A 1990 Census figures show that nationwide less than 23% of people of working age with a disability are actually in the labor force. Many believe this dismal statistic is a result of the difficulties non-drivers have in gaining access to employment (Marston, James R., 1997).

Using GPS technology in conjunction with a structure like public transportation, those with visual disabilities could be provided with more career opportunities, thus resulting in a more independent lifestyle. It is important to note that orientation and mobility are hardly limited to the public transit system, The increase in the ability to navigate one’s surrounding, such as walking down the street, is the simplest and most basic step that will help to promote an independent lifestyle.

### 2.4 Assessment of the Challenges in the Current Public Transit

One focus of this project will be on the usage of public transportation, therefore it is important to make note of what challenges are currently present. All users of public transportation rely on information about the routes and schedules to assist them in their
trips and commutes. Such information is widely available on signs, maps posted at the stations and on the vehicles, and personal pamphlets that can be picked up or printed offline. However such emphasis on visual cues and aids puts blind and partially sighted people at a disadvantage, for many times they have to rely on help from conductors, personal assistants, and other public transportation users in order to get around.

Furthermore, technological advances in the transit industry, such as automatic fare collection and passenger-activated doors, highlight the need to work with blind and partially sighted people to resolve information access and travel issues. (Hastalis, 1997)

An example of one of the technological breakthroughs that is meant to ease the usage of public transportation and orientation for the blind and partially sighted are the “Talking Signs.” This remote infrared technology consists of “short audio signals sent by invisible infrared light beams from permanently installed transmitters to a hand-held receiver that decodes the signal and delivers the voice message through its speaker or headset” (Talking Signs, 2006). It identifies the landmarks around the individual and sends him/her short messages telling what’s ahead. Such technology can be also applied to bus systems, informing the user of the current buses and schedules. However, one of the major concerns with this system is that it requires the installation of the specific transmitters, and although these transmitters are becoming more widespread and popular, blind people cannot depend on transmitters being there.

2.5 The Danish Public Transportation System

The Danish public transportation system is a very well structured and efficient system designed to accommodate the many commuters, inhabitants, and visitors of
Copenhagen. It consists of a commuter rail (also known as the S train), as well as buses and a metro, and their maps and schedules can be viewed in Appendix A, B, and C.

Although such a well rounded system is effective and adequate for most of its users, it does sometimes leave those who are blind and partially sighted behind. Although public transit stations have accommodations for some physical disabilities, such as wheelchair access and handicap parking, they are yet to have a full support network for the blind and partially sighted in a form of more audio accessible information.

Public transit is just one example of an aspect that will be tested in this project. The project will also examine the possibility of introducing portable GPS devices with Euman’s LifePilot software to assist in navigation through cultural districts, and incorporation of safe routes. In the preliminary phase, the project will focus on testing LifePilot’s ability to provide blind and partially sighted users with essential information along a walking route adjacent to the main buildings of the Danish Association for the Blind.

### 2.6 How GPS Works in General: The Good, the Bad and the Promising

GPS works when satellites in Earth’s orbit transmit a digital code signal which is then picked up by GPS receivers (like PDA’s or mobile phones that are GPS equipped) on the Earth’s surface. This code tells the receiver the time it took for the signal to reach the device, after which a mathematical calculation is used to figure out the distance between the satellite and the receiver on the Earth’s surface. By determining the distance between four or more satellites, one can get information about the latitude, longitude and height of the receiver. Some GPS technologies can use as little as two or three satellites, but may only give a location on the Earth’s surface in latitude and longitude.
Understanding the basics of GPS technology can also lead to logical conclusions about when GPS would not be effective. The signals from satellites used in current GPS technology are not capable of going through stone, concrete, metal, dirt, etc. This inability would make GPS devices virtually un-adaptable in underground subway systems.

Furthermore, another issue with the currently marketed GPS devices specifically designed for the blind and partially sighted is that they are used in conjunction with an already uploaded map to determine the individuals’ location relative to businesses, parks and the like. However, if these maps are not updated frequently, the location identified to the user as a recreational park may now be a new drugstore. While GPS technology gives the longitudinal, latitudinal, and height location relative to Earth’s surface, without an accurate physical map it cannot tell you what new restaurant replaced the old post office.

Lifepilot technology is an exception to this major GPS deficiency. The portable devices (such as a mobile phone) that carry the Lifepilot software are connected to a server that allows for continuous update to the most recent maps. More about GPS technology and the unique advancements of Lifepilot will be discussed in the next section.

2.7 Background on Current Available Technology

Technological advancements are made practically everyday incorporating all aspects of life. Assistive technology to aid the blind and partially sighted can increase the individuals’ quality of life and enable them to better communicate and navigate in the growing world.
There are various types of assistive technologies that are currently available to blind and partially sighted users. One example is the text-telephones (TTY), which have specially designed Braille keyboards. Audio Visual Mart, Inc. markets this type of product, called the Braillephone, and this eight pound phone for in-home use sells for $62.95. Another example refers to cell phone technologies, more specifically software that can be uploaded to individual phones and address some of the concerns that the blind and partially sighted have. TALKS Series 80 is designed to work specifically with Nokia 9290 mobile phones, and can speak to users in several different languages, allow them to listen to voice mails and even write and send e-mails. This technology is sold by Beyond Sight and retails for $395.

The current market also includes a variety of speech synthesizing devices with the ability to connect to a computer. DoubleTalk LT is an example of such technology that converts text into electronic speech and can be purchased for $299. Voice recognition software like the Dragon NaturallySpeaking Professional, which costs $695.99, is also on the market. All of these products and many more can be found on the National Federation for the Blind’s Technology Resource List.

All of these products are beneficial in their own way, however, none of them has the ability to guide a blind or partially sighted person walking through the streets of Copenhagen, or attempting to ride the bus. By integrating these technologies and more (specifically, location based services like GPS), for the blind and partially sighted, navigating through the streets may become easier.

2.7.1 Commercially Available GPS Technology for Blind and Partially Sighted
Specialized GPS products are the main technological focus of this project. How can such advances in mobile technology benefit the blind and partially sighted? What specific features are desired by the intended users? What is the economic value of a personal navigation product? These are all issues that need to be addressed. According to a review done by the National Federation for the Blind, conducted in February of 2006, there are three main products marketed today. However, it is important to note that new technologies are being researched and developed even as this paper is being written. The three most popular technologies will be discussed below in order to understand what is available in the market currently and what they offer blind and partially sighted individuals. By assessing currently available technologies it will help us know what areas still need to be addressed, and therefore assist us in making recommendations for possible features.

The Sendero GPS Version 3.5, which sells for $1,549 (for a baseline model, upgrades will cost additional money), is a software that works with any BrailleNote product. This technology looks like a miniature computer and can be worn easily on the individual. The Sendero Group, LLC focuses their marketing on six main features that are found in the product, including its ability to:

- Automatically create routes for either walking or riding in a vehicle.
- Understand the street layout before traveling to a new city by means of the "virtual explore" mode.
- Generate detailed information about your speed, the direction you are traveling and your altitude.
- Immediately calculate the distance and direction to a street address or intersection.
- Determine your location relative to millions of "points of interest." Focus your points-of-interest search by category.

(Sendero Group, LLC)

GPS technology, like Sendero, helps the user navigate the streets. The ability to hear if there is an upcoming street intersection, bus stop or train station greatly increase
the ease at which a blind or partially sighted individual can live and travel as an independent.

In a review by the National Federation for the Blind, the Sendero GPS system is one of the best available technologies in the United States. The review concluded that, “Of the three systems we examined, the Sendero Group product offers the greatest flexibility in features and ease of use. Currently the GPS system cannot print or emboss a created route.” (GPS Technology for the Blind, a Product Evaluation). The recommendation to improve this technology is to add the capability to print the routes in Braille.

The main features of various GPS systems are roughly about the same however it is the options that set them apart. Maestro, by Humanware, is a PDA that incorporates GPS technology (called Trekker). Besides basic personal navigation, with Maestro, the user is also able to do things like record voice memos, check e-mail and listen to music. This product is distributed world wide and by Instrulog Rehab specifically in Denmark.

In a review done by the National Federation for the Blind (US), the Technology Staff found the Trekker GPS software (specifically Version 2.7) user friendly. They did find a few flaws with the technology and came up with recommendations for improvements like the:

…ability to load more than one map at a time, which the company is working on; adding more Bluetooth GPS receiver support; and adding the ability to print and email created routes. According to Humanware the list of supported receivers is growing.

(GPS Technology for the Blind, a Product Evaluation)

The recommendation of allowing the routes to be printed is echoed again in this review of the Trekker system. For the purposes of our study, the desire for a printability
feature should be discussed and viewed as an option to be incorporated in Lifepilot technology, although for the blind and partially sighted to utilize this software independently the printing would have to be in Braille or translated into voice directions.

The last major GPS technology to be discussed is the Street Talk GPS Solution by Freedom Scientific. For use with PAC Mate system, the Street Talk GPS system is retailed at $599.00. Like the previous two technologies, the Street Talk GPS Solution allows the user to create a route in order to get from one location to another. In contrast though, Street Talk GPS Solution does allow the user to print a Braille-friendly version of the travel route, however there are still some improvements that could be made. The review by the National Federation for the Blind makes recommendations on features this technology is lacking compared to Trekker and Sendero by saying that some improvements for

…future upgrades are the ability to create pedestrian routes and the capability for a traveler to preview walking a route. This should include information on cross streets and points of interest in the same way as the other two GPS systems provide.

(GPS Technology for the Blind, a Product Evaluation)

By researching the top three products marketed as navigational tools for the blind and partially sighted, it can be seen what technology already has to offer. It should be noted that besides common GPS features, additional features like the ability to emboss and print routes should be explored. It has been discovered that it is not so much a question of can location based services aid the blind and partially sighted community, but more an exploration into how can this technology be modified to better aid in navigation.

2.8 Lifepilot
One of the aims of this research project is to identify the possible ways that the Lifepilot technology, developed by Euman A/S, can be adapted for use by the blind and partially sighted community. A specific focus will be on products from the Lifepilot Local technology like Lifepilot Tour, M-log and Documentor. All of these products work in conjunction with the Lifepilot server. A GPS signal is sent and received by the portable device (mobile phone or PDA) which is then connected to the Lifepilot service platform for immediate information.

The Lifepilot Tour allows the user to have a pre-determined path, location to location, usually for a specific theme. This technology could be very beneficial to the blind and partially sighted who wish to travel from the bus stop to a friends’ house and back to the bus stop again. Lifepilot is an internet based program and Euman has partnerships with several providers of maps that cover all roads and addresses in the European Union. Since these maps can be provided to the mobile phone, or device using the Lifepilot technology, this allows for a more accurate orientation of stores, restaurants or bus stations relative to the individual.

Lifepilot M-Log software works with a mobile phone that has a built-in camera, allowing the user to save multimedia images which can then be shared online. The Lifepilot Documentor allows the user to save positions, texts, images, sound files and video on applicable devices. Data can be recorded and then sent out instantly via the Lifepilot server connection. Another aim of this project, besides the benefit of GPS navigation, is to determine if M-log and Documentor technology can be used to help the blind and partially sighted community share information quickly and efficiently. Also, perhaps a combination of these technologies can be used to design a virtual tour around Copenhagen for the visually impaired.
2.9 Integration of GPS Technology in Danish Museums

The usage of Global Positioning System technologies is becoming more widespread not only with the individual but with large companies searching for new ways to address old issues. GPS systems allow for interactive solutions that center around the individual, and thus make a difference one person at a time by including customization to suit that person’s needs.

One example of the integration of GPS technology can be seen during a visit to the Frilandsmuseet located in Lyngby, Denmark. The Frilandmuseet, a branch of the Danish National Museum, is a free air museum located just outside of Copenhagen with over one hundred buildings, dating from the 17th century to the mid-20th century, covering nearly one hundred twenty acres of land area (Pedersen, 2002). In an effort to capture the attention of younger audiences, and increase the number of visitors and satisfaction level for that age group, the museum implemented a mobile phone tour guide system with GPS components as part of his/her museum experience. This technology gives the individual an audio tour depending on their location, as well as allows for games between visitors, discussion of the exhibits from one mobile phone to another, and other interactive features that are designed to keep younger audiences interested while they are learning valuable lessons of history. This technology is thought to be a great pedagogical breakthrough, for it broadens the museum’s educational experience from just tangible history (such as the actual buildings) to a combination of the tangible and intangible history (the stories behind the building), therefore inspiring the younger generation with knowledge.

Such a system is already implemented in numerous museums throughout the country, including the Danish National Museum, where an assessment done by a
Interactive Qualifying Project group in 2006 on the devices’ popularity, concluded that such technology was a great success.

2.10 Sponsor: The Euman Company

The Euman Company is a specialist in Wireless Information Services, and is the developer of the Lifepilot. Its mission is to provide users with all of the information needed to lead an independent life. Euman’s Wireless Information Services are based on a time and location aware content brokerage system named GOF (General Object Functionality) (Euman Products), thus allowing their devices to communicate the user’s location very accurately and precisely. The company is determined to use their innovative discoveries and devices to implement a better communication network for its clients.

