LRN: 05D053I

IQP-DPC5-46

Project Number: DPC5

Mobile Digital Culture Dissemination

An Interactive Qualifying Project Report

submitted to the Faculty

of the

WORCESTER POLYTECHNIC INSTITUTE

in partial fulfillment of the requirements for the

Degree of Bachelor of Science

by

Caitlin R. McMonagle

Thomas A. Schindler

Date: May 10, 2005

Professor Helen Vassallo, Major Advisor

1. museums
2. mobile phone
3. pilot testing

Abstract

The team formulated a protocol for user pilot tests of the Life-Pilot system within the Open Air Museum in Lyngby, Denmark. Museum staff and visitors were interviewed and surveyed about the proposed usage of the new handheld information device. Data collection techniques were analyzed, and, from this analysis, a specific plan was recommended as to how the museum should conduct pilot testing. In addition, the team reviewed the technology, noted where problems occur, and generated suggestions for managing the devices.

Acknowledgements

The WPI project team, Caitlin McMonagle and Thomas Schindler, would like to extend its thanks to Frilandsmuseet and all of the employees who aided the team during the course of the project. We thank our liaison, Klaus Støttrup Jensen, who, although an extremely busy project manager, was still able to make time to meet with us and help us redirect our project. We give our many thanks to Inger Tolstrup, the head curator, for allowing the team to use the space and resources available within the museum. Also, we appreciate the help, information, and time offered by Rikke Ruhe, Niels Erik Jensen, Boum Pyudiah, Berit Heine and other staff members through their involvement in interviews with the team. Anne Kjøge greatly aided our efforts in communicating with the non-English speaking visitors through a document she effectively translated into Danish. We would also like to thank Else Michelsen for supplying us with a key to our office every morning.

There are several individuals at other institutions who also deserve the team's thanks and appreciation for aiding in the progress of the project. Those who we wish to thank include Henrik Sell, the curator of the Naturhistorisk Museum in Århus; Dorthe Langkilde, the employee at the Nationalmuseet front desk; and Jacob Fjellerad, the employee at Euman. We would like to extend our appreciation toward our advisors Professor Helen Vassallo, Tom H. Thomsen, Professor Peder C. Pedersen, and Professor Kent P. Ljungquist for giving us this opportunity, preparing us for the work, and helping us finalize the project.

Table of Contents

1.0 Introduction

The advent of interactivity in communications has created many new ways of providing people with information of all types. Interactivity allows connection of businesses with their clients, educators with their students, and the media with the public on much wider avenues than ever imagined in the early days of mass communication. The use of this technology has increased exponentially, the paradigm shifting from the plaything of scientists to the plaything of four-year-olds. Interactivity is everywhere, and society becomes better informed through interactive information distribution every day.

Museums in general have not yet benefited from the huge strides recently made in the communications field. Upon observing the cultural world as it is in the 21st century, it seems that when most people visualize a museum, they think of a static monument to things judged "old" or "obsolete", a place where art and culture have become more a curiosity or a thing on the wall, rather than an opportunity to explore cultural heritage. It also seems evident that today's youth are not inclined to go to museums because they reason that they can get everything they need from the internet available in their own homes. Their assumption is obviously untrue. There is no substitute for firsthand experience, especially in the experience of culture.

To evolve the museum into an institution of the 21st century, professionals in the field must find new ways to make culture interesting, even fun. The new generation of museum patrons needs more than to just see the exhibits. They want to absorb information on a higher, faster, newer, better level. At this point in interactive information evolution, the museum collaborative pilot program in progress in Denmark entitled the Nordic Handscape Project can be employed. This project is a new interactive

tool to enhance the museum experience. The project is sponsored by the Nordic Council and is being implemented at a branch of the Danish National Museum called Frilandsmuseet, known in English as the Open Air Museum and located north of Copenhagen in Lyngby, Denmark.

The project team believes that the modes of culture dissemination currently in use are not adequate for the needs of the new generation of patrons. These patrons do not want to be limited by tour guides ushering them from one piece of culture to the next. Nor do they want to listen to headphones with scratchy recordings that force them to follow the path chosen for them by some nameless, faceless curator.

This project presents a new and exciting alternative to these outmoded methods. The Nordic Handscape Project, using Nokia mobile phones with the Euman Life-Pilot system, Global Positioning System (GPS) tracking (Appendix B), and Bluetooth digital (Appendix D1) communications links, allows museum patrons to freely visit exhibits in any order, guide their own tour, and create their own unique cultural experience. The technology allows for information transfer lacking from the other current static media, making the patrons satisfied with their experience rather than confused, lost, or thirsting for more. The system "knows", by GPS tracking technology, where the patrons are located, and retrieves, from a central server, the information pertaining to the nearby exhibits. This information may be merely text, or it may be audiovisual presentations. This system gives the patrons a new degree of freedom, empowering them to have an experience that they will, in all likelihood, better remember and eagerly relate to friends. This will, in turn, add to the number of patrons coming into the museum.

The task of the WPI Interactive Qualifying Project group is to devise a way to determine the reception of the new system by patrons during its preliminary phase, planning methods of analysis and ways to judge the reactions of users via survey and interview techniques. The goal is to map out the means to accomplish a comprehensive study of the system, its level of usage and practicality under normal museum conditions, its positive and negative aspects, and to get an overall impression of quality, efficiency, and user satisfaction. The team will then present the planned course of action for scrutiny by the Danish National Museum staff. The desired result is that the team will pave the way for the Mobile Digital Culture Dissemination project to develop smoothly, finally resulting in a new and exciting permanent addition to the museum environment, inviting new patrons to explore Frilandsmuseet in a whole new way.

This report consists of several sections detailing completed research, accomplished research methods, the team's impression of the system and its components from the initial prototype phase, a projected plan for the accomplishment of test phase tasks, and issues that should be considered as the project progresses from this point forward. In conclusion, the team presents an overall idea of how the project has progressed and should continue, and the goals and expectations for future system implementation.

2.0 Background Information

2.1 Frilandsmuseet

Frilandsmuseet represents mainly the farmstead culture of Danish history, while the industrial Brede Værks (Brede Works), which was originally built in its current location, exhibits the factory buildings and the industrial history of Denmark.

2.1.1 History

Founded in 1897 by Bernhard Olsen at the Rosenborg Gardens in Copenhagen, Frilandsmuseet has since moved ten miles north to its current location in Lyngby. Bernhard Olsen, who had a vision to create a place in which total cultural immersion could be possible, originally established it as a Danish Folk Museum focusing on the "daily lives of ordinary people - how they lived, ate, and dressed" (Pedersen 6). Since the move in 1901, the museum has grown into a heritage park of roughly one hundred twenty acres where over one-hundred authentic buildings that date from the 17th century to the mid-20th century were relocated and reconstructed (7-8). In 1920, Frilandsmuseet became a branch of the National Museum, and in the 1990s, the museum expanded to incorporate the "early-industrial landscape" of Brede Værks (8).

Olsen searched the countryside and collected the buildings that represented the culture of Danish history, with the "concept of evolution central to [his] collection" (6). The buildings around the museum exhibited the "development from single-room building with no chimney sheltering both man and beast, to the four-wing Southern Scandinavian farmstead with several fireplaces and separate living quarters and stables" (6-7). Today geography, time-periods, and social status are the three guiding principles for building

selection at Frilandsmuseet.

The objective of this open air museum is to allow visitors to immerse themselves in historical Danish culture. Today, this also includes culture from Sweden, northern Germany, and the Faroe Islands. Olsen sought to replace classical museum collections with exhibitions. Other than the buildings, material authenticity was not the goal of the folk museum as much as attaining an authentic appearance, atmosphere, and naturalistic setting (Skougaard). The museum buildings exhibit the untainted history and culture of the Scandinavian tradition. The buildings, however, are only a portion what the museum has to offer. The people who work on the lands represent the living history of the culture. The staff dresses in period costumes, makes replicas of old-style tools, furniture, and crafts, and also raises ancient Danish breeds of livestock (Mouritsen 112). The story of Denmark's "rural daily life" is presented through all the "historical artifacts, livestock, living history interpreters, guided tours, and publications" (Pedersen 10).

2.1.2 Touring the Museum

Frilandsmuseet allows several ways in which to experience the history and culture throughout the one hundred twenty acres. The visitors take advantage of the museum in the ways that they feel will help achieve their primary goal. The four available options the visitors have when arriving at the museum include the following: self-guided tours with only a map of the museum, a detailed guidebook, a guided tour with one of the museum staff members, and, lastly, the living history throughout the museum.

Most visitors, regardless of age or visiting purpose, opt for the self-guided tour with a large color map of the entire museum including Brede Værks. The visitors can plan their own walk around the grounds as they decide how far they want to walk, and

what exactly they want to see. The large expanse of land can never be entirely seen in one single visit, but if approached in the correct way, most of the exhibited buildings can be explored. In this way, the museum can be experienced and enjoyed.

The guidebook, which was printed by a local publisher in 2002, presents information about all the buildings within the museum before the time of printing. Since it has been printed no new buildings have been added to the museum, but some information regarding the older buildings has been altered. The guidebook costs 50 DKK (8.60 USD) and must be purchased from the main entrances. There are two introductory sections. The first is a preface from the Head Curator, Inger Tolstrup, describing the purpose of the guide. The second is the "How to Use the Guide" section. The guide continues with a brief outline of the history of the museum, and then supplies details about all the buildings, building traditions, animals, and living history interpretations. The end of the guide contains a black and white map of the museum grounds, as well as a map showing the origin of each of the transplanted buildings. The guide presents eight possible tours ranging in length and subject matter. There are also four themed sections on important aspects of the museum. Roughly ten to fifteen guidebooks are sold in one day, in which approximately seven hundred visitors pass through the entrances. It is not the most popular form of touring the museum, but, to date, it presents the most information in one available source.

The guided tours present another option to the museum patron. All of the tours have themes and none of them encompasses the entire museum. A museum staff member leads the group through the history and culture of the museum and makes the museum come alive through traditional oral communication and story telling.

The living history of the museum is the most interactive and engaging aspect of the museum. Throughout the grounds, museum staff members present a part of Danish historical culture, whether through traditional storytelling, dress and costume, traditional activities and craftwork, or events prepared for children to participate. The youngest museum visitors can enjoy and learn from the living history at Frilandsmuseet, but it can also captivate all visitors of any age.

2.2 Life-Pilot Technology

The new technology, which promises to add still another dimension of experience at the museum, was developed by Euman and designed specifically for usage within the mobile phone programming software. Life-Pilot is the user interface and the connection between the information, the Global Positioning System (GPS), and the Bluetooth systems. All data is received and presented through the Life-Pilot programming, which was developed in Lithuania. Besides the main purpose of displaying exhibit information, the software consists of additional features. The Documentor, which is used to record places a user has traveled, can store pictures, voice messages and structured text. The Tracker is the module that follows where the user has been, and allows the user to view the route on screen. The Fleet program allows a user to view where other users in his group are at any given time. These services are all accomplished by using a GPS receiver that communicates with a Nokia 6600 cell phone through use of Bluetooth technology. The phone takes its position from the GPS receiver and downloads the appropriate information via GPRS (Appendix D5).

3.0 Methodology

The team gathered its information for the future pilot testing at the museum using five research methods: observation, investigation into other museums, investigation into alternative technology, interviews, and pilot surveys.

The project began with an intense look into the current information distribution within Frilandsmuseet. Observations regarding visitor population segments, staff members, available information resources, and the museum layout set the groundwork for the project.

Further investigation into other museums and alternative technology systems prepared the team for the process and the necessities for introducing a change into an established organization.

Interviews with the museum officials, staff, and visitors dictated the overall opinion and interest in the proposed system. From this data the team planned to ascertain whether the population of museum goers, in general, would welcome the new system and would use it to enhance a visit to the museum. The additional information collected from the museum employees augmented the overall understanding of the intentions for the information system and how the museum plans to use it in future applications.

Pilot surveys helped the team understand visitor population subgroups and the museum visit expectations. The surveys were presented in such a way not only to gauge interest in the proposed technology system, but also to develop a technique and plan for how to approach musum visitors for information.

4.0 Results

This section will present the results compiled from the data collected from the methods, namely observation, investigation of other museums and alternative technology, interviews, and pilot surveys, previously described in the Methodology chapter.

4.1 Observation

The team observed the museum details regarding visitor population segments, staff members, available information resources, and the museum layout.

4.1.1 Defined Museum Population Segments

The culture of Frilandsmuseet encompasses a broad variety of roles for the daily stream of visitors. The population segments are defined mainly by age, but occasionally by purpose. The largest visitor group is, by far, children under the age of ten. Groups of small children with a few adult caretakers gather outside the museum entrance before the doors open. Once the museum unlocks the door, there is a steady stream of children walking two-by-two through the main entrance and toward the open grounds of the museum. The other large population segment comes from schools. The groups of students are usually of ages ten to fifteen. The miscellaneous groups of museum visitors include the artists, older adults, families, couples without children, and dog-walkers.

The purpose each segment has within the museum grounds varies greatly. The youngest visitors come with the intention to be outside, run around through old buildings, see animals, and maybe be entertained by a show put on by a museum staff member.

There is no need for information or depth of attention from these visitors. They are simply here to have fun and expend energy.

The school groups arrive with the plan of the teacher to have the students learn about Danish history. This plan may or may not also be the plan of the students. Many might see it as an escape from the normal classroom setting; others may be truly interested in the exhibits of the museum. Whether or not they have an assignment from the teacher, they are touring the museum and hopefully learning something about the culture of Denmark.

Some specific groups are from local art schools. The museum presents hundreds of architectural themes for individuals to practice their artistic talent. The sole purpose of their visit to the museum is to seek a subject for their canvas and to spend the rest of the time focused completely on the task at hand.