This project is a collaboration between the Euman Company’s Lifepilot technology and the Danish Association of the Blind, in the hopes that such GPS devices will provide the blind and partially sighted with the necessary timely information which will enable them to travel independently.

2.11 Sponsor: The Danish Association of the Blind

The Danish Association of the Blind, or “Dansk Blindesamfund” in Danish, is an all blind organization founded in 1911 by a group of blind and partially sighted individuals. The organization plans activities, as well as educational programs, and provides support for its members.

Part of the organization’s responsibilities is to promote equality by fighting for and helping with the installment of accommodative features in public buildings and the like. Furthermore, the organization is responsible for representing its members in local councils and advisory boards. Representation is very important in Danish society, where
due to decentralization of authorities there has been a breakdown of responsibilities within counties and other localities. This lobbying enables the organization to bring about social changes by speaking up, voicing concerns and discussing solutions to common problems that face its members (DAB, 2006).

2.12 Previous Research: Path Study

*Study 1: Towards an Accessible City: Removing Functional Barriers to Independent Travel for Blind and Vision-Impaired Residents and Visitors (Referred to as Path Study)*
Reginald G. Golledge James R. Marston

This study was conducted in Santa Barbra California in order to test an infrared sign system to aide blind and partially sighted in locating buses and their terminals. The approach of the study involves questioning the blind and partially sighted population to find their needs, and current methods of transportation. The project team realized that the overall problem is the stress and anxiety associated with the blind and partially sighted not being able to predict where they are and what is happening around them. These feelings need to be considered so that a reliable and accommodating solution using technology can be implemented. Informational reliability will allow the blind and partially sighted to function in society as easily as people with immobility issues (such as persons using wheelchairs or canes).

The purpose of this study is stated as:

When trying to access urban services such as public transit, we use them to identify street intersections, buildings, transit stops, different transit vehicles, and amenities such as telephone, fare and information booths, rest rooms, and specific stores. People who cannot read signs experience difficulty when traveling through unknown territories because of their inability to access the information on signs. The eight to nine million blind or vision impaired people in the United States face this problem when attempting to independently use public transit. They have limited access (e.g. via mobility assisting devices such as canes, dogs, or sonic beams), to information about pathways, traffic flows (both vehicular and pedestrian), as well as an inability to identify vehicles by route number or written
destination. It is difficult to find the appropriate entrance or exit door either to vehicles or to the terminal. Necessary facilities within buildings such as elevators, escalators, or stairs, either have to be remembered by rote learning after repetitive trials or searched for exhaustively with the assistance of an obstacle avoider (e.g. cane) or found by asking passersby. The question is how can we change accessibility to public transit such that travel independence can be increased and the potential for searching for and holding employment at some distance from a place of residence is enhanced. (PATH, 1)

The following are the published results of several surveys conducted by Golledge and Marstons’ research team to figure out exactly what problems blind and partially sighted travelers’ encounter, and how severe they rank each problem.

1. Finding a bus stop: In suburban areas bus stops are identified in a variety of ways. The most common is for a metal plate to be displayed on a cylindrical metal pole with information about the arrival times of buses, the route name, and the bus number on them. Sometimes these plates are fixed to streetlight poles. Bus stops can be located immediately before an intersection, immediately after an intersection, or somewhere along a specific block face. Some stops have benches and/or shelters: many do not and thus the task of identifying a stop increases in complexity with the presence or absence of associated cues. The blind person has to be able to identify the block in which a stop is likely to be located, and be able to find the bus stop indicator efficiently and effectively on each trip. (PATH, 3)

2. Selecting the proper bus: When more than one bus operates along a particular route, the blind user must signal the bus to stop, find the entrance to the vehicle, and question the driver as to which bus number and route is being accessed. At key locations such as in some downtown areas, a succession of buses might be stopped at their appropriate signal points along a block face; this presents a particular problem in that the blind traveler must ask for information from each driver in turn or from passersby or other potential passengers. At a terminal when one might expect many buses to be parked in an irregular fashion, sometimes with multiple lanes of vehicles, the problem becomes even more intense. Under these circumstances finding the correct bus is an extremely difficult process and often the time taken to independently search for the appropriate bus exceeds the time which has been allocated for the bus to stay at that station. (PATH, 3)

3. Finding transfer points and crossing streets: One of the most difficult activities for a blind person using a public transit system is when bus transfers are involved. The former two problems of finding a stop and finding the correct bus are exacerbated by intervening problems such as transfer time constraints, remembering the number and destination of the bus to which transfer must be made, or finding a safe and convenient way to cross a street in order to make such a transfer. In many cases transfers that require the crossing of streets are made in the absence of traffic signals with pedestrian control. (Path, 3)
4. Learning bus terminal layout and boarding areas: Even things as simple as finding entrance and exit doorways, information or ticket windows, and using amenities such as bathrooms, stairs, escalators or elevators, drinking fountains, and even change machines, can be extremely difficult and highly stressful for blind travelers. It is often difficult for a sighted person to realize the enormity of the problem faced by a blind traveler in finding and using these amenities because they are so much a part of everyday understanding and activity that it is often not possible to accept that these “simple” tasks represent major obstacles for some people. Using facilities and amenities in a bus terminal obviously gets more difficult as the terminal increases in size and the number of facilities and amenities are increased. (PATH, 3)

5. Finding the appropriate boarding area and selecting the correct bus from a set of possible alternatives is stressful, time consuming, and often the task cannot be completed within an appropriate time window. (PATH, 4)

Blind or vision impaired travelers are often taught strategies for dealing with these problems as part of Orientation and Mobility training or as part of survival skills taught by friends or wellwishers. The problem in each case, however, is that the environment must be learned before it can be used and a considerable amount of locational, orientational, directional, and distance information has to be remembered, recalled, and used for each specific task. Vision, of course, allows all these problems to be handled with ease in that spatial information and the geometry of the task situation can be perceived and assessed almost simultaneously. Traditionally, travel aids for blind and vision impaired travelers (such as the long cane and guide dogs or electronic aids such as laser canes and ultrasound sensing devices) have been developed primarily for obstacle avoidance purposes and not for learning routes or layouts or the spatial relations embedded in those layouts. Thus, in many cases, the mental maps of blind persons are disconnected, and are linearized and incomplete renderings of an environment when compared to the richer information incorporated into the mental maps of those with vision. (PATH, 4)

2.13 Previous Research: Spatial Displays

Study 2: Evaluation of Spatial Displays for Navigation without Sight
JAMES R. MARSTON and JACK M. LOOMIS, University of California Santa Barbara; ROBERTA L. KLATZKY, Carnegie Mellon University; REGINALD G. GOLLEDGE, University of California Santa Barbara; ETHAN L. SMITH, University College London.

This study tested a GPS receiver unit coupled with infrared receiving and the participants were all placed on equal levels of blindness (using blindfolds). The purpose was to field test the use of this system to discover its strengths, limitations and feasibility.
We report on two route guidance tasks using a highly accurate GPS receiver. Eight participants who were visually impaired or blind traveled two routes, one on a city sidewalk, and one in a city park. We tested and compared two types of spatial output devices that give route guidance information. One output display used a hand-held pointer, using a standard Talking Signs receiver that integrated the GPS signal information with the Talking Signs® signal information. This device gave travel instructions and on-course confirmation pointed in the proper direction. The other spatial display used auditory virtual reality that presented the audible spatial information (waypoint direction and distance) through small air-tubes inserted into the ear. Travel times, distance, and errors were recorded. In addition, we tested users’ ability to find precise locations, such as the intersections of small paths and a bus stop pole. Various subjective ratings were collected about blind participants’ needs and perception of the various display and output options that they used. All subjects completed the tasks with both output displays, found all the waypoints and locations, and rated the two displays highly. The virtual sound display produced superior times overall and received slightly higher favorable ratings. (Evaluation, 1)

Even with all the advancements in technology, several people either choose not to use it or do not know how to use it. The second goal in this study was to provide user feedback as to what features are helpful, and what features are distracting, and if there is anything extra they can do to improve its functional use.

The second goal of the research was to see how often people would choose to use the spatial display to find the precise direction to the next waypoint. In normal travel on streets and sidewalks, the average blind user has available navigation skills learned over time and through Orientation and Mobility (O & M) training. It is possible that these skills are sufficient for most guidance, so that a Personal Guidance System would be queried only infrequently. We also wanted to test if the directional cues would be used less in a structured space, as when walking along a city sidewalk, than in other, more open situations, where fewer cues are available to guide travel. By allowing people to control the amount of time directional spatial information was received in various locations, we could measure their usage. We further investigated whether more skilled (i.e., faster) blind travelers would use spatial display cues less often. To address these issues, the experiment measured usage by a group of blind travelers in two different environments and also investigated the relationship between total travel time and usage. (Evaluation 111-112)

The data from both tests was obtained both analytically and by using surveys that provided feedback from the users. Overall the system performed excellently and received faster times and better ratings then using nothing. However one of the primary drawbacks
to this technology is the significant amount of set up that must be done in cities to make this technology feasible.

Time to complete each path, errors made, the percentage of the total time that users accessed the spatial directional information, and the distance traveled were recorded. With eight subjects, two displays, and two devices, there were 32 trials. Two trials were not run or aborted because of power supply failures. Of the remaining 30 observations, all participants were able to follow the routes and finish the experiment by finding the final waypoint, with no outside assistance. All users found the seven waypoints in the park, which were at the intersections of sidewalks and gravel paths having widths of 1.8 and 1.2 m, respectively. In the city sidewalk test, all participants found the first two sidewalk intersections and the third waypoint with the GPS-signaled bus stop. All subjects also successfully used both devices to find the last waypoint in the street environment. That waypoint—a bus stop pole—was announced through the PGS output display when users approached it within 10 m. They were then required to find it with the HPI RIAS directional beam, as shown in Figure 4, or, when using the virtual sound display, they used the RIAS receiver that was worn around the neck. The RIAS-equipped bus stop pole required, in both conditions, the transition from use of the GPS output to the RIAS output. All participants found all the waypoints and finished the test paths with both spatial displays. (Evaluation 116)
2.14 Previous Research: Urban Environments

Study 3: Comparing methods for introducing blind and visually impaired people to unfamiliar urban environments. M. ANGELES ESPINOSA, SIMON UNGAR, ESPERANZA OCHAITA, MARK Blade, AND CHRISTOPHER SPENCER.

This study was conducted in Madrid, Spain and is a comparison designed to see how the blind and partially sighted learn their surroundings. A diverse age group, ranging from 12-50, was selected and two different routes established. Each group then had to complete the route using tactile learning or direct experience.

This paper reports two experiments which compared the effectiveness of different methods for introducing blind and visually impaired people to the spatial layout of urban environments. In Experiment 1, 30 blind and visually impaired adults learned a long and complex route through an area of central Madrid (Spain) either by direct experience or by a combination of direct experience and a tactile map or a combination of direct experience and a verbal description of the area. Performance on measures of practical spatial knowledge and of representational spatial knowledge was significantly better in participants in the tactile map condition. In Experiment 2, participants learned a similar route in an area of Sheffield (Britain) using either just a tactile map or by direct experience. No significant difference was found between the two conditions using the same measures as in Experiment 1. (Comparing, 1)

While the conclusion of direct experience is far better than tactile learning, the three dimensional maps where far better than having nothing at all.

We argue that the combination of two procedures (direct experience and tactile maps) constitutes a useful procedure which should be used by orientation and mobility instructors. The joint use of the two procedures may overcome any limitations of each method used in isolation. For this reason we would stress the value of using a procedure which combines both methods. However, in situations where it is impractical or impossible to provide guided direct experience, then even a tactile map used in isolation can be an adequate means of familiarizing oneself with an environment. (Comparing, 6)

2.15 Interviews / Training

It is important for any researcher that is aiming at a specific group in the population to have the ability to empathize and understand those he or she is trying to
help. Because we have had little to no experience with actually being blind and partially sighted it was important for us to obtain a basic understanding of how the blind feel and function in today’s world, which was achieved in a few different ways, including conducting interviews, undergoing sensitivity training, practicing common tasks blindfolded in unknown areas, examining the current adaptation present in buildings and just generally interacting and socializing with blind and partially sighted persons. This new acquired blind and partially sighted psychology will then hopefully be used to make more accurate product recommendations to the Euman Company, and much better represent the needs of the DBS.

2.15.1 Sharon Strzalkowski and Michael Cataruzolo.

Prior to leaving for Copenhagen, we had the opportunity to have lunch with Sharon Strzalkowski, and visit Mike Cataruzolo at the Perkins School for the Blind in Watertown, MA.

Sharon, who has been blind from birth, works at a blind and partially sighted advocacy company in the Worcester area. During our lunch with her, we had the opportunity to have an open discussion about the difficulties she faces daily, and how she overcomes them. A few of the things that were addressed were the technology she uses to accomplish communicative tasks, such as reading and sending emails, and the services she depends on for transportation. Sharon talked about how when a blind and partially sighted person plans to travel, they make sure to have detailed directions, as well as plan everything according to schedules and routes before even considering stepping a foot outside the house. She herself mentioned that she rarely uses public transportation due to many factors that she cannot plan for, such as detours and late buses. She referred to a trip she took once on the bus: although the trip was planned well in advance, due to some
technical difficulties, the bus had to stop and its passengers had to relocate to another bus. If it wasn’t for a passenger who offered his help to guide her to the new bus, she wouldn’t have known where to go. Sharon talked about a company named Yellow Cab whose services she uses often. This company is a door to door cab service that is utilized by many blind and partially sighted people. One of its greatest advantages is that it picks up the person right outside of their building within a time frame of about 10 minutes, however, one of the biggest disadvantages is that in order to use it, one has to call in a request about a day in advance and ask for a specific time. Sharon mentioned how one day she’d like to just decide she wants to go somewhere and have the ability to do that, without planning it a day in advance, but she commented that she is aware that that is not a possibility right now.

Overall, Sharon was able to give us an excellent introduction to how the blind and partially sighted function doing every day things (such as voting, and reading the menu at a restaurant).

After our lunch with Sharon, we preceded to schedule a meeting with Mike Cataruzolo, a member of the Perkins School for the Blind in Watertown, MA. The Perkins School for the Blind is known worldwide as a resource for those who suffer from visual disabilities (including blind-deaf and blind people who are also mentally handicapped), and is particularly famous for one of its students, Helen Keller. Mike Cataruzolo is very prominent member of the institution, and used to serve as its athletics director. He gave us a tour of the place, and pointed out the many creative and innovative accommodations that were put in place, from the hand carved flowers on the church’s seats to indicate the separation of the seats, to the raised border surrounding the swimming pool.
As part of our visit, our group had the opportunity to go through sensitivity training which included simple instruction on how to guide a blind and partially sighted person, and what information is vital when describing a room. We learned that by doing role-play, where one of the group’s members was blindfolded, while the other guided him or her.

Perhaps the most popular part of the tour occurred when we practiced sports, such as jogging, blindfolded, using the accommodative railing that was put in place.

We learned a lot about the history of Perkins, as well as got a hands-on insight to understanding blind and partially sighted psychology. Mike also gave us the contact information of one of his friends, who is a blind GPS user, and our interview with him was as follows.

2.15.2 Interview with Brian Charlson from the Carol Center for the Blind.

In an attempt to find out how a Blind GPS user feels about technology we contacted Brian Charlson, an avid user of the Street Talk Pack-Mate from Freedom Scientific. Below is a brief description of the key things learned from the conversation:

Brian uses a Street Talk Pack-Mate from Freedom Scientific. This device works off of automobile GPS. Brian commented how he does not like the fact that this is a car unit, because it references to the white line in the middle of the street, therefore, making left turns extremely difficult at places like a T intersection and sometimes even leading him up the wrong way on a one way street. Brian uses it for just about everything in conjunction with a guide dog, but along with the size, the cost is very expensive (ranging in the thousands of dollars). It’s important to note that once installation is done it takes anywhere from 15-25 minutes to get ready to leave the house.
We questioned Brian about his ideas and suggestions on how to improve upon this device, and categorized his comments in the following way:

**Simplification**- Brian mentioned that he would like to see everything shrunken down and simplified, the installation process most of all. This particular unit has a 90+ step installation process out of the box: Bluetooth to receiver to Software (via USB) to map download, to finally placing them on the device. Brian would like to see this installation process simplified.

**Size**- The current device is about the size of a large keyboard, making it too heavy and bulky for average use. Furthermore, it cannot be linked to a refreshable Braille keyboard, and the GPS unit is a separate feature mounted on a shoulder strap.

**Receiver interfaces**- The device in use has one button for on and off commands, where the user has no way of telling its state in a way other than by trial and error. It uses flash cards, seven in all with maps of twenty six states, and all the states are broken down into regions. However detailed the devices gets, it’s important to note that the bigger the map the slower the response time, and interface is known to be wrong. This is a common downfall in most GPS systems, where it can get you to the “center off the parking lot” not the front door, and can be off anywhere by about 9’ to 3 blocks.

Brian gave a personal example of his house, which is located at 57 Grandview. The GPS doesn’t recognize the given address instead it sees it as 59 Grandview. Brian recognized that the more you interact with the device, the more familiar you get with the technology. He suggests that features such as waypoint setting for door to door access and labeling of key things such as restaurants and home could make device much more user friendly.

Since the device has no obstacle avoidance Brian still needs a guide dog as an assistive tool to get from one place to another. He also mentioned that the voice that is used to indicate audibly when the user is approaching the waypoint, gets really annoying for it notifies you as frequently as every five seconds.

**Interfaces**- Some of Brian’s suggestions included voice recognition commands, refreshable Braille, smaller more compacted devices, little to no maintenance, no different maps, and both inside and outside areas covered. He would like to see the devices be more pedestrian oriented, rather than automobile oriented, and have some way of turning them on and off so they can be a multi purpose device.

**Waypoint/navigation tools**- According to Brian, right now navigation is limited to setting waypoints: go to A from A find B from B go to C and from C take me home, and again, he would like to see this made to be much more pedestrian friendly.

**Accuracy**- Brian emphasized accuracy as being a very important feature that needs to be further build on. He would like to see an improvement in accuracy, both indoors and outdoors, without the waypoint settings, while having programmable maps still be an option.
2.16 Dialogue in the Dark- Copenhagen, Denmark

With over two million visitors in more than fourteen European countries, as well as North America and Japan, Dialogue in the Dark is a unique exhibition that allows participants to feel what it’s like to be completely blind, and lean how to “see” again by not seeing (The Exhibition). Before entering the pitch-black exhibition hall, individuals receive walking sticks to help them guide themselves as they walk through the simulated streets, parks, and even cafés, lead by a blind tour guide, for a period ranging from one to three hours.

Fortunately, this exhibition was available at Copenhagen’s Experimentarium during the month of March, and we had the opportunity to take a day trip and visit it ourselves. As part of our tour, we walked on a side walk, feeling all the cars and bikes around us, sat down on a bench in the park, and even ordered coffee and cake as we sat down to talk to our guide about her experiences as a person living with blindness. It was truly a role reversal, for we, as sighted people, were lead by a blind guide, who had a much better grasp of the environment. During our talk she mentioned that seeing accounts for as much as 84% of our environment assessment, and it was up to us to make the most out of the 16% left behind.

There is no argument that today’s society is very visually based, and there was an initial bit of a shock factor when that sense was taken away from us. However, as time went by, we learned how to concentrate and use our other senses, such as touching and hearing, so that by the time we reached the café, we had no problem ordering our cappuccinos and paying in complete darkness.
Overall, this was a unique experience that assisted in giving us a better understanding of the project, for experiencing it ourselves really helped in giving us a better perspective on the issue, as well as underlined the importance of this IQP topic.

3.0 Methodology

The Euman Company currently markets a variety of products that further one’s ability to orient him/herself in their environment and enables better and more thorough communication between users. This project investigated how blind and partially sighted people can benefit from the location based services, and addressed five different aspects of life to which such technology can be integrated:

a) Cultural Experience
b) Navigation
c) Sharing of knowledge
d) Traffic information
e) Mobility

A. Cultural Experience

One of the great advances in GPS technology is the LifePilot TourGuide, which allows individuals to customize their tour routes and receive information about historical building and monuments based on their location. This is a great advantage to anyone who would like to tour a city based on their own time and interest. Our project examined the possibility of accommodating such device for the blind and partially sighted. One aspect considered was to create routes that follow symmetrical/geometric shapes, i.e. walking in a rectangular route as opposed to walking in circles.

B. Navigation
The navigation investigation addressed the question of “can the information be structured and presented in such a way that blind and partially sighted can easily find their way?”

Most of the current Euman products take advantage of visual display in the forms of icons and different color schemes. For example, LifePilot Guide can provide you with relevant tourist locations in the neighborhood (such as overnight accommodations, attractions and activities, as well as restaurants, museums and buildings), and it does so by means of icons that are displayed on a map. In order for a location feature to benefit those with visual disabilities, the product will have to be developed in a way to present such information via audio means. Since Copenhagen is a big city full of many restaurants and attractions, it will be essential to make sure that there is a way that will give the user the specific information he or she needs, without overloading them with lists of all the attractions around.

C. Sharing of Knowledge

The ability for instantaneous sharing of information is one of the great features LifePilot devices have to offer their users. This access is also very beneficial to those who are blind and partially sighted.

For example, LifePilot M-Log includes a built in camera and sound recorder, so that when you are at a certain location you can make a note-to-self, which you can then also share with others. This capacity could be a great way to share information about different places’ accommodations for the visually handicapped, especially the sound recorder feature.

Another example is the Documentor, which creates geo-related documents consisting of positions, texts, images and sound files. Such abilities could be used by a
person to document specific things about buildings, including personal instructions about how get around them (i.e. the elevator is five steps away from the door to the right), but this would again require audio description.

D. Traffic Information

How can GPS technology make the usage of public transportation easier for the blind and partially sighted? As described in the introduction, the main problem that faces visually handicapped users of public transportation is the lack of information, since most schedules and routes are communicated via visual displays. The best way to address that issue is by having all that information available in audio form that the users could access via their mobile phones.

E. Mobility

Lastly, we determined if LifePilot technology can be used as a supplement to mobility training during learning of routes or by means of tracking the position of a person.

LifePilot Fleet has a variety of options that might be useful for mobility. It can track down the current location and history of traveling of the mobile resources, and includes the abilities to automatically update the positions on the map and locate the nearest unit in relation to a point or an address. Such device could hypothetically be used if, let’s say, blind and partially sighted people go in a group and decided to break up to pursue individual attractions; they could use this feature to track down each other and meet up at the end. The challenges with this device would be to modify it for visually handicapped people, since as of now it uses colors and icons to represent the different people and locations.

As seen above there is a lot blind and partially sighted persons can benefit from current LifePilot technology. However, to make that possible, the main avenue for
communication between the device and the person needs to be done via audio options, as opposed to visual diagrams. Also, added features, such as the ability to print things in Braille for example, should be considered to make the device more useful within the blind and partially sighted community.

3.1 How to Select Assistive Technology

Since the technology in this study should be designed primarily to aid people with disabilities it is first and foremost important to understand the potential market that we will be investigating. Because the blind and partially sighted have a specific impairment, their needs and functionality are greatly different from sighted people’s perception. A model must be created and research done into what the blind and partially sighted currently use for technology and how they feel about new technologies, especially those technologies meant for navigational aides. From this study, a conclusion can be drawn as to what features and what interfaces are best suited for blind and partially sighted users. The basis for our study comes from a tried and proven method called the “Matching Person and Technology Model”. This model can be seen below:

Matching person and technology Model
(Evaluating Selecting and Using Appropriate Assistive Technology pg. 14)
Figure 3.1.1 Matching person and technology Model (Evaluating, selecting, and using appropriate assistive technology pg 6-7)

This model serves as a guideline to compare such things as personality with background and matching a specific technology to the user. This matching is a very effective method when applied to an individual, but is very difficult to perform with accuracy on a broad scale because of individual opinions and individual circumstances surrounding every user.

3.2 Questions Answered
To counter the individuality problem, we created a survey (refer to Appendix D) and conducted focus groups to ascertain the critical points users’ desire, along with any special features the users need. Also, volunteers from the focus group tested a pre-constructed route and gave their feedback on the helpfulness of the GPS technology (a section detailing the construction of the route will be presented in section 3.4).

The following is a list of questions it is vital to answer before any assistive technology is to be tested. The answer to these questions will not only gauge in marketing decisions but also allow for goals and a definitive measure of successfulness to be formulated. These questions are for the masses only and can be varied in select cases by individual participants-another good reason to have more than one tester over a wide range of disabled persons.

- What does the person want to do when and where?
- What functional abilities skills and interests does the person have?
- What tools can best be used to accomplish the task?
- Any expectations or changes that might occur?

(Evaluating Selecting and Using Appropriate Assistive Technology pgs 5-24)

### 3.2.1 Device Characteristics (Analysis of Features)

Once a technology is developed, or theorized, in accordance to the responses from the questions above, it should be tested or at least evaluated to discover the demands. Listed below are the criteria for testing, i.e. possible things to mention in a focus group, to Euman or the DAB. In order to be successful, a product should pass all of the below criteria. Any one of the following can be linked to a failure point in product usage. The following is a rough list of aspects that need to be examined, possibly through a more specific survey or a focus group:

- Are there changes in consumer functional abilities or activities?
- Is there a lack of consumer motivation to use the device or do the task?
- Is there a lack of meaningful training on how to use the device?
- Ineffective device performance.
- Are there environmental obstacles to use such as narrow doorways or curbs?
- Is there a lack of access to information about repair and maintenance?
- Is there no need for the device or minimal need for it?
- Device aesthetics weight size and appearance?

The following points can be used on an individual basis however we are not focusing on an individual but rather the blind and partially sighted community as a whole. These may prove pertinent to our project:

1. Characteristics of the Milieu in which the assistive technology is to be used
2. Pertinent features of the individual’s personality preference and temperament
3. Salient characteristics of the assistive technology itself

The following are the essential steps that must be performed in order to have a successful development and implementation of assistive technology:

- Establish goals and expectations.
- Assess need for a no technology, low technology or high technology device.
- Match person and technology
- Select and fit assistive technology to the person
- Train person for assistive technology use
- Assess/evaluate outcomes of assistive technology use according to goals and expectations
- Return to Number 1

The following checklist is used to test the technology after it is being developed. It is important to think of real life considerations when doing the evaluation. Once you have a final product, you must discover if that product is a viable part for every day life. We
have made this checklist to verify that all important aspects of the product have been studied:

**Technical Evaluation checklist**

- Tech
- Work
- Strong and safe
- Compatibility
- Reliability
- Durability

**Personal Evaluation Checklist**

- Ergonomic
- Secure feeling
- Simplicity
- Size
- Comfort
- Aesthetically appealing

### 3.3 Seven Week Schedule

The following is the schedule followed while in Denmark on a weekly basis for our study: (there was a general orientation week before week 1….)