The older visitors most often are "Friends" of the museum and have a membership that enables them to come to the museum often to enjoy the area. They are not at the museum to learn or be entertained. Instead they go to relax, get some exercise, and spend time in a peaceful, quiet, outdoor environment.

The families, depending on the age of the children, either come to the museum for some fresh air as they slowly push a baby carriage, or they come to help their children learn about and experience the exhibits that the museum has to offer.

Couples without children and dog-walkers may use the museum in a similar way, except they may choose to either spend their time learning about the history of the buildings, or they may just follow the paths and simply enjoy the area.

4.1.2 Staff Members

The employees at the museum fall into several categories, the primary individuals being those who plan for improvements and oversee the maintenance of the museum environment. The curator, assistant curators, architect, event coordinators, information compiler, project managers, and business manager, as well as several others, create the backbone to the entire museum infrastructure.

The employees who represent the link to the visitor population base are the crucial aspect for the museum to ensure the patrons receive the information, entertainment, and aid they desire. Initial contact with the main entrance personnel includes paying the admission fee, if required, and receiving preliminary information via maps, guidebooks, or verbal communication with the employees. The other staff members throughout the museum grounds include the security personnel who are available to the patrons for safety purposes, but also become information sources when patrons request directions or exhibit facts. The last section of the museum personnel is composed of the entertainers. These individuals are the tour guides, actors and actresses, living history members, and activity supervisors. These representatives to the museum present the details of the museum to the visitors through oral traditions.

4.1.3 Available Information Resources

The information resources, outside of staff members, available to the visitors are limited. As previously discussed, the guidebook, although a source for a great abundance of information and facts is not a popular method the patrons employ for touring the museum. Throughout the museum itself there are no current means for supplying information. The exhibits and houses are marked only with small, unobtrusive,

numbered signs, which correspond to the map and the guidebook. The map itself displays the location, as well as the time period and name, of each exhibit. No further details are available from the map source. There are currently plans to implement yet another form of information distribution through signs displaying information about each exhibit. This project will be described in the Discussion chapter.

4.1.4 Museum Layout

There are two main gates through which the visitors can enter the museum. One is located in the southeastern corner and the other in the northwestern corner of the museum grounds. Between these two entrances lie the museum's one hundred twenty acres of land and over one hundred buildings. The paths through the museum wind through the grounds, and remain unpaved. The buildings and houses are placed throughout the museum according to location of origin, time period, and, in some cases, the social status of the inhabitants. Original geography is the main separation between the segments of the museum. The guidebook describes the exhibits of each clustered grouping from a specific location of historical Denmark. The limited signs around the museum also point the way to each "land." The industrial Brede Værks, located in the far northwestern corner of the museum grounds, represents the only portion of the museum that has not been transplanted.

4.2 Other Museums

The team investigated other museums and institutions with technology based information dissemination systems.

4.2.1 Nationalmuseet

The team investigated the National Museum for the methods employed there for communicating information to the visitors. The National Museum is entirely indoors, and, in some areas, the rooms are darkened to prevent light damage to the fragile exhibits. Besides the standard textual information, presented in both Danish and English, the museum also offers an audio tour technology to the visitors. The audio tour provided is an in depth tour available for a few of the museum exhibitions. The tour allows for a user to browse through some of the museum exhibits at their leisure and obtain additional information supplementing the text on the signs at each exhibit.

4.2.2 Naturhistorisk Museum

Prior to developing an understanding regarding the situation Frilandsmuseet, another museum was contacted regarding the implementation of technology as a means for information distribution to visitors. The investigation of another museum was approached with the intent of collecting information and data, as well as suggestions and opinions about how to introduce technology into a non-technological arena. The team relied heavily on information gathered from the interview with the Århus Naturhistorisk (Natural History) Museum curator, Henrik Sell, as well as observations of the museum technology itself. The Naturhistorisk Museum had an established information technology within one exhibit of the museum. The system was used by visitors on a daily basis. The interview with the curator allowed for an understanding of the process by which the technology was finally available to the museum patrons as an option for touring the exhibit. The points most stressed included the development stages of the project, the interest of various population segments, the trial testing phase of the project, the

advantages of the technology, and the complications that arose throughout the entire process. Although the processes employed at the Naturhistorisk Museum were not expected to be used as a blueprint for the development at Frilandsmuseet, several aspects gave the team a more defined picture of how to approach the plans for applications specific to Frilandsmuseet.

4.2.3 National Cultural Heritage Agency

The Nordic Handscape project itself extended beyond the borders of Frilandsmuseet. The intended plans were for the system to cover all of Denmark. The entire country would thus become one enormous museum. In order to develop an understanding and appreciation for this grand scale application, the team interviewed an advisor for the documentation department of the National Cultural Heritage. The advisor, Claus Dam, had a role directly connected to the information from the national database records to be used within the system as it applies not only to Frilandsmuseet, but also the larger nationwide application supported by the Danish Ministry of Culture. The discussions with Claus Dam allowed for the bigger aspect of the project to be followed. Since the entire nation cannot be overseen as the testing ground for the new technology, Frilandsmuseet became the confined segment in which user testing could be monitored and analyzed.

4.3 Alternative Technologies

The following three technologies were those investigated at the previously discussed museums.

4.3.1 Audio Tour Technology

The audio tour applications investigated at the Nationalmuseet (National Museum) in downtown Copenhagen provided additional methods for which to experience a museum. The audio tour system presents additional information to the visitor in such a way that it is not a distraction from the actual exhibit. The artifacts and exhibitions can still be viewed and investigated while the narrator of the tour explains the details and the story behind each one. The audio tour guide presents an option to all visitors, but especially to those who are visually impaired. The exclusively audio-based information enables individuals to experience the exhibits even though they may not be able to see the displayed pieces. Even for sighted individuals, reading the text on the exhibit signs or in the guidebooks may be difficult in the darkened rooms. The information is provided through the medium of a compact disc and player, which is a hands-off technology once the exhibit number has been programmed into the specialized player.

4.3.2 PDA and RFID Interactive Technology

The Naturhistorisk Museum in Århus, Denmark has undergone the process of introducing a new technology system that expanded the available services to its patrons. The technology, which is based around the Personal Data Assistant (PDA) device and Radio Frequency Identification (RFID) tagging (Appendix D2), has the means for creating an interactive experience for the visitors who choose to use the technology. The

specifications of the technology, which is entitled "TaggedX", will be described in the Discussion chapter. Although primarily developed for children and students, the system can also enhance the experience of English speaking visitors of all ages. The system has three options for exploring the exhibit in which it is functional. One option includes a direct English translation of the Danish text presented at each exhibit. This selection is most beneficial to the English-speaking members of the visitor population. The other two system choices are a question and answer game and an educational option, both of which were developed primarily for students and young children. Each of these programs present questions that the user must answer, creating an engaging interactive tool for learning about the museum exhibits.

4.3.3 Expansion to Mobile Phone Technology

The ultimate goal of the Danish application of the Nordic Handscape project is to create a nationwide museum from the thousands of historical, archeological, and cultural sites of interest complied in the data servers for the Danish national records. The information is drawn from the same system as the Life-Pilot mobile phone technology, but the nationwide application and range will include far more sites than just those available at Frilandsmuseet. For the museum specific system, the target audience dictated the presentation of the information. Simple language, lots of visuals, and interactive applications would capture the interest of students more so than plain, in-depth text. However, the use of the national records project was not geared for any particular audience and contained just key information regarding the sites. The nationwide system would be very advantageous for professionals in the field, especially archeologists, to log newly found sites.

4.4 Interviews

Interviews with the museum employees presented opinions that aided the team in ascertaining whether the population of museum goers, in general, would welcome the new system and would use it to enhance a visit to the museum. Additional information collected from the museum personnel augmented the overall understanding of the intentions for the information system and how the museum plans to use it in future applications.

Interviews with Frilandsmuseet employees were not structured beyond a prepared list of discussion prompts. Each interview was specific for obtaining information or opinion regarding a particular aspect of the system or technology. The interviews remained informal and allowed the interviewer to develop questions during the session if the discussion allowed for a deviation from the prepared questions. Interviewing the employees naïve to the new system required the team to introduce the mechanics of the Life-Pilot product and request the opinions of the staff on the implementation into the daily workings of the museum. The employees who work closely with the museum patrons proved to be a valuable link to the visitor base and also how the visitors may receive the new technology.

4.4.1 Assistant Curator

The team interviewed the Frilandsmuseet assistant curator, Rikke Ruhe. The conclusions included the positive attitude the curator held for the new technology and also the educational intentions that she envisioned for the use of such a system within the museum. An additional project was described involving a development in new

information signs to place around the museum. This project will further supplement the visitor experience and learning environment on the grounds.

4.4.2 Architect

The museum architect, Niels Erik Jensen is responsible for overseeing the care and upkeep of the museum grounds. Niels Erik provided the team with invaluable information about the timeline of the Nordic Handscape project. He informed the team that two previous proposals for a similar system had never left the planning stages, but the nationwide Nordic Handscape Project funded by the Nordic Council allowed the museum to continue with its plans to develop a system. Niels Erik believes the value in this system is that it will provide the museum with a way to provide up-to-the-minute information about exhibits at the museum. Also, the system could become a real-time source for information regarding current museum events and announcements.

4.4.3 Visitor Population Statistician

Boum Pyudiah is a living history specialist, activities coordinator, mill expert, and statistician at Frilandsmuseet. His main job is to coordinate the special events at the museum that are designed to improve museum attendance. Boum Explained to the team that the museum had an estimated attendance of 150,000 people in the 2004 season. He also made mention that he expects the attendance to increase to over 170,000 in the 2005 season. Boum investigated the Life-Pilot software and relayed his opinion that it would be a beneficial add-on to the museum visitor experience.

4.4.4 Front Desk Employee

The interview with the front desk employee presented the present situation about how the different visitors approach the museum visit. Also, the team learned that these staff members who have direct contact with the visitors represent the primary source for information. With the addition of a new information system, these individuals will no longer be required to know all the facts and information about the museum exhibits, but in some cases the employees may be hesitate to rely on the technology instead of supplying the visitors with the information verbally.

4.4.5 Museum Entertainment Staff

The team conducted interviews with a few museum staff members. In one particular interview the team spoke with a museum entertainment staff member who was acting in a children's show about Hans Christian Andersen fairy tales. When asked her opinion of the Life-Pilot device, she informed the team that she views the museum as a peaceful and quiet place, and although she herself would not use the proposed system, she could predict some of the museum population having an interest. She commented that the phone information system would be a much more engaging and interactive guide than one of the printed guidebooks.

4.5 Pilot Surveys

The museum patrons were a main source for information regarding interest in the proposed system. Since the patrons will eventually be using the system, it was vital that their opinion be taken into consideration in the final implementation. Several museum visitors were informally questioned as to their thoughts and opinions of the new proposed

information system. Based on initial visitor contact and basic questions, the team developed visitor surveys as a pilot test for dictating the logistics for conducting the surveys once the entire system has been implemented. Simple questionnaires and brief discussion with the visitors clarified the distinct population subgroups, as well as their expectations for a museum visit. The team used the collected information to plan a protocol for testing the fully functional system, as well as obtaining user satisfaction and system evaluation.

4.5.1 Survey Subgroups

The project team completed a series of pilot surveys, which gauged the user's level of interest in the Life-Pilot system. Users of all different age groups were asked how they felt about the proposed system, specifically if they would use the system, if they thought it would enhance the museum experience, and if they would be willing to participate in the pilot testing. The different user groups were defined based on the responses to each of these questions. Six different groups were identified based on age. Individuals less than ten years of age were not surveyed. The next group included the students aged ten to fifteen years old. Mostly the student group was targeted because these individuals presented the most enthusiasm about the system. The people aged sixteen to twenty-five seemed to be less interested than the younger school children. From the twenty-six to forty year olds, the forty-one to sixty-four year olds, and the visitors over sixty-five there was a steadily declining interest in the system.

4.5.2 Survey Data

The results of the pilot surveys appear in Table 1.

Age	Number	Would Use	Would Enhance	Would Test
<10	0	0/0	0/0	0/0
10-15	3	3/3	3/3	3/3
16-25	2	1/2	2/2	1/2
26-40	3	2/3	2/3	2/3
41-64	7	4/7	6/7	4/7
>65	2	0/2	0/2	0/2

Table 1. Pilot Survey Results

4.5.3 Problems

During our survey attempts the team found a multitude of problems, and was constantly revising the way the visitors were approached. The primary obstacle was a language barrier. When a team member attempted to talk to older individuals, the patrons had a difficult time communicating due to an inability to understand English, but more so due to the project group's inability to speak Danish. Some younger individuals and students also could not be surveyed due to this language barrier. This was overcome in some cases with a translator, usually a teacher or friend of the individual, relaying the explanation of the system. The other difficulty with this approach was that much of the description and technical details were lost in the translation. The individuals receiving the translation instead of directly communicating with the team member also appeared to

become bored and disinterested. The team, with the help of a Danish and English speaking museum employee, was also able to produce a Danish version translated from the English survey questions. This also helped overcome the language barrier with the visitors.

Other problems developed such as one teacher assuming that the team was trying to sell them the mobile phone software product. This was avoided in the future by clearly stating that the system was to be a free service that the museum was going to provide to the visitors. Some students also were hesitant to answer questions due to lack of time or disinterest in helping the team. In other cases, people were too preoccupied with watching over children or students or in a rush to do what they came to do at the museum. The team ended up conducting an entire interview with a teacher while walking back to the main building. The teacher at first did not want to speak with the team, since he needed to stay with his students and catch a bus. After the team offered to walk with him, he was very willing and helpful in answering the team's survey questions and gave excellent insight as to how a school group could use the devices, all while walking with his students.

5.0 Discussion and Analysis

In this section the team discusses the results and provides some analysis of the data.