**WEEK 1**

- Introductory meeting with D.A.B. and Euman Sponsors
  - Discussed project progress and determined main goals/aim of the project (i.e. field study to be conducted and focus group)
- Reviewed and assessed survey data that was gathered prior to arrival in Denmark
- Learned about how Lifepilot technology works and began to develop a route around the DBS neighborhood for volunteers from the focus group to perform.

**WEEK 2**

- Finalized and test the designed route around the DBS neighborhood.
- First meeting of focus group and initial trials of GPS technology via blind/visually impaired volunteers
- Submitted preliminary version of revised Introduction, Background and Methodology chapters to Professor Zeugner on March 30th, 2007.

**WEEK 3**

- Worked on problems related to the GPS software
- Worked on written report of safe routes (took pictures to illustrate a safe route versus a non-safe route)
- Determined relevant questions for the focus groups and set up schedule
WEEK 4-
- Conducted focus groups on April 12\textsuperscript{th}-13\textsuperscript{th}, 2007
- Began assessment on data gathered from focus group.
- Submitted final version of introduction, background, methodology and preliminary draft of results to Professor Zeugner on April 14\textsuperscript{th}, 2007.

WEEK 5-
- Continued analysis of data, results and began formation of recommendations
- Submitted final version of results and preliminary version of analysis, results and conclusion to Professor Zeugner on April 21\textsuperscript{st}, 2007.

WEEK 6-
- Finished recommendations
- Submitted final version of analysis, conclusions and recommendations to Professor Zeugner on April 28\textsuperscript{th}, 2007.

WEEK 7
- Submitted final version of IQP to Prof. Zeugner on May 5\textsuperscript{th}, 2007.
- Gave final presentation to Professor Zeugner, Euman and The DBS on May 7\textsuperscript{th}, 2007.

3.4 Detailed Methodology

After an introductory meeting with both the Danish Association for the Blind (DBS) and Euman, it was decided that the project would encompass a test run of this software by a small number of the focus group participants. In February, an advertisement was placed in the DBS members’ newsletter asking for interest in completing a survey and participating in a focus group regarding the usage of GPS technology. A majority of the time during the first couple weeks was spent assessing survey results, learning to use the Lifepilot program and designing a safe route for the experiment.

The participants who responded to the survey varied in ages (25-77) and in previous knowledge and usage level of GPS technology, and were asked ten questions about their transportation means and attitudes towards the devices. See Appendix D for
the survey in English. Seventeen surveys were collected via phone by DBS staff (refer to Appendix E for survey results), and the answers were analyzed (please refer to Results section 4.1).

These data gave the team insight to the kind of people who will participate in the focus group, as well as pointed out the key elements that should be included in the final test path. For example, 100% of the participants use some form of public transportation, and therefore, would like to have bus stops and train stops marked on the path. Also, almost a third of the participants have used a GPS device before, and out of those who haven’t, a majority (88%) would like to try.

It was the group’s decision to set the beginning of the route at the DBS building, and the end at Hulgårds Plads bus stop (which has busses leading to Nørrebro train station) on Frederikssundsvej. Such a route can benefit many of the members who come to the DBS, for Nørrebro station is accessible to a large variety of buses and trains, and is easy to get to from any point in the city of Copenhagen. Different paths were examined (Results section 4.2 discusses this topic further) and eventually, the following path was chosen:

Figure 3.4.1 – Chosen Path
Five points were picked as reference along the route: in front of the DBS building, at the intersection of Peter Ipsens Alle and Frederikssundsvej, at both sides of the major crosswalk, and at the bus stop. A voice memo was recorded for each point (see Appendix L for the script used to set the Points of Interest) in Danish to inform the user of their location. The memos were designed to be self activated when the user was within range of the points.

The path was tried out by the IQP group members, as well as the sponsors and focus group. The goal of this focus group was to discuss what it would take (features, design, etc.) to make the Lifepilot technology best adapted for use by blind and partially sighted individuals. Refer to Appendix M for the focus group questions/topics.

4.0 Results

The following section details the results of the surveys, knowledge gained from the process of setting up the path, the discussion of the focus groups, and further includes an overview of the success of the experiment.
4.1 Surveys

The seventeen surveys collected by the group were analyzed to provide ideas and critical information about the subjects, their needs and concerns regarding setting up a path and hinted at important issues for a focus group to discuss. A data summary of the answers can be viewed in Appendix F; Appendix G contains percentage breakdown of all the answers, and Appendix H provides a visual summary of graphs and charts, with a diagram per survey question.

Out of the seventeen participants, 94% expressed a desire for Safe Path features, where the path chosen includes comfortable and safe sidewalks, as well as avoids major traffic points and has beeping crosswalks. This focus on safe routing is a common concern in the blind and partially sighted community, for a majority of cities are not accommodated, and traffic always provides a substantial risk.

Figure 4.1.1 Question 9 from the Survey
Another important point that came across from the surveys was that all of the seventeen individuals who completed the surveys travel independently, see figure 4.1.2 and regularly use public transportation. Participants were further asked to comment on their preferred method of public transit, and figure 4.1.3 sums up their answers.

**Figure 4.1.2 – Independent Travel**

<table>
<thead>
<tr>
<th>Q5: Do you run your errands unaccompanied?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>12%</td>
</tr>
<tr>
<td>88%</td>
</tr>
</tbody>
</table>

**Figure 4.1.3 – Popular Methods of Traveling**

<table>
<thead>
<tr>
<th>Q10: What is Your Main Mean of Transportation?</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of People</td>
</tr>
<tr>
<td>Walking</td>
</tr>
<tr>
<td>Bus</td>
</tr>
<tr>
<td>Train</td>
</tr>
<tr>
<td>Taxi</td>
</tr>
<tr>
<td>Private Car</td>
</tr>
</tbody>
</table>

4.2 Choosing a Path

Once the beginning location, DBS and the final location, Nørrebro Station, were picked, the next step taken was to examine all the different routes that could get
participants from point A (DBS) to point B (Nørrebro Station). This included walking through different streets and examining their accessibility for the blind and partially sighted. An example for one of the paths can be seen in Figure 4.1.3 – Experiment Route 1. The advantage of that path was that it was a straight walk directly from the DBS to the station. However, out of the eight intersections, five had a crosswalk, and out of those five, only one included a beeping feature for visually impaired people. Furthermore, the street is a very busy street, with a lot of traffic and commotion, making the overall path not safe.

Figure 4.1.3 – Experimental Route 1

Other maps and comments for experimental routes can be found in Appendix I.

The advantages of the chosen path (see figure 3.4.1) include 100% beeping crosswalks (Safe Route features), minimal number of turns and final destination at a bus stop, where three different lines run and all can take you to Nørrebro station. Pictures of the described features are found in Appendix J.
4.3 Focus Group

Two focus groups were conducted on Thursday, April 12th and Friday, April 13th 2007. The groups were composed of eleven participants (eight and three), ranging in age, GPS experience and visual capabilities and members were asked questions that fit into three different categories: device (software and interfaces), GPS technology in general, and other comments (see Appendix M for complete list). The individuals were given the opportunity to comment on the topics, voice any concerns and give suggestions for the future. The second focus group had an additional chance to try out a shorter version of the route planned (due to technical difficulties with the server not all the marked points were able to work, and so a shorter route, that included the first two points, i.e. the entrance at the DBS to the corner of Peter Ipsens Alle and Frederikssunsvej was tested). A map of the route and a further detailed explanation of the technical difficulties can be found in section 4.3.4.

The following is a summarized outline of the three main topics of the Device, the GPS and other additional comments from the focus group discussion. Details about the specific suggestions can be found in the analysis section 5.2.

4.3.1 The Device

The individuals were given a description of the device, as well as the opportunity to physically examine it and try it out. They commented on its size, battery life, and discussed possible advantages and disadvantages of interfaces for accommodating for the blind and partially sighted community. Furthermore, the group remarked on both the common and the unique software features, as well as made suggestion for other features they thought to be vital.
4.3.2 The GPS Technology

Since not everyone in the group was familiar with GPS technology, there were many inquiries as to its capabilities, which led to a broad discussion among the group. Those who have had previous experience with the technology were more than helpful in both detailing the advantages and downfalls for prospective users. Participants made suggestions about what they want to see in GPS devices, and what information would be most useful to them.

4.3.3 Other Comments

To give the project social depth and discuss any cultural issues that could arise, a discussion on the topic of being a blind or partially sighted individual in Denmark was undertaken. It was to our benefit that many of the focus group members have had opportunities to travel around the world and live in other countries. Such travel allowed them to compare and contrast being blind or partially sighted in Denmark as opposed to other countries. It also brought up any transit difficulties faced while traveling.

In fact, perhaps one of the biggest topics which came up during the GPS discussion was issues with the current public transportation system. Members emphasized the importance of accommodating buses, trains, etc. to the blind and partially sighted, and brought up a couple of ideas and suggestions on how to go about doing that (such ideas and suggestions are mentioned in the recommendation section).

4.3.4 Altering the Route

Although there was already a chosen path marked on the GPS devices, as mentioned previously, a shorter version of it was run by the second focus group, which
included only two points. The decision to cut the route was made due to a variety of technical issues that came up prior, and on the day of the focus group meetings. Such issues included:

1. Limited number of devices – while there are three GPS and mobile phone units, only one was functioning at the time of the focus group.

2. Sound Files – The chosen path included five pre-recorded points, each with a corresponding sound file that was suppose to go off as the person enters within a certain radius of the point (usually 3 meters). When running the path prior to the arrival of the focus group members, only two of the points would load, leaving three points unaccounted for. Throughout the course of setting up the route, and test running it before the focus groups, the issue with the pre-recorded sound files was a reoccurrence, where downloading the files would cause the system to crash or the system would download the wrong files for the point. One explanation for such a glitch is that there is enough free memory in the phone to store the first two points, however, to download the other three the device would have to connect to the server, so that if the server is down for repairs or for any other reason, the points would not load properly.

Figure 4.3.4.1 – Tested Route
4.4 End of Study Results

Towards the conclusion of this study, an issue with the software that affected the focus group trial was solved. All five of the preset points were able to automatically play while walking the route (as opposed to the two points that worked during the focus group trial). Thus the technology is improving everyday and has potential to be a useful navigational aid to the blind and partially sighted community.

The Danish Association of the Blind would also like to be able to use the Euman LifePilot GPS technology for a nature walk at the retreat center (Fuglsang Skov). The team, along with Michael Jensen, from the DBS, tested the route in the woods near the conclusion of the study. Similar issues that existed in the city route with accuracy and inconsistency of sound files. LifePilot has potential to be used for the nature hike; however, it simply has to be more accurate and consistent.

5.0 Analysis and Conclusions
The following section will detail the analysis and conclusions drawn from the study.

5.1 Surveys

The surveys showed that although not many people have had the opportunity to experience GPS, the technology already has a reputation for being a promising vital aid in orientation and navigation. The results from the surveys indicate that many of those who are blind or partially sighted in Copenhagen and the neighboring areas strive to lead an independent life, which includes unaccompanied trips on the public transit, and self-reliant traveling. Therefore, it is desired by many for the software to be able to indicate the location of bus stops, train stops, and other public transit landmarks. Furthermore, individuals would also greatly benefit from more detailed information about time schedules, and platforms, as well as a description of the inside of the stations (bathroom location, information desk location, exits to specific streets, etc.)

Other popular information requests included specific addresses, and indications of which side of the street the individual is on. More about that would be discussed in the following section.

5.2 Focus Group

5.2.1 Feature Analysis

A few specific features relating to the GPS device and the Euman software were brought up for discussion to the focus group, which included the ability to,

- Communicate with others
- Upload information at home
- Receive updated information about the five nearest addresses
Use the “guide me” function

Record memos in specific locations

Perhaps one of the more popular out of those mentioned was the ability to upload routes through a server on one’s personal computer. This capability gives blind and partially sighted people the advantage of setting up their course in the privacy of their homes, where they can take their time and if needed ask for help. The focus group members stressed that they never leave their house to go to a new and unfamiliar places without memorizing the route and the path which they will be taking first. By allowing them to set the route on the GPS prior to the traveling it reinforces the path and gives them a chance to learn it, thus adding to the overall sense of being prepared.