5.1 Project redirection

In order to proceed with the mobile phone information dissemination project Frilandsmuseet, the team envisioned a probable scenario for work in Denmark. The original methodology assumed that the system would be fully operational at the time of arrival. The team planned the work to rely heavily on the ability to perform trial runs of the system with museum visitors and employees with the major tasks involving system tests and end-user questionnaires. Because the project deviated from the original specifications, an alternate methodology was developed. The team redirected the approach and viewed the project as involving a completely theoretical proposal for future implementation. Information gathered led the team to further design the pilot-testing phase that would eventually be carried out by the museum itself.

5.1.1 Earliest Methodology Proposal Draft

The first edition of the methodology included a three-tiered project plan. Depending on the status of the system implementation at the time of arrival, the project would have proceeded in different ways. The optimal plans of action would have relied heavily on the ability to perform trial runs of the system with museum visitors and employees. If the system remained unfinished, the team prepared a procedure as if the system was entirely limited to theoretical function. Under this condition, the goals of the project would have been restricted to further academic research, defining public opinion regarding proposed implementation of this system, and preparing the museum personnel

to conduct the pilot testing later at the appropriate level of system completion. If the system developments were mostly or fully complete, the tasks would have involved more extensive testing and obtaining end-user opinions following a visit to the museum with the Life-Pilot device.

The proposed methods for collecting information from museum visitors and employees would have included interviews, on-site and off-site questionnaires, focus groups, and field research and observations. The available resources, the language barrier, system functionality, and time would have determined the usability of each method. No matter the completion of the technology upon the team's arrival, certain methods would be achieved. These include additional research into other similar museum technologies, interviews with Euman, and interviews with museum officials, staff, and visitors. The best-case scenario would have been using as many of the proposed methods as possible with a fully functional system and presenting Frilandsmuseet with a complete impression of public satisfaction, as well as suggestions for improvement for the permanent implementation.

Each staged scenario involved some of the same procedures despite the completion level of the system. The most important of these included the following: interviewing the employees of the museum, introducing the new technology and overall mechanics to those unfamiliar with the Life-Pilot system, and requesting opinions on the system implementation into the daily workings of the museum. Among those with whom the team required contact included museum officials, project stakeholders, the employees who work closely with the museum patrons, and the visitor base.

The team intended to gather opinions, concerns, and hopes for the future from the museum officials and project stakeholders. Interaction with Euman resources would have allowed a greater understanding of the system regarding the inner workings, as well as the limitations of the technologies. Museum patrons' opinions were deemed vital for consideration of the final system implementation. The users might have been able to offer additional insight, a point of view not apparent to the team.

A theoretical system would represent the case in which the project experienced delays and problems extending the length of the project development. Only the phone and GPS hardware components would be desired at this point for inspection, but under these conditions no applications were expected to be available. Any questions posed to the visitors would only attempt to ascertain their overall feeling about the proposed system, what they would like to see in such a system, and if they think such a system could improve their museum experience. Although it would have been difficult to clearly describe the system or define the specifics, the visitors would have been provided with an idea of the new technology, as it would exist within the museum. This method would hopefully generate data representing the museum's entire visitor demographic.

The partially completed system was the scenario the team had planned on finding once immersed in the project on-site at the museum. A partially completed system would have involved the technology at a stage where it was ready for user testing, but not all of the planned applications or server information available. At a stage such as this, technical difficulties or defects in the programming would have been the greatest inconvenience. The technology would have been tested by the primary user groups and later analyzed in detail by the team. Surveys and focus groups could have been

administered to the patrons on-site directly following their museum tour with the Life-Pilot system. Questions would prompt more opinion-based responses on the users' attitudes toward the new technology after having experienced it themselves. In this phase, if the specific application for saving information for later retrieval was available, student groups would have been requested to use the system to explore the museum and choose which information they wished to save to review later when back in the classroom. Before departing the museum, the teachers would have been supplied with questionnaires to prompt student responses after all available features of the Life-Pilot system were experienced.

A fully functional system was not expected to be in existence upon arrival at the museum, but the team presented this aspect as the optimal situation in the final proposal report. The goal in this case would not be a validation of system functionality within the museum, but rather an evaluation of the quality of the system. At this level of system functionality, the questions posed to the primary users would require a more qualitative evaluation. Questions regarding user comfort level, ease of system use, system reliability and accuracy, and overall impression of the system's informational content should be asked. Also, a procedure of monitoring the system in use would supply data that could give quantitative measurements of system dynamics. The most important aspect of analyzing the system in this stage of completion would have been developing a series of recommendations for future modifications. These modifications could include, but were definitely not limited to, improvements or additions to the available information, increased accuracy solutions, new and reengineered applications proposals, and solutions to various problems such as indoor usage.

5.1.2 Final Proposed Project Methodology

At the culmination of the preparatory work for the Interactive Qualifying Project at the Denmark project site, the project team had the goal to complete the designed pilot testing strategy. The team planned and prepared for the optimal scenario of the system completion. With fully operational technology, the methodology constructed for usage at Frilandsmuseet would have aided the project team in structuring and completing the pilot testing phase of the overall Danish Nordic Handscape Project. The principle means for data collection would have been user feedback gathering procedures, such as questionnaires and focus group, which contained questions specific to the actual functions and applications of the Life-Pilot programming. Additional data, facts, and opinions would have been compiled from all stake-holding parties and organizations with information distribution systems of a similar use and purpose. All portions of the original methodology would have led the project team to conclusions regarding the efficacy and stability of the new system, as well as interest levels in each of the defined user segments. The primary intentions of the proposed plan involved completing the user pilot tests of the fully operational system and supplying the museum and project directors with overall user satisfaction and suggestions for improvements.

5.1.3 Causes for Project Redirection

Upon arrival to the project site, the team discovered that several delays had occurred within the project pushing back the date of system installation. The extension of the project timeline was caused by problems in the software programming, prolonged information development and uploading, political problems, and funding issues. The halted progression of the project would have serious effect on of the proposed plans of

the project team. Since the system was not to be ready until mid-April, the team members had to redefine the purpose of the particular role they had to play in the overall scheme. Whereas much of the methods involving additional research and interviewing proceeded as expected, the agenda regarding the pilot testing applications was delayed. After being informed that the hardware and some software would be ready within a few weeks, the team continued with proposed plans, only rescheduling the pilot-testing portion until after the system was obtained.

The most important interview the team needed to accomplish was a meeting with the primary technology provider. Although the team initially did not have any hardware or software applications to test, the interview with the technology provider would be a key to preparing the team for investigation into the details and specific applications of the system. Despite repeated contact and several interview attempts, the team was not able to meet in person with the employee from Euman. Although this delay set the team back in learning about the details of the technology, the team did received and examined one sample of the hardware with some limited applications. The team was eventually able to elicit a telephone interview from an employee at Euman. Some valuable information was collected from the contact, the most important of which was that the version of the software running on the sample device was not the most up-to-date version that was being used with the current system. The team also posed some inquiries that could not be answered during the interview and required further contact with the provider. The purpose of the interview with the Euman resource was to develop a greater understanding of the system regarding the inner workings, as well as the limitations of the technologies.

These aspects of the system were either acquired from alternate sources, such as the team liaison Klaus Støttrup Jensen, or inferred and assumed by the team.

Since the technology was not ready for user testing, the team realized that the project was not going to proceed as intended. In the third week of the team's project timetable, the overall project goal and expectations were redirected entirely. The team now had to develop a plan for the museum itself to carry out the pilot testing. Several aspects of the project that were previously not important to the goals of the team, now had a major part to play in the redefined project. Whereas the team was told not to investigate museum staff and visitor opinion on the theoretical system at the outset of the on-site work, it now became the focus of the team's methods. Defining the logistics for, as well as detailing the costs of, accomplishing a significant and effective user pilot test became the final goal of the team.

5.2 Information Distribution System

The team investigated the proposed new information dissemination system for the museum. The project intent was to gauge interest in the proposed system and, also, develop the most effective and efficient plan to obtain feedback from museum visitors on their satisfaction with how the information is delivered to them once the system becomes operational.

Without the aid of the new system, museum patrons attend the exhibits in one of two ways. The first method by which visitors can see the exhibits is on their own with no guidance or extra information other than what they can gather from surrounding signs, plaques, or the exhibits themselves. The other option for museum-goers is to be involved in a guided tour. A guided tour can either be led by a museum employee, called a docent,

who is very knowledgeable in all the artifacts and exhibits in the museum or the museum patrons can be lent headsets with a recording of the information for specific exhibits. In both cases, due to the lack of time and resources, it is extremely difficult to see all the sites during one single tour. The guided tours are predetermined and leave no room for the visitor to deviate from the path of the guide, human or electronic.

A new development in communication technology for museum information dissemination involves devices equipped with Global Positioning System (GPS) tracking mechanisms and a single central data storage facility containing the exhibit information. The device tracks the movement of the visitor, and when the device is within the range of an exhibit, the information regarding that exhibit is displayed for the visitor to see, read, and possibly hear if sound or a video is available. The display will be part of a Nokia-brand mobile phone, which is equipped with a Bluetooth technology link and the software package Life-Pilot provided by the Euman company, a Danish technology firm.

The Nordic Council funds this project for integrating technology into the museum experience. Museums in Denmark, Finland, Iceland, Norway, and Sweden are all involved in the program to show various solutions on distributing information about culture with each country determining its own solution. Frilandsmuseet is working in collaboration with the Danish Ministry of Culture, using the same equipment and provider, to further expand and develop this integration of society and technology.

5.3 Observations

Methods of observation implemented in order to establish the project within Frilandsmuseet became the first goal of the team. The team utilized this course of action for initial orientation to the museum. First on the team's agenda was to research the daily

workings and dynamics of the museum. This included analysis of common routes of visitor traffic and observation of museum demographics. Once the Life-Pilot technology was available, further observations and analysis were conducted on the software and the hardware aspects of the technology. The team completed a review of the software and the available tracking and map applications. Testing for device accuracy and outdoor usability were the primary goals of the technology observations.

5.3.1 Frilandsmuseet

Frilandsmuseet, the Danish Open Air Museum, is a tract of 120 acres of land located in Lyngby, Denmark. All of the "sites" within the museum are authentic architecture from all of Denmark, northern Germany, the Faeroe Islands, and other Scanian Provinces. All of these lands, at one point in Danish history, were under the rule of Denmark and, therefore, are a significant part of Danish cultural history. While in Denmark, the team proceeded with on-site project work at the Frilandsmuseet main building. The grounds of the museum contain more than 100 separate buildings all grouped according to the location they were originally erected. The Frilandsmuseet represents mainly the farmstead culture of Danish history, while the Brede Værks, which was originally built in its current location, exhibits the factory buildings and the industrial history of Denmark.

The daily activities of the museum, which is open 10am to 5pm from Tuesday to Sunday, are significantly based around the younger population of its visitors. A substantial number of the museum visitors are young school children or families with younger children. The activities out in the museum grounds include several children specific games and events, such as animal petting, wool brushing, potato sack races, stilt

walking, and museum staff dressed in period clothing who describe the museum exhibits to eager visitors. The animals, including goats, sheep, horses, cattle, poultry, and swine, are a big attraction to visitors of all ages. The largest numbers visit the museum on weekends and on Wednesdays when the museum provides free admission to the public.

The museum can be toured in a variety of ways, but the most common way currently is to just walk around, in and out of the buildings, and viewing the animals in the fields. There are no signs directly on the buildings or on the insides describing anything about the particular time period or architecture. There are only small, unobtrusive signs denoting a number for each building. The numbers, which are only located on one side of the buildings, correspond to the ones in the tour guide, which will be described later, available for purchase in the gift store. Other than the numbered signs, there are information signs planned for introducing a select number of the buildings. The signs are brown with white and yellow text, low to the ground and very easy to miss. They are, however, a good height for children. The signs are almost purely textual information regarding the original location, how the building was constructed, the history of the original inhabitants, and the purposes of the type of building, whether it be for farming, housing livestock, or simply for housing a family. The signs are printed in both Danish, white text, and English, yellow text. Details about the proposed implementation

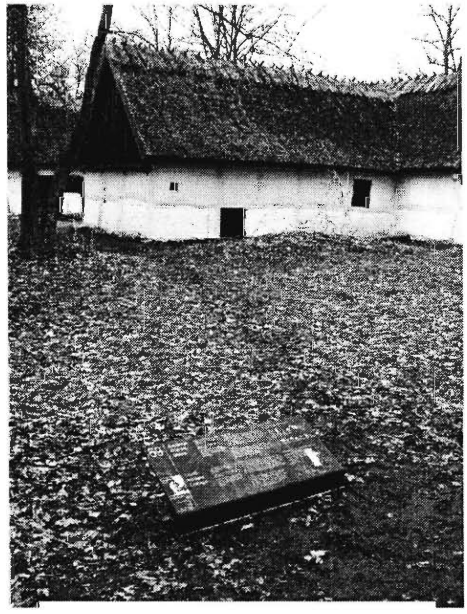


Figure 1. Frilandsmuseet Sign

of the information signs throughout the entire museum will be detailed later in the interview summary with the assistant curator, Rikke Ruhe.

If the visitors prefer some structure to their visit there are printed tour guides available for 50 DKK (8.60 USD) in the museum gift shop. The guidebooks, printed in 2002, are available in both English and Danish. They are a very well organized with eight tours and four thematic sections and contain in-depth information regarding each building, as well as the other sites on the grounds. At the back of the guide there are two maps, one with a complete map of the museum grounds and the other marking the original locations of all the buildings. The guides have a preface from the Head Curator, Inger Tolstrup, a brief history of the museum, and each time period of the museum is discussed separately using colored pictures, maps, and drawings. There is also an initial section about how to use the guide to get the most out of the museum experience. The guide allows for the visitors to follow the eight suggested tours, or to design their own tour. The eight tours are outlined in the guide including the following: The World of the Estate, Mills and Industry, Manors and Country Houses, The Open Landscape, Denmark: The Island Realm, The Faeroe Islands, Northern Schleswig, and The Scanian Provinces. The tours are both long and short, or include most of the buildings or only a select portion of them. This is all clearly detailed in the introductory "How to Use the Guide" chapter of the guidebook. The only trouble with creating one's own tour is that it is not easy to locate the information about any one particular building unless one of the tours is closely followed.