Just as popular of a feature, which is currently still under construction, was the “five nearest addresses locator,” where with a push of a button, the user is told information about the five nearest addresses to where he or she is standing. One point that came up from the surveys was that people needed more help in finding private residences, as opposed to restaurants and malls, and would like to see such assistance offered by the GPS devices. As one member from the focus group, who is a current user of GPS technology, stated:

A lot of the time the numbering of the houses changes drastically from one side of the street to another, and it can really throw you off when you’re looking for someone’s apartment. For example, it is not unusual for the houses on the odd side of the street to be in the fifties, while the even houses just across the street are in the thousands

By knowing the five nearest addresses, one can not only orient himself or herself as to which side of the street they are one, but also know, approximately, how far down the street they are, thus making finding personal addresses an easier task.
One of the unique features to Euman, which helps distinguish it from other GPS software companies, is the ability to freely and instantaneously share information through a server. As mentioned previously, those who are visually impaired are very careful in their planning of unfamiliar routes, and they memorize those routes which they travel daily. However, there are some factors, unlike the location of the side walk or which side of the street they should be on, that can not be memorized or prepared for. Such factors, a recent construction site for example, are obstacles that concerned many of those who attended the focus groups. While the current GPS technology on the market does not allow a stream of updates of construction sites or potholes, Euman technology gives people the ability to make on the spot notes (through a voice memo for example) and immediately send it to others or upload it to a server for others to see. Such notes are automatically associated with their GPS location, and therefore can be added to maps, which makes this feature to be of interest to the blind and partially sighted community.

By discussing the different features offered by Euman, the focus group helped identify a range of information that they, as blind and partially sighted individuals, would find useful for navigation purposes. Those who attended the second focus group also got the opportunity to try out some of the features, specifically the “guide me” function, which allows for audio delivered instructions to be communicated to the user about where to go or what is around them (those who attended the first focus group were able to listen to the voice memos as they were played in the room while the second focus group was actually able to test the device). The overall comments suggested that simple memos stating the name of the street you are on, or “you are approaching the corner of such and such” are much better than elaborate information. The members of the focus groups were very impressed with the ability to replay the last memo, for one problem they encounter
while using GPS, is that it plays once, and if there was traffic or anything noisy in the way that distracted them from hearing it the first time, the information was lost.

5.2.2 Extra Features

On top of commenting on the current features offered by LifePilot technology, the members of the focus groups had suggestions about other features they would like to see. Many stressed the fact that it is important for them to know the estimated time of travel when they are choosing a path. While Safe Routes are very important, those who are very independent in their commutes mentioned that sometimes they would take a chance with the shorter distance route, instead of taking the Safe Route, especially if there is a substantial difference in time. Therefore, a feature that could compare distances and estimated travel times between a Safe Route and the shortest route was determined to be very much desired.

5.2.3 Device and Interfaces

Once we established specific features that blind and partially sighted people would find helpful from their GPS devices, the next step was discussing the different ways of delivering the information to the users.

Out of the eleven people who participated in the focus groups, only two were fluent in reading Braille. This lack is not uncommon for many of those who are visually impaired either had their sight at some point in their life or just never learned Braille. Therefore, it was established that perhaps the best way for communication would be through audio. It should be noted, however, that those who did read Braille were very adamant about at least having the option of connecting the device to a Braille display. Both said that, “it was reassuring to be able to feel something and read it with your hands,
as opposed to just listen to it all the time.” Many of the group’s members also mentioned that it would be most useful for them to have the ability to request the information with a push of button, as opposed to having a constant communication between the GPS device and the user where the device goes off by itself every five seconds, five minutes, or any other pre-set amount of time. They reasoned that when walking, one’s attention should be given to their surroundings, while concentrating on listening to the sounds around them to give them a better idea of the environment. Being constantly bothered by a GPS would jeopardize their ability to read their environment via sounds.

Last, but not least, was a short discussion about the interface of the actual device itself. Members expressed their frustration with the new generation cell phones, where the buttons are too small and too close to each other, making it difficult or nearly impossible to use. There was an overall agreement that simplicity was one of the most important factors. As prospective and current users of mobile devices, the members of the focus group suggested bigger, more separated buttons, where the power button had a different shape or texture and the device was compatible with screen reader software. It was vital for them to be able to hang the device on a neckband, so their hands would be free, and, if possible, have the GPS device and the phone itself be one unit. Some further suggestions included different levels of complexity for the phone’s software (i.e. the amount of features available), which would be decided upon by the users.

5.2.4 Dependency

As with any new technology, issues regarding software glitches and device functionality arise. While factors such as signal reception, which gets affected if one is surrounded by tall buildings, or if the sky is cloudy, or GPS accuracy (which in
accordance with military law requires a margin of error when reporting a location) cannot be changed, it is important the software itself is as glitch-free as possible, i.e. that all the sound memos work for example. One member of the second focus group, a current GPS user, who had a chance to run the two points that were set commented,” I can deal with accuracy issues as long as I know the device is going to work.”

5.2.5 The Cultural Aspect

The group members were asked to comment on the attitudes and sensibility they encounter by other members of society in Denmark and, if possible, compare and contrast it with any other countries they had a chance on visiting or residing in. The overall consensus was that people were generally nice and helpful when inquired for information. A few people mentioned that in other countries, referring specifically to Germany, sighted people take more initiative in approaching the blind and partially sighted and in volunteering their help. However, such comments were rebutted by other group members who attributed Danish reticence to the lack of experience and lack of information the common Dane has with interacting with the blind and partially sighted. For example, when helping a blind individual cross the road one should offer an elbow for the blind person to hold on to, as opposed to the common mistake people make in taking the hand of the blind and attempting to pull them down the street. Such mistakes are often, if not always, done in good nature, where the individuals leading just didn’t know any better, and can be corrected by a small remark from the blind person. Educational announcements to the general public might be a good solution for such issues; however, the members of the focus group did not express any major concern for such public guidance.
It was noted that some of the people in the focus group were wearing a button on the outside of their clothes with an icon of a person with a walking cane (see picture below):

![Image on the button](http://www.deafvision.net/mba/bkmarks.html)

They were asked to elaborate on the meaning of the button, and comment on whether or not wearing it in visible places created a change on the attitudes of others around them. “Although the button is the official symbol for blind and partially sighted,” said one of the members, “usually the cane gives it away before people even get a chance to see it, and therefore it doesn’t really matter if you wear the button or not.” However, to those with partial sight who do not require canes, the button serves as the only visual icon of their condition, but since it does not provide any specifics on the quality of their vision, it doesn’t do much but inform those around to look out, just in case.

### 6.0 Conclusions and Recommendations

After assessing the suggestions and comments from the surveys and focus groups, the project team came up with the following recommendations about software features and device interfaces.

### 6.1 Software Features
- **Nearest Address Locator** – a feature which will allow the user to receive information about the five nearest addresses around them

- **Time Estimation** – a feature that will allow estimating the time of travel following a specific path

- **Home Information Sharing** – the ability to upload and download maps and other GPS related files from the convenience of one’s own home

- **Instant Information Sharing** – the ability to send voice memos and text, correlating with a specific GPS location, to other users instantaneously

- **Repeat Option** – The ability to play back the last voice memo that came up

- **On Demand Information** – the ability to receive instantaneous information regarding one’s whereabouts (i.e. name of the street) with a push of a button

- **Corner/Intersection Alert** – the ability to receive a warning when one is approaching a street corner or an intersection, which will include the names of the streets.

- As little hierarchy in the menu as possible, with an option for shortcuts for popular features

### 6.2 Device Interfaces

- **Audio Commands** – voice recognition software which will allow individuals to go through the menu using audio commands

- **Braille Display Option** – the ability to connect the device to a Braille display

- **Distinct Buttons** – phone interface where the buttons are big, and well separate. Different shapes or texture is also a suggestion – especially for the On/Off button

- **No touch screens**
The following recommendations are made based on the analysis of this entire study and the conclusions that were drawn from it.

6.3 Public Transportation

Perhaps one of the more talked about issues that came up during the focus group discussions was the lack of accommodations in the public transit system. While there is currently an operating network used by the Greater Copenhagen Authority to announce and keep track of times for trains, buses, etc., the Euman Company has been having difficulties to connect their GPS software to operate alongside with it. And so although the ideal solution of having your GPS device tell you what bus stop you are at and which bus is approaching next, is still out of reach at this point, the members of both focus groups were still able to come up with a variety of accommodative aids, both GPS related and non-GPS related that would ease their travels. Their suggestions included:

6.3.1 GPS Related Recommendations about Public Transportation

- **A special route with all the bus stops** – A great way to take advantage of the LifePilot server would be to store a map that includes all the bus stops in the city that members could easy download to their devices as they go about their traveling. It was mentioned by several members of the focus groups that bus stops are used not only for the obvious reason of waiting for the bus, but also as an marker to further help those who are visually impaired in orienteering. Therefore, even if you do not need the 5A bus for your traveling, knowing that the stop is there could help you figure out your surroundings.
A pre-recorded memo at each stop to include the name of the buses and estimated time of arrival – To further expand on the bus route map mentioned above, it would be very useful if voice memos could be recorded to correspond to every stop, stating the name of the stop, identifying the buses that go through it, and maybe even including a short information memo about the frequency (for example, “you are at the 350S stop. Monday through Friday the bus starts at 7:00am and comes every 7-9 minutes”). This voice memo would be able to be played by the device and could be extremely useful to the user.

6.3.2 Non-GPS Related Recommendations about Public Transportation

On demand information about the bus numbers through a button located on the bus stop itself – since not all visually impaired people use, or wish to use, a GPS device, having a voice box that could produce the information mentioned in the “pre-recorded memo” by a push of a button would greatly benefit the blind and partially sighted community as a whole.

On demand information (through a push of a button) about whether the light at a crosswalk is green or red – when asked to comment on the beeping crosswalks, some members of the focus group brought up concerns that there are occasions when the beeping is overpowered by the traffic. Therefore, they would like to be able to have the information of whether or not it’s safe to cross the street available through other means. One suggestion, that turned out to be very popular among the group, was a voice box connected to the lights system that if pressed, would tell the person whether the green man is on, or the red man. This way, people would not have to depend on others to know such information. However, one
downfall for this idea is that, unlike the beeping sounds produced by the beeping crosswalk devices help, there would be nothing to alert individuals that they are approaching an intersection or help them in their orientation.

6.4 RFID

Although not directly related to GPS technology, we recommend looking into the possibility of integrating Radio Frequency Identification (RFID) for use by blind and partially sighted individuals. For information on companies throughout Europe that currently market RFID technology, refer to the website:


The following is background research on the potential of this technology.

Another approach to blind and partially sighted orientation that is showing signs of promise is the usage of RFID. Such system requires the presence of a microchip, an antenna, and a reader, where the reader sends out electromagnetic waves, which are received by the antenna, and converted to digital data by the microchip (Roberti).

This is a newly developed technology, and like any other, it faces challenges that have been preventing it from taking off in the market. The two biggest concerns with RFID systems include the radio wave frequency standards, and the cost. Currently there are standards developed for both high and low frequency RFID systems, however, more and more companies are seeking usage of Ultra High Frequency (UHF), for which the standards have not been developed until recently (for a complete list of RFID frequencies please refer to Appendix K). Also, the cost of RFID tags starts at 20 cents, which, considering that a building would have to be covered in them – identifying each and every object individually - sums up to be a large cost (Roberti.)
However, the challenges of the RFIDs may be very well outnumbered by the benefits that their installment can provide to the blind and partially sighted community. If placed on key locations, such as labeling the meat section, candy aisle, and vegetable stands at grocery stores; the teller booth, the automatic ticket machines, the stairs, and the directions to different platforms at train stops, or even the entrance, sinks, and bathroom stalls at public restrooms, RFID tags can give the blind and partially sighted a virtual tour of their surroundings. We would highly recommend that Euman undertake research on the possibility of including an RFID scanner within their Lifepilot phone, since the cheapness of this entity and its immediate usefulness make it highly likely to be adopted in the future.

6.4.1 RFID Information Grid for Blind and Partially Sighted Navigation and Wayfinding

A study done for the Computer & Information Science & Engineering Department of the University of Florida focused on evaluating the RFID tag system as an aid for blind and partially sighted students on college campuses. RFID systems were examined as the solution for the common issues that arise with wayfinding, such as the inaccuracy concern with GPS devices, and addressed the following challenging requirements:

• The user must be informed of their location in the room within the context of the room, or outdoors within familiar contexts such as intersections, bus stations, and buildings.
• The system should be able to report the location, distance and direction of items in the room such as office equipment, furniture, doors and even other users.
• It must be a reliable system that minimizes the impact of installation and maintenance to the building owner
• It must provide absolute location with no possibility of error from outside influences
• The system should not be obvious to an external observer
• The proposed solution should meet or exceed the standards proposed in the Principles of Universal Design [4].

(Willis, et al.)
The equipment used in the experiment included advanced electronics with support for Bluetooth and Java programming, where each unit (RFID and Bluetooth combination) was priced at $170. (Willis, et al)

When creating the RFID layouts it was important to differentiate between outdoor and indoor infrastructures. The outdoor infrastructure had to include special covers for RFID tags to allow them the durability for outdoor weather (i.e. waterproof and heat resistance). Furthermore, “Outdoor campus navigation is primarily concerned with route information from origin to destination. This limits the amount of information that needs to be stored or conveyed to the end user and the density of RFID tags to established routes.” (Willis, et al) Outdoor RFID tags could be placed along sidewalks and edges of curbs, and furthermore, they do need to label every single object outside (such as all the trees in the park to the left). Indoor RFID tags on the other hand are there to convey detailed information about the room and the objects to the users. When the tags are used in a room, they are placed in a grid layout, to allow for better orientation (however, they could still be place in a single line in hallways and other narrow spaces). The tags could be either weaved into new carpets, or installed underneath existing carpets, where each tag would contain the information about its surroundings, for example, “RFID tags located in a traffic pattern leading to a door would provide information related to the door location, type of handle and opening direction.” (Willis, et al) Since all the information is stored within the tag itself, RFID systems do not require a connection to a central service, and thus provide the users with privacy.

On average, there is 2000 bits of information storage per ID tag. (Willis, et al) Such information includes the global positioning of the tag, as well as inventory information of everything that’s in the room or in the surrounding area, and its position
relative to the tag. But perhaps one of the biggest advantages of the tag over the currently used GPS systems is its ability to be give feedback to the user very quickly. In their paper, Scooter Willis and Sumi Helal state that, “The reading of the RFID grid should have minimal impact on how the user walks through the space. This creates a requirement that the tags must be read as quickly as possible, when the reader, which is attached to the shoe or walking cane, is moving.” In fact, “The command execution time for tag selection is approximately 140 ms and is required to issue any subsequent read commands.” (Willis, et al).

An experiment done by the Willis and Helal set up 20 foot carpet path with a 55mm x 55mm tag placed every 12 inches, and measured the number of tags read by groups of individuals walking at different speeds. The following graph was produced:

Although there is no argument that in order to see the benefits of RFID systems there needs to be an extensive installment process, the overall conclusion of the study was that, “The concept of setting up an RFID Information Grid in buildings is technically and economically feasible.” (Willis, et al)
6.4.2 Guiding Visually Impaired People in the Exhibition

A study was done to assess the implementation of RFID tags placed in the EuroFlora 2006 exhibit (a major flower exhibit in Europe), to assist over a hundred blind and partially sighted visitors in orientation. The exhibition, held in Genoa every five years, presents itself to be a critical task for the one hundred and twenty blind and partially sighted visitors, who often find themselves overwhelmed by the unfamiliar crowded and noisy site. (Bellotti, et al)

In order to ease their experience, sets of RFID tags were strategically placed throughout the exhibition, marking important landmarks such as entrance, exit, and restrooms. The user had constant access to such information, including pre-set paths to direct them to the place. Furthermore, the RFID tags also included information about the exhibits themselves, however, that information was event-driven, meaning that the users was informed of the particular information when they were in the vicinity of the specific landmark, where they had the choice of whether they wanted to listen to it or not. (Bellotti, et al)

The evaluation process consisted of three main performance factors: “usability (including effectiveness, efficiency and pleasantness of use), usefulness and capability to
support spatial orientation (in particular the approach to the points of interest).” (Bellotti, et al). The individuals gave each one of the factors a score, ranging between one and five, five being the highest in satisfactory level, and a summary can be viewed in the following table:

**Table 1. Overall survey results**

<table>
<thead>
<tr>
<th>Issue</th>
<th>Average</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usability</td>
<td>4.00</td>
<td>0.64</td>
</tr>
<tr>
<td>Usefulness</td>
<td>4.25</td>
<td>0.75</td>
</tr>
<tr>
<td>Reach and point of interest</td>
<td>4.20</td>
<td>0.66</td>
</tr>
<tr>
<td>Session length time</td>
<td>201’</td>
<td>30’</td>
</tr>
</tbody>
</table>

From that, it was concluded that the RFID based guiding system was “widely appreciated, in particular because of its ability to support the user in having a new, engaging experience.” (Bellotti, et al) In fact, one of the visitors commented on his liking of the technology, saying that, “after always having been guided, for the first time I myself have been able to guide my wife and explain her the exhibition!” (Bellotti, et al) This experiment shows further supports for the RFID technology, making it stand out as a promising future solution to assistive aids for the blind and partially sighted.
Appendix A: Map of the Bus System in Copenhagen

Source: Greater Copenhagen Authority (HUR, 2004)
Appendix B: Map of the S-train System in Copenhagen

Source: Danish Trains Association (DSB, n.d.)
Appendix C: Map of the Metro System (S-Train) in Copenhagen

Source: Ørestad Dev. Corporation (Metro, 2003)
Appendix D: Survey

Note: This is the translated version of the survey that was conducted by staff members at the Danish Association of the Blind (DBS) via telephone in Danish.

a. name
b. age
c. residual sight. Blank means totally blind
d. attends focusgroup. Blank does not
e. uses guidedog. Blank does not

Answer is highlighted:

1. Do you use public transportation?  
   Answer is marked Yes or No

2. Do you use GPS technology?  
   Answer is marked Yes or No

3. If no, would you consider using GPS technology for your transportation need?  
   Answer is marked Yes or No

   (I explained when necessary that this means planning a trip, by foot and by public transportation)

4. Would you consider GPS technology as a navigational tool?  
   Answer is marked Yes or No

   (I explained when necessary that this means getting additional information while traveling by foot.)

5. Do you go out on errands, to work, to visit a friend, etc. unaccompanied by an individual?  
   Answer is marked Yes or No

6. How often do you engage in such activities?  
   Answer is marked Daily, Weekly, Monthly

7. Would you be interested in a technology that allows you to send e-mails or other forms of communication from a portable device?  
   Answer is marked Yes or No

8. Would you consider using GPS technology for mobility training (i.e. to help learn routes you travel)?  
   Answer is marked Yes or No

Open Ended Questions

Answer is marked x:
9. What types of navigational aid would you like a GPS device to have, for example, the ability to find:
restaurants
museums
shops
parks
private homes
public offices
bus stops
train stations
taxi parking
safe routes (alternative to fastest walking distance)
other (see comments)

10. What is your main mode of transportation:
walking
bus
train
taxi
other (family car)

Comments:
Appendix E: Completed Surveys
*Sprgeskema 01 (Survey 1)*

a. Dennis Rasmussen
b. Alder: 25
c.
d.
e.

1. Bruger du offentlige transportmidler?    **Ja**    Nej

2. Bruger du GPS teknologi?    **Ja**    Nej

3. Hvis nej, kunne du tænke dig at bruge GPS teknologi i forbindelse med dit transportbehov?    **Ja**    Nej

4. Kunne du tænke dig at bruge GPS teknologi som navigationsværktøj/instrument?    **Ja**    Nej

5. Går du ærinder, på arbejde, på besøg og lignende uden brug af ledsager?    **Ja**    Nej

6. Hvor ofte er du afsted uden ledsager?    **Dagligt**    Ugentligt    Månedligt

7. Vil det interesserer dig at kunne sende tekstbeskeder fra en bærbar enhed?    **Ja**    Nej

8. Kunne du tænke dig at anvende GPS teknologi i mobility træning, f.eks. som en hjælp til at lære nye ruter.    **Ja**    Nej

9. Hvilke typer navigationshjælp vil du gerne have i en GPS (fx. muligheden for at finde: restauranter x museer x forretninger x parker x private hjem ? offentlige kontorer x busstoppesteder -x tog-stationer x taxaholdepladser x trafiksikre ruter x
10. Hvad er din sædvanlige måde at transportere dig på:
gå  
bus x  
tog x  
taxi

Comments:
Exchange of points of interest

Sprgeskema 02

a. Curt Bjälby  
b. Alder: 65  
c. orienteringssyn  
d. Focusgroup

e.

1. Bruger du offentlige transportmidler?  
   Ja  Nej

2. Bruger du GPS teknologi?  
   Ja  Nej

3. Hvis nej, kunne du tænke dig at bruge GPS teknologi i forbindelse med dit transportbehov?  
   Ja  Nej

4. Kunne du tænke dig at bruge GPS teknologi som navigationsværktøj/instrument?  
   Ja  Nej

5. Går du ærinder, på arbejde, på besøg og lignende uden brug af ledsager?  
   Ja  Nej

6. Hvor ofte er du afsted uden ledsager?  
   Dagligt  Ugentligt  Månedligt

7. Vil det interessere dig at kunne sende tekstbesked fra en bærbare enhed?  
   Ja  Nej

8. Kunne du tænke dig at anvende GPS teknologi i mobility træning, f.eks. som en hjælp til at lære nye ruter?  
   Ja  Nej

9. Hvilke typer navigationshjælp vil du gerne have i en GPS (fx. muligheden for at finde: restauranter x museer x forretning x parker x private hjem x

74
offentlige kontorer x
busstoppesteder x
tog-stationer x
taxa holdepladser x
trafiksikre ruter x

10. Hvad er din sædvanlige måde at transportere dig på:
gå x
bus
tog x
taxi

Kommentarer:
Shall be easy to use

Sprøgeskema 03

a. Poul Vinkel Larsen
b. Alder: 46
c. Orienteringssyn
d. Focus group
e.

| 1. Bruger du offentlige transportmidler? | Ja | Nej |
| 2. Bruger du GPS teknologi? | Ja | Nej |
| 3. Hvis nej, kunne du tænke dig at bruge GPS teknologi i forbindelse med dit transportbehov? | Ja | Nej |
| 4. Kunne du tænke dig at bruge GPS teknologi som navigationsværktøj/instrument? | Ja | Nej |
| 5. Går du ærinder, på arbejde, på besøg og lignende uden brug af ledsager? | Ja | Nej |
| 6. Hvor ofte er du afsted uden ledsager? | Dagligt | Ugentligt | Månedligt |
| 7. Vil det interessere dig at kunne sende tekstbesked fra en bærbar enhed? | Ja | Nej |
| 8. Kunne du tænke dig at anvende GPS teknologi i mobility træning, f.eks. som en hjælp til at lære nye ruter. | Ja | Nej |
| 9. Hvilke typer navigationshjælp vil du gerne |
have i en GPS (fx. muligheden for at finde:
restauranter x
museer
forretninger x
parker x
private hjem x
offentlige kontorer x
busstoppesteder x
tog-stationer x
taxa holdepladser
trafiksikre ruter x

10. Hvad er din sædvanlige måde at transportere dig på:
gå x
bus x
tog x
taxi

Sprøgeskema 04

a. Annette Nielsen
b. Alder: 50
c. Orienteringssyn
d. Focusgruppe
e.

1. Bruger du offentlige transportmidler?   Ja   Nej

2. Bruger du GPS teknologi?   Ja   Nej

3. Hvis nej, kunne du tænke dig at bruge GPS teknologi i forbindelse med dit transportbehov?   Ja   Nej

4. Kunne du tænke dig at bruge GPS teknologi som navigationsværktøj/instrument?   Ja   Nej

5. Går du ærinder, på arbejde, på besøg og lignende uden brug af ledsager?   Ja   Nej

6. Hvor ofte er du afsted uden ledsager?   Dagligt   Ugentligt   Månedligt

7. Vil det interessere dig at kunne sende tekstbesked fra en bærbar enhed?   Ja   Nej

8. Kunne du tænke dig at anvende GPS teknologi i mobility træning, f.eks. som en
9. Hvilke typer navigationshjælp vil du gerne have i en GPS, fx. muligheden for at finde:
   restauranter
   museer x
   forretninger x
   parker
   private hjem
   offentlige kontorer x
   busstoppesteder x
   tog-stationer x
   taxa holdepladser x
   trafiksikre ruter x

10. Hvad er din sædvanlige måde at transportere dig på:
   gå x
   bus
   tog
   taxi

**Sprgeskema 05**

a. Karl Asger Deth Jensen
b. Alder: 72
c. orienteringssyn
d.
e. Guidedog

1. Bruger du offentlige transportmidler?   Ja   Nej

2. Bruger du GPS teknologi?   Ja   Nej

3. Hvis nej, kunne du tænke dig at bruge GPS teknologi i forbindelse med dit transportbehov?   Ja   Nej

4. Kunne du tænke dig at bruge GPS teknologi som navigationsværktøj/instrument?   Ja   Nej

5. Går du ærinder, på arbejde, på besøg og lignende uden brug af ledsager?   Ja   Nej

6. Hvor ofte er du afsted uden ledsager?   Dagligt  Ugentligt  Månedligt

7. Vil det interessere dig at kunne sende tekstbeskeder fra en bærbart enhed?   Ja   Nej
8. Kunne du tænke dig at anvende GPS teknologi i mobility træning, f.eks. som en hjælp til at lære nye ruter.  

Ja  Nej

9. Hvilke typer navigationshjælp vil du gerne have i en GPS (fx. muligheden for at finde:
restaurant x
museer x
forretninger x
parker x
private hjem x
offentlige kontorer x
busstoppesteder x
tog-stationer x
taxa holdepladser x
trafiksikre ruter x

10. Hvad er din sædvanlige måde at transportere dig på:
gå x
bus x
tog x
taxi
egen bil x

Comments:
Focus on security in the sense of not getting lost

Sprgeskema 06

a. Jan Diemer
b. Alder: 57
c.
d. Focusgroup
e. Guidedog

1. Bruger du offentlige transportmidler?  
Ja  Nej

2. Bruger du GPS teknologi?  
Ja  Nej

3. Hvis nej, kunne du tænke dig at bruge GPS teknologi i forbindelse med dit transportbehov?  
Ja  Nej

4. Kunne du tænke dig at bruge GPS teknologi som navigationsværktøj/instrument?  
Ja  Nej
5. Går du ærinder, på arbejde, på besøg og lignende uden brug af ledsager? Ja Nej

6. Hvor ofte er du afsted uden ledsager? Dagligt Ugentligt Månedligt

7. Vil det interessere dig at kunne sende tekstbeskeder fra en bærbar enhed? Ja Nej

8. Kunne du tænke dig at anvende GPS teknologi i mobility træning, f.eks. som en hjælp til at lære nye ruter. Ja Nej

9. Hvilke typer navigationshjælp vil du gerne have i en GPS (fx. muligheden for at finde: restauranter x museer x forretninger x parker x private hjem offentlige kontorer x busstoppesteder x tog-stationer x taxa holdepladser x trafiksikre ruter

10. Hvad er din sædvanlige måde at transportere dig på: gå x bus x tog x taxi x

Comments:
Important information is names of crossroads on the route.