The guidebook also describes a few other aspects of the museum in four themed sections. Rural Building Traditions, Landscapes and Gardens, Agriculture and Livestock,

and Living History Interpretations are not written for any particular building or other static exhibit, but more for the living history aspects of the museum. Especially in the Living History Interpretations "exhibits", the museum visitors experience the life and times of the periods of Danish history they walk through on their tour. Staff dressed in "contemporary late 19th century clothing tell stories, guide tours, and demonstrate daily rural chores and activities" (Pedersen 70). The third way for the visitors to tour the museum would be to either follow one of the staff guided tours, or to go from building to building and hear the story from the costumed individual playing the role of a traditional 19th century man or woman.

5.3.2 Life-Pilot Review

The Life-Pilot software runs on a Nokia 6600 cell phone. The screen on this phone is large enough to clearly display most information in a readable format. The keypad buttons on the phone are small and close together, but this is no different than normal mobile phone keypads. Those used to such technology will be able to operate the phone with no problems. Even if someone is not familiar with mobile phones, after five to ten minutes with the phone most new users should be able to handle the phone properly and not hit multiple keys at once. The phone requires a Bluetooth GPS unit to be connected in order to acquire the user's location. This device is about three-quarters the size of the phone. It has a power switch, a charging port, an external antenna port, and three small light emitting diodes (LEDs) to signify uplink connection. Both the mobile phone and the GPS unit are lightweight, easy to hold, and small enough to fit in a pocket for carrying when not in use.

Figure 2. Life-Pilot Hardware

The cell phone is powered on by a button located on the top of the phone and will boot up in roughly 30 seconds. A switch located on the side of the GPS unit activates the device, and it takes approximately 30 seconds to locate a connection with the GPS satellite system. Using the cell phone, the user must start the Life-Pilot software by clicking the middle button on the left side of the phone to access the 'Applications' menu, and then selecting the 'Life-Pilot' application icon using the joystick in the center of the

phone. Pushing the joystick in opens the application. This process may cause users some confusion, as they may not know exactly what to do unless specifically instructed. A way to simplify these tasks for the user would be to enable the Life-Pilot software prior to handing out the device, or to have the Life-Pilot software boot immediately when the phone is activated.

Once activated, the Bluetooth GPS unit has a blinking blue LED light indicating the Bluetooth connection is active. Initially, the center green LED light is on steady. It will remain steady until the GPS unit has acquired its location via satellite connection, which occurs in less than ten seconds, and then the green LED will blink continuously. The cell phone connects to the GPS unit via Bluetooth. There is a GPS connection indicator in the upper right-hand corner of the mobile phone screen. When the indicator displays 'GPS' in green, the phone can access the satellite information. If the indicator turns yellow, the connection has been lost. A red indicator represents no available connection. There is no audible signal notifying the user that the connection has been established or that the connection has been lost.

Within the Life-Pilot software there are four options: Documenter, Locator, Tracker, and PlaceFinder.

Documenter requires connection a to the GPS device. When opened, the program scans for the GPS unit, and attempts to connect to it. Once connection is established, the phone acquires location data, and then loads the camera view. The user can take a picture of a location, and also record a sound message as well. Both the image and the sound will be connected with the location established by the GPS unit. The user has the option to upload the image and sound, along with a title for the location, to the central database.

Tracker presents maps of the mobile phone location based on GPS information for its triangulated position. In this mode, the user has the option of viewing updated trip data, which displays total distance, time and average speed.

PlaceFinder requires connection to the Life-Pilot server only to acquire data from the National Map Service. This program enables a user to manually enter an address, city, or specific place, and the location is then shown on the map. For this function the GPS connection to satellite is not necessary. However, when used in tandem with the GPS module, the PlaceFinder program facilitates navigating to a desired destination.

The GPS unit must be held with the GPS design logo face-up. If it is held sideways at the user's side, the GPS will lose the lock on the satellites, and the signal and position track will be lost. Since the cell phone does not give any audible indication of when the signal is lost, it may go unnoticed to the user that the device is no longer connected.

The battery life on both the phone and the GPS unit are acceptable for prolonged usage. The phone battery operates for approximately three hours, possibly more, of continuous Life-Pilot use. The GPS unit battery will normally outlast the phone battery.

While using Tracker the maps are slow to download. Even when set on "Medium" or a lower quality, the phone seems to take at least thirty seconds to download a new map image. When traveling in a vehicle, Tracker follows the vehicle's location, but the red arrow indicator does not stay centered on the map image. As the red arrow encounters the edge of the screen, the map must be manually scrolled to follow the location of the mobile unit. A feature that automatically shifts the map instead of the red

arrow indicator would be a valuable feature so the user does not have to continually watch the screen and adjust the map to find the location.

The menus within the software are presented logically and function appropriately. One of the few problems encountered when switching between modules in the program was that the GPS would stay active in the first module, causing an error message to display which reads "Unable to connect. Max number of Bluetooth connections already in use." The user must reselect the option to start the new program before the connection can be made. Disconnecting the Bluetooth before closing the individual program services could easily solve this problem.

Occasionally, the phone randomly resets itself for unknown reasons. With no indication of any problems, it shuts off and resets. This presents a problem for a user, since it takes approximately thirty seconds to reboot. Any open applications and programs will have to be reopened from startup. This would not be a major problem for the user who knows how to get back into the software.

When the GPS/Tracker combination is used, placement of the GPS unit is important to maintaining the connection. Without a way to clip the GPS unit to either clothing or a bag, it is difficult to comfortably hold the device and operate the phone at the same time. If held one in each hand, the phone and GPS units could hinder performing simple tasks, such as opening a door. A fastening band or clip should be added to the GPS unit, so that it can easily be attached to the shoulder strap of a backpack, for instance, and make it easier to carry.

The Tracker is extremely useful when traveling in unfamiliar cities. A user can type in an address, have it as a waypoint, and have a map of where they are relative to their destination.

5.4 Research

Team research conducted in the United States identified several institutions with similar systems to the one that implemented at Frilandsmuseet. Contacts with these museums and other tourist-oriented attractions provided insight into the operation of such technology. The team furthered this research while in Denmark to include additional institutions within Denmark, as well as other parts of Europe. Research into alternate forms of museum technology was primarily web-based, but also included on-site investigation and observation. Although the original intention of the research was to discover the popularity of the technology in such instances, it also became a resource for investigating user testing and overall user satisfaction where such information was available. The team continued the research all through the project by exploring the subjects of Frilandsmuseet, examining all material received from interviews and questionnaires, and gathering insight regarding the Nordic Handscape project and other sites under the auspices of the Danish Ministry of Culture.