Sprgeskema 07

a. Lars Kjær Hansen
b. Alder: 34
c.
d. focusgroup
e.

1. Bruger du offentlige transportmidler? Ja Nej

2. Bruger du GPS teknologi? Ja Nej
3. Hvis nej, kunne du tænke dig at bruge GPS teknologi i forbindelse med dit transportbehov? Ja Nej

4. Kunne du tænke dig at bruge GPS teknologi som navigationsværktøj/instrument? Ja Nej

5. Går du ærinder, på arbejde, på besøg og lignende uden brug af ledsager? Ja Nej

6. Hvor ofte er du afsted uden ledsager? Dagligt Ugentligt Månedligt

7. Vil det interessere dig at kunne sende tekstbesked fra en bærbare enhed? Ja Nej

8. Kunne du tænke dig at anvende GPS-teknologi i mobility træning, f.eks. som en hjælp til at lære nye ruter? Ja Nej

9. Hvilke typer navigationshjælp vil du gerne have i en GPS (fx. muligheden for at finde: restauranter x museer forretninger x parker x private hjem x offentlige kontorer x busstoppesteder x tog-stationer x taxa holdepladser x trafiksikre ruter x

10. Hvad er din sædvanlige måde at transportere dig på:
    gå x
    bus x
    tog x
    taxi

Comments
Equipment shall be easy to use, not voluminous and preferably one unit

Sprgeskema 08

a. Bo German Thomsen
b. Alder: 36
c. orienteringssyn
d. focusgroup
1. Bruger du offentlige transportmidler?   Ja  Nej

2. Bruger du GPS teknologi?   Ja  Nej

3. Hvis nej, kunne du tænke dig at bruge GPS teknologi i forbindelse med dit transportbehov?   Ja  Nej

4. Kunne du tænke dig at bruge GPS teknologi som navigationsværktøj/instrument?   Ja  Nej

5. Går du ærinder, på arbejde, på besøg og lignende uden brug af ledsager?   Ja  Nej

6. Hvor ofte er du afsted uden ledsager?   Dagligt  Ugentligt  Månedligt

7. Vil det interessere dig at kunne sende tekstbesked fra en bærbar enhed?   Ja  Nej

8. Kunne du tænke dig at anvende GPS teknologi i mobility træning, f.eks. som en hjælp til at lære nye ruter.   Ja  Nej

9. Hvilke typer navigationshjælp vil du gerne have i en GPS (fx. muligheden for at finde: restauranter x museer forretninger x parker x private hjem x offentlige kontorer x busstoppesteder x tog-stationer x taxa holdepladser x trafiksikre ruter x

10. Hvad er din sædvanlige måde at transportere dig på: gå x bus x tog x taxi

Sprøgeskema 09

a: Tim Kehoe
b: Alder: 46
c: orienteringssyn
d: fokusgruppe
e.

1. Bruger du offentlige transportmidler? Ja Nej

2. Bruger du GPS teknologi? Ja Nej

3. Hvis nej, kunne du tænke dig at bruge GPS teknologi i forbindelse med dit transportbehov? Ja Nej

4. Kunne du tænke dig at bruge GPS teknologi som navigationsværktøj/instrument? Ja Nej

5. Går du ærinder, på arbejde, på besøg og lignende uden brug af ledsager? Ja Nej

6. Hvor ofte er du afsted uden ledsager? Dagligt Ugentligt Månedligt

7. Vil det interessere dig at kunne sende tekstbeskeder fra en bærbar enhed? Ja Nej

8. Kunne du tænke dig at anvende GPS teknologi i mobility træning, f.eks. som en hjælp til at lære nye ruter. Ja Nej

9. Hvilke typer navigationshjælp vil du gerne have i en GPS (fx. muligheden for at finde: restauranter x museer x forretninger x parker x private hjem x offentlige kontorer x busstoppesteder x tog-stationer x taxa holdepladser x trafiksikre ruter x

10. Hvad er din sædvanlige måde at transportere dig på: gå x bus x tog x taxi x
Comments
System should cater for the needs of pedestrians. Position information at any time.

*Sprgeskema 10*

a. Søren Høeg  
b. Alder: 43  
c.  
d. Focusgroup  
e. Guidedog  

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<td>6. Hvor ofte er du af sted uden ledsager?</td>
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<td>taxa holdepladser x</td>
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<tr>
<td>trafiksikre ruter x</td>
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</table>
10. Hvad er din sædvanlige måde at transportere dig på:
gå x
bus x
tog x
taxi x

Comments:
Suggests information on
airport premises
Choice of alternative routes
Construction work
Public lavatories

Sprøgeskema 11

a. Louis Lundborg
b. Alder
c. orienteringssyn
d.
e.

1. Bruger du offentlige transportmidler?  Ja  Nej

2. Bruger du GPS teknologi?  Ja  Nej

3. Hvis nej, kunne du tænke dig at bruge GPS teknologi i forbindelse med dit transportbehov?  Ja  Nej

4. Kunne du tænke dig at bruge GPS teknologi som navigationsværktøj/instrument?  Ja  Nej

5. Går du ærinder, på arbejde, på besøg og lignende uden brug af ledsager?  Ja  Nej

6. Hvor ofte er du af sted uden ledsager?  Dagligt  Ugentligt  Månedligt

7. Vil det interessere dig at kunne sende tekstbesked fra en bærbar enhed?  Ja  Nej

8. Kunne du tænke dig at anvende GPS teknologi i mobility træning, f.eks. som en hjælp til at lære nye ruter.  Ja  Nej

9. Hvilke typer navigationshjælp vil du gerne have i en GPS fx. muligheden for at finde:
10. Hvad er din sædvanlige måde at transportere dig på:
   gå x
   bus x
   tog
   taxi

Comments:
Navigational "Private homes" as a dictionary for personal use, street names passed, detailed information for pedestrians.

Sprøgeskema 12

a. Jeannette Møller Johansen
b. Alder 41
c. orienteringssyn
d.
e.

1. Bruger du offentlige transportmidler?  
   Ja  Nej

2. Bruger du GPS teknologi?  
   Ja  Nej

3. Hvis nej, kunne du tænke dig at bruge GPS teknologi i forbindelse med dit transportbehov?  
   Ja  Nej

4. Kunne du tænke dig at bruge GPS teknologi som navigationsværktøj/instrument?  
   Ja  Nej

5. Går du ærinder, på arbejde, på besøg og lignende uden brug af ledsager?  
   Ja  Nej

6. Hvor ofte er du af sted uden ledsager?  
   Dagligt  Ugentligt  Månedligt

7. Vil det interessere dig at kunne sende tekstbeskeder fra en bærbar enhed?  
   Ja  Nej
8. Kunne du tænke dig at anvende GPS teknologi i mobility træning, f.eks. som en hjælp til at lære nye ruter.  

Ja  Nej

9. Hvilke typer navigationshjælp vil du gerne have i en GPS fx. muligheden for at finde: restauranter x
museer x
forretninger x
parker x
private hjem x
offentlige kontorer x
busstoppesteder x
togstationer x
taxa holdepladser x
trafiksikre ruter x

10. Hvad er din sædvanlige måde at transportere dig på:

gå x
bus x
tog x
taxi

Comments:
Search in private address list with link to route.

Sprgeskema 13

a. Viggo Smedegård
b. alder 73
c
d. . focusgroup
e.

1. Bruger du offentlige transportmidler?  

Ja  Nej

2. Bruger du GPS teknologi?  

Ja  Nej

3. Hvis nej, kunne du tænke dig at bruge GPS teknologi i forbindelse med dit transportbehov?  

Ja  Nej

4. Kunne du tænke dig at bruge GPS teknologi som navigationsværktøj/instrument?  

Ja  Nej

5. Går du ærinder, på arbejde, på besøg

86
og lignende uden brug af ledsager? Ja Nej

6. Hvor ofte er du af sted uden ledsager? Dagligt Ugentligt Månedligt

7. Vil det interessere dig at kunne sende tekstbeskeder fra en bærbar enhed? Ja Nej

8. Kunne du tænke dig at anvende GPS teknologi i mobility træning, f.eks. som en hjælp til at lære nye ruter. Ja Nej

9. Hvilke typer navigationshjælp vil du gerne have i en GPS fx. muligheden for at finde: restauranter museer x forretninger x parker x private hjem x offentlige kontorer x busstoppesteder x togstationer x taxa holdepladser x trafiksikre ruter x

10. Hvad er din sædvanlige måde at transportere dig på: gå bus x tog x taxi egen bil x

Comments:

Sprøgeskema 14

a. Kirsten Almdal
b. Alder 63
   c. orienteringssyn
d.
e.

1. Bruger du offentlige transportmidler? Ja Nej

2. Bruger du GPS teknologi? Ja Nej

3. Hvis nej, kunne du tænke dig at bruge GPS
teknoLOGI i forbindelse med dit transportbehov?  **Ja**  Nej

4. Kunne du tænke dig at bruge GPS teknologi som navigationsværktøj/instrument?  **Ja**  Nej

5. Går du ærinder, på arbejde, på besøg og lignende uden brug af ledsager?  **Ja**  Nej

6. Hvor ofte er du af sted uden ledsager?  **Dagligt**  Ugentligt  Månedligt

7. Vil det interessere dig at kunne sende tekstbesked fra en bærbar enhed?  **Ja**  Nej

8. Kunne du tænke dig at anvende GPS teknologi i mobility træning, f.eks. som en hjælp til at lære nye ruter.  **Ja**  Nej

9. Hvilke typer navigationshjælp vil du gerne have i en GPS fx. muligheden for at finde: restauranter museer forretninger x parker x private hjem x offentlige kontorer busstoppesteder x togstationer x taxa holdepladser trafiksikre ruter x

10. Hvad er din sædvanlige måde at transportere dig på: gå bus x tog x taxi x

Comments: uses GPS for sailsport

**Sprøgeskema 15**

a. Jørgen Kristensen
b. Alder 57
c. orienteringssyn
d.
e.
1. Bruger du offentlige transportmidler?   **Ja**   Nej

2. Bruger du GPS teknologi?   **Ja**   Nej

3. Hvis nej, kunne du tænke dig at bruge GPS teknologi i forbindelse med dit transportbehov?   **Ja**   Nej

4. Kunne du tænke dig at bruge GPS teknologi som navigationsværktøj/instrument?   **Ja**   Nej

5. Går du ærinder, på arbejde, på besøg og lignende uden brug af ledsager?   **Ja**   Nej

6. Hvor ofte er du af sted uden ledsager?   Dagligt Ugentligt Månedligt

7. Vil det interessere dig at kunne sende tekstbeskeder fra en bærbar enhed?   **Ja**   Nej

8. Kunne du tænke dig at anvende GPS teknologi i mobility træning, f.eks. som en hjælp til at lære nye ruter.   **Ja**   Nej

9. Hvilke typer navigationshjælp vil du gerne have i en GPS fx. muligheden for at finde:
   restauranter x
   museer x
   forretninger x
   parker x
   private hjem adresseliste
   offentlige kontorer x
   busstoppesteder x
   togstationer x
   taxa holdepladser x
   trafiksikre ruter x

10. Hvad er din sædvanlige måde at transportere dig på:
    gå x
    bus x
    tog x
    taxi x
    privat bil x

Comments:
Address at actual position for safety reason. Save position and address at any time for return journey.

_Sprgeskema 16_

a. Sonja Holbøl
b. Alder 77
c. orienteringssyn
d. focusgroup
e.

1. Bruger du offentlige transportmidler?  
   - Ja  
   - Nej

2. Bruger du GPS teknologi?  
   - Ja  
   - Nej

3. Hvis nej, kunne du tænke dig at bruge GPS teknologi i forbindelse med dit transportbehov?  
   - Ja  
   - Nej

4. Kunne du tænke dig at bruge GPS teknologi som navigationsværktøj/instrument?  
   - Ja  
   - Nej

5. Går du ærinder, på arbejde, på besøg og lignende uden brug af ledsager?  
   - Ja  
   - Nej

6. Hvor ofte er du af sted uden ledsager?  
   - Dagligt  
   - Ugentligt  
   - Månedligt

7. Vil det interessere dig at kunne sende tekstbesked fra en bærbar enhed?  
   - Ja  
   - Nej

8. Kunne du tænke dig at anvende GPS teknologi i mobility træning, f.eks. som en hjælp til at lære nye ruter?  
   - Ja  
   - Nej

9. Hvilke typer navigationshjælp vil du gerne have i en GPS fx. muligheden for at finde:  
   restauranter  
   museer  
   forretninger x  
   parker  
   private hjem x  
   offentlige kontorer  
   busstoppesteder x  
   togstationer x  
   taxa holdepladser x  
   trafiksikre ruter x
10. Hvad er din sædvanlige måde at transportere dig på:
gå x
bus x
tog x
taxi

Comments:
Nice if the color of traffic light could be told. Info about construction work

Sprøgeskema 17

a. Anni Skov Nielsen
b. Alder 33
c.
d. focusgroup
e.

1. Bruger du offentlige transportmidler?   Ja    Nej
2. Bruger du GPS teknologi?   Ja    Nej
3. Hvis nej, kunne du tænke dig at bruge GPS teknologi i forbindelse med dit transportbehov?   Ja    Nej
4. Kunne du tænke dig at bruge GPS teknologi som navigationsværktøj/instrument?   Ja    Nej
5. Går du værinder, på arbejde, på besøg og lignende uden brug af ledsager?   Ja    Nej
6. Hvor ofte er du af sted uden ledsager?   Dagligt   Ugentligt   Månedligt
7. Vil det interessere dig at kunne sende tekstbesked fra en bærbar enhed?   Ja    Nej
8. Kunne du tænke dig at anvende GPS teknologi i mobility træning, f.eks. som en hjælp til at lære nye ruter.   Ja    Nej
9. Hvilke typer navigationshjælp vil du gerne have i en GPS fx. muligheden for at finde:
   restauranter x
   museer
   forretninger x
   parker x
   private hjem x
offentlige kontorer x
busstoppesteder x
togstationer x
taxa holdepladser x
trafiksikre ruter x

10. Hvad er din sædvanlige måde at transportere dig på:
   gå x
   bus x
   tog x
   taxi

Comments:
Need for precition when used by pedestrian. Need to know the address I am at. Need to save routes for later use.
Appendix F: Data Summary for Survey Answers

Note:
Dagligt = daily
Ugentligt = weekly
Eggen bil and Privat bil = private car

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Question 10

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<td>82</td>
<td>88</td>
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### Appendix G: Percentage Breakdown of Survey Answers

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<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>NA</th>
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<tbody>
<tr>
<td>Do you use public transportation?</td>
<td>100% (17)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you use GPS technology?</td>
<td>29% (5)</td>
<td>65% (11)</td>
<td>6% (1)</td>
</tr>
<tr>
<td>If not, would you consider using it?</td>
<td>88% (15)</td>
<td>12% (2)</td>
<td></td>
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<tr>
<td>Would you use GPS as a means of acquiring additional information when walking?</td>
<td>94% (16)</td>
<td>6% (1)</td>
<td></td>
</tr>
<tr>
<td>Do you run your errands unaccompanied?</td>
<td>88% (15)</td>
<td>12% (2)</td>
<td></td>
</tr>
<tr>
<td>How often?</td>
<td>76% (13)</td>
<td>12% (2)</td>
<td>12% (2)</td>
</tr>
<tr>
<td>Would you be interested in a device that allows you to send e-mails or other forms of communication from a mobile device?</td>
<td>82% (14)</td>
<td>12% (2)</td>
<td>6% (1)</td>
</tr>
<tr>
<td>Would you consider using GPS for mobility training?</td>
<td>94% (16)</td>
<td></td>
<td>6% (1)</td>
</tr>
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### Question 9

<table>
<thead>
<tr>
<th>Attraction</th>
<th>% Interest</th>
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<tbody>
<tr>
<td>Restaurants</td>
<td>70</td>
</tr>
<tr>
<td>Museums</td>
<td>59</td>
</tr>
<tr>
<td>Shops</td>
<td>100</td>
</tr>
<tr>
<td>Parks</td>
<td>82</td>
</tr>
<tr>
<td>Private Homes</td>
<td>88</td>
</tr>
<tr>
<td>Public Offices</td>
<td>88</td>
</tr>
<tr>
<td>Bus Stations</td>
<td>100</td>
</tr>
<tr>
<td>Train Stations</td>
<td>100</td>
</tr>
<tr>
<td>Taxi Parking</td>
<td>94</td>
</tr>
<tr>
<td>Safe Routes</td>
<td>94</td>
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### Question 10

<table>
<thead>
<tr>
<th>Type of Transportation</th>
<th>% people</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking</td>
<td>82</td>
</tr>
<tr>
<td>Bus</td>
<td>88</td>
</tr>
<tr>
<td>Train</td>
<td>88</td>
</tr>
<tr>
<td>Taxi</td>
<td>30</td>
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<tr>
<td>Other</td>
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<tr>
<td>Private Car</td>
<td>18</td>
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</table>
Appendix H: Visual Data (graphs and charts)

Q1: Do you use public transportation?

- Yes: 100%

Q2: Have you used GPS technology before?

- Yes: 29%
- No: 65%
- NA: 6%

Q3: If not, would you consider trying it?

- Yes: 88%
- NA: 12%
Q4: Would you use GPS as a means of acquiring additional information when walking?

- Yes: 94%
- No: 6%

Q5: Do you run your errands unaccompanied?

- Yes: 88%
- No: 12%

Q6: If yes, how often?

- Daily: 12%
- Weekly: 12%
- More: 76%
Q7: Would you be interested in a feature that allows you to send e-mails or other forms of communication from a mobile device?

- Yes: 82%
- No: 12%
- NA: 6%

Q8: Would you consider using GPS for mobility training?

- Yes: 94%
- NA: 6%
Q9: What Type of Attraction Would You Like the GPS to Locate?

Q10: What is Your Main Mean of Transportation?
Appendix I: Maps and Comments

Figure J1 – Test Route 2

Figure J2 – Test Route 3
Comments:

These routes were examined as alternative routes to address the issue of high traffic and commotion. Unlike the first test route, they both followed back streets, with little to no automobile activities. However, as seen in the following pictures, the sidewalks were not suitable for blind and visually impaired individuals: they were not clearly marked and had parked cars blocking half of them. Furthermore, they included intersections with no lights.
Appendix J: Pictures of Chosen Path Features

Figure J1

Figure J2

Figures J1 and J2 – Beeping crosswalk device

Figure J3 – Intersection crosswalks
Figure J4 and J5 – Bus stop
Appendix K: Complete List of RFID Frequencies

Table L1: Frequency ranges used for RFID-systems (August 2006)

<table>
<thead>
<tr>
<th>Frequency range</th>
<th>Comment</th>
<th>Allowed fieldstrength / transmission power</th>
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<tbody>
<tr>
<td>&lt; 135 kHz</td>
<td>low frequency, inductive coupling</td>
<td>72 dBµA/m max</td>
</tr>
<tr>
<td>3.155 ... 3.400 MHz</td>
<td>EAS</td>
<td>13.5 dBµA/m</td>
</tr>
<tr>
<td>6.765 .. 6.795 MHz</td>
<td>medium frequency (ISM), inductive coupling</td>
<td>42 dBµA/m</td>
</tr>
<tr>
<td>7.400 .. 8.800 MHz</td>
<td>medium frequency, used for EAS (electronic article surveillance) only</td>
<td>9 dBµA/m</td>
</tr>
<tr>
<td>13.553 .. 13.567 MHz</td>
<td>medium frequency (13.56 MHz, ISM), inductive coupling, wide spread usage for contactless smartcards (ISO 14443, MIFARE, LEGIC, ...), smartlabels (ISO 15693, Tag-It, I-Code, ...) and item management (ISO 18000-3).</td>
<td>60(!) dBµA/m</td>
</tr>
<tr>
<td>26.957 .. 27.283 MHz</td>
<td>medium frequency (ISM), inductive coupling, special applications only</td>
<td>42 dBµA/m</td>
</tr>
<tr>
<td>433 MHz</td>
<td>UHF (ISM), backscatter coupling, rarely used for RFID</td>
<td>10 .. 100 mW</td>
</tr>
<tr>
<td>865 .. 868 MHz</td>
<td>UHF (RFID only), Listen before talk</td>
<td>100 mW ERP Europe only</td>
</tr>
<tr>
<td>865.6 .. 867.6 MHz</td>
<td>UHF (RFID only), Listen before talk</td>
<td>2W ERP (=3.8W EIRP) Europe only</td>
</tr>
<tr>
<td>865.6 .. 868 MHz</td>
<td>UHF (SRD), backscatter coupling, new frequency, systems under developement</td>
<td>500 mW ERP, Europe only</td>
</tr>
<tr>
<td>902 .. 928 MHz</td>
<td>UHF (SRD), backscatter coupling, several systems</td>
<td>4 W EIRP - spread spectrum, USA/Canada only</td>
</tr>
<tr>
<td>2.400 .. 2.483 GHz</td>
<td>SHF (ISM), backscatter coupling, several systems</td>
<td>4 W - spread spectrum, USA/Canada only</td>
</tr>
<tr>
<td>Frequency Range</td>
<td>Description</td>
<td>Power Level</td>
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<td>-------------</td>
</tr>
<tr>
<td>2.446 GHz to 2.454 GHz</td>
<td>SHF (RFID and AVI (automatic vehicle identification))</td>
<td>0.5 W EIRP outdoor</td>
</tr>
<tr>
<td>5.725 GHz to 5.875 GHz</td>
<td>SHF (ISM), backscatter coupling, rarely used for RFID</td>
<td>4 W USA/Canada, 500 mW Europe</td>
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</table>

Figure L1: Frequency-ranges used for RFID-systems shown with the corresponding field strength and power levels.

Images courtesy of http://www.rfid-handbook.de/rfid/frequencies.html
Appendix L: Script for Points of Interest

D.B.S. – You are across the street from the main entrance of the Danish Association of the Blind, the route will start here. This route will take you from the DBS to the Hulgårds Plads bus stop on Frederikssundsvej. Start walking. You are walking on Peter Ipsens Alle heading towards Frederikssundsvej.

First Turn – You are at the intersection of Peter Ipsens Alle and Frederikssundsvej. Turn right onto Frederikssundsvej.

Second Turn – You are at the intersection of Frederikssundsvej and Tomsgardsvej. Proceed to the beeping crosswalk and cross to your left onto the other side of Frederikssundsvej.

Third Turn – You have now crossed Frederikssundsvej. Turn left and continue approximately 5 meters to the Hulgårds Plads bus stop.

Bus Stop – You have now arrived at Hulgrds Place Bus Stop. This is the bus stop for 5A, 81N, 350S which stops at Nørrebro Station.
Appendix M: Focus Group Questions and Procedural Write-up

Focus Group Set-Up
April 12-13, 2007

Hello everyone. We are (Sofie, Christine and Troy). We are from a college (Worcester Polytechnic Institute) in the US. We are working on a project in conjunction with the DBS and the Euman Company to investigate how GPS technology can be used to aid the visually impaired.

Thank you for attending our focus group today. Before we begin, we’d like to start out by saying that if at any time you do not feel comfortable answering a question or participating in an activity, please just let us know. The goal of today is to be able to identify the factors that will allow GPS technology to be the most beneficial for use in the blind community, so we want your opinion on everything.

Focus Group Questions

What are some of the challenges that you face when traveling from point A to point B?

What methods (i.e. companion, guide dog, walking stick, etc.) do you currently use to navigate your way from point A to point B?

Does anyone currently use GPS technology? If so, what types do you use/have you tried? What is most useful about it? What are the advantages and disadvantages?

Do these methods help with the challenges mentioned above? Do these methods create other difficulties as well?

Do you find aids like a beeping crosswalk to be helpful when walking city streets?

GPS technology has the potential to be used, in conjunction with aids like a walking stick, as a navigational tool. What are some of your concerns with being guided by this technology?

GPS technology is not capable of telling you about the upcoming sidewalk or dip in the road, however, with Lifepilot, you could set voice memos yourself and make note of these hazards. Does this seem like a particularly useful feature?

If the features were available, would you find the ability to send information from your phone to a friends phone useful? What type of information would you share, i.e. restaurants, travel routes etc.
Compare/contrast Danish attitudes towards blind and partially sighted towards other cultures.

Do you feel the Danish government provides adequate aid—could it be better/worse?

Thank you. Now, we’d like to take three volunteers to walk a route we have designed using the Lifepilot GPS technology. There will be a 1:1 ratio (one of us to every one of you) along the whole way. We would like you to tell us anything (good or bad) you discover while doing the test route. The route will take you from the DBS to the bus stop on Frederikssundsvej. We will guide you back to the DBS. This should take approximately 15-20 minutes to complete. If there are more than three volunteers, we’d be happy to run the test again as long as you don’t mind waiting. If you need to leave now, then again, thank you for taking the time to come out here today. We really appreciate all of your help!

Post-Test Questions

What did you find most helpful about navigating with the GPS?

What changes/improvements would you like to see with this technology?

What were your overall thoughts on this experience?
Bibliography


TraficInfo. 20 Jan. 2007 <http://trafikinfo.hur.dk/001c84c5-9e1d-46fF-ae45-8c8dab36179.W5Doc?mid=F87C3D2C-4AFE-4897-B0C0-0A6D7C430612>.


http://doi.acm.org/10.1145/1124772.1124941