5.4.1 Vikingeskibsmuseet

The Denmark museum project extends further than the grounds of the Frilandsmuseet. The Nordic Handscape project has also been ongoing at the Vikingeskibsmuseet, the Viking Ship Museum. The Viking Ship Museum, however, has a different approach to the project. Since most of the "exhibits" are underwater, the

museum will be relying heavily on the data supplied by the cell phones to the visitors. When the visitor takes the boat tour of the fjord or walks along the coastline, the cell phones will be able to display information regarding wreckage sites located far beneath the surface of the fjord. The limitation will be the amount of information able to be shown for each site. Only a certain length of text, one image, and one sound clip will be available for each site. The museum currently has 273 points of interest that will be available on the system. The museum plans to obtain ten test phones for the summer once the exhibit information has been uploaded. The cell phone information system will be a free service to the visitors who buy a ticket to the museum. Devices will be distributed and collected at opposite sides of the fjord where the boat tour starts and ends. There will be a deposit of 50 DKK (8.60 USD) required in order to use the system, but the visitor reclaims the deposit once the cell phone is returned.

The entire Nordic Handscape project at both the Frilandsmuseet and the Vikingeskibsmuseet hinges on the technology and service provider, Euman. The Viking Ship Museum still plans to continue the implementation of the cell phone based information distribution system with the Euman software and service. The team working on the museum's project has found it difficult to communicate with Euman, and was not able to proceed with several of their project plans, which were rejected by Euman. The team ended up not connecting with Euman on their particular project. The main point of interest to the Viking Ship Museum team is the user interface, and since they had not been successful in obtaining information from Euman, their particular project diverted from the particular system the museum will be implementing. The team, instead, focused more on using a PDA (Compaq iPAQ) as a test product and developed a hardwired user

interface for an information distribution system. This is not so different from the cell phone system, since several PDAs currently have mobile phone applications and services.

The final result of the Viking Ship Museum team's project will be a thesis describing a mock-up version of a user interface for an information distribution system. They developed a prototype combining a current Compaq PDA model, an HTML coded interface, and hardwired information. The functions of the product were to include text, image files, sound clips, and video files. The user would also be able to leave comments, as well as connect to other users using a text message based system. The system would be able to include links to additional text. The team's main interest is in how the user interface is affected. They have discovered that it is not easy to select options on the screen using the stylus pen, which could also be an issue for small children unable to hold the small pen or older adults with arthritis. Also, the screen has very low visibility in direct sunlight, which is a serious problem for the Viking Ship Museum, since most of the exhibits will be visited out of doors. The PDAs, however, have a much larger screen than the Nokia cell phones planned for usage at the Frilandsmuseet and the Vikingeskibsmuseet.

In addition to the Nordic Handscape project, the team from the Viking Ship Museum was able to supply additional documentation regarding museums located around Europe using similar technology for information distribution within the exhibitions. Other museum projects included the London "Guide" system (Appendix A1), Austria's LoL@ project, and the system at the Marble Museum in Italy. Within Denmark there is also the DKC project of the Danish cultural sites and points of interest all across the country. Museums within Denmark with high-tech information systems include the

"TaggedX" RFID system at the Naturhistorisk Museum and another Euman GPS system at the Mobile Tourist Information. Both museums are located in Århus, Denmark.

The information received in this interview was invaluable to the team for several reasons. The main objective accomplished was to achieve a better understanding of the problems and pitfalls of orchestrating such an involved project, and the team learned what to expect over the duration of the project.

5.4.2 Nationalmuseet

The Nationalmuseet (The Danish National Museum) is located in downtown Copenhagen. "The National Museum is Denmark's largest museum of cultural history. The museum's main domicile is a classical 18th century mansion just a stone's throw from 'Strøget' at the center of Copenhagen" (National Museum). The main building has several permanent exhibits including Danish Prehistory, Danish Middle Ages and Renaissance, Modern Danish History, and also a Children's Museum (National Museum). The team was able to visit the museum to experience the various tours available to the museum patrons.

The museum is set up with most of the artifacts and cultural items presented behind protective glass cases. The lighting is also dim in order to prevent light bleaching of the more delicate objects. Signs placed near the objects contain brief descriptions written in both Danish and English. Besides the textual information, there are also drawings depicting historical objects, people, or places. In some cases, there are pictures of the sites from which the artifacts were found or pictures of recreated historical scenes. When appropriate, there are comparisons made through the use of scale drawings to show differences between historical standards and current standards, especially when

pertaining to livestock. Throughout the entire museum most of the information is presented to the visitors via textual descriptions.

The museum has a few methods of touring the exhibits available to the visitors. "Guided tours in Danish of the Victorian Home start from the National Museum's at 12pm, 1pm & 2pm on Saturdays, Sundays and holidays" (National Museum). There are no guided tours for any of the other exhibits within the main building. There are three self-guided tours through the use of themed tour pamphlets. These pamphlets include a map of the sections of the museum involved in the tour as well as a plan for how to navigate the museum. Each exhibition has only a few sites described within the pamphlet tours. The three available tours are "Danmarkshistorien på 60 minutter (The History of Denmark in 60 Minutes)," "Jorden Rundt på 60 minutter (Around the World in 60 Minutes)," and "Familietur på 60 Minutter (60-Minute Family Tour)." Each of these tours is written for a slightly different audience, but each pamphlet has both Danish and English text.

The audio tour also available to the visitors allows for non-linear, self-paced exhibition viewing, but gives additional information for only a few of the exhibits in each of the rooms. Each exhibition included in the tour has an overall description and then some sites within the rooms of that exhibition have individual descriptions. Six of the eleven exhibitions have the English audio tour sites; these include sixteen in Prehistoric Denmark, eleven in Mediaeval Denmark, eight in Danish Renaissance, two in The Coin and Medal Collection, fourteen in The Peoples of the World, and fourteen in The Collection of Antiquities. The sites that have information from the audio tour are denoted by a headphone symbol below the exhibit. The symbol also has a number

corresponding with the number of the audio tour exhibits. The audio tour is offered in both Danish and English versions; however not all the audio tour sites are for both versions. The Danish tour symbols are green, while the English tour symbols are black.

When the visitor on the audio tour wishes to hear the description about the site with an audio tour symbol, the number of that site must be programmed into the CD player using the numerical buttons on the top of the player. The "Play" which is in the shape of an arrow must be pressed after the site number is entered. The player will skip to that site's description and within a few seconds the voice of the tour narrator is heard. At the end of the initial description, there are a few sites that have additional information. For the English audio tour there are thirteen sites with additional information. If the visitor wishes to hear this extra information he must press the arrow Play button again. This additional information is usually not essential to the piece, but may be a more in-depth description of a specific part or a story about the piece. The most positive aspect of the audio tour is that after the exhibit number is programmed into the player, the user can listen while the description or story is being told, and can also inspect the exhibit simultaneously. With the audio tour there is no visual distraction from the actual museum artifacts.

The device used for the audio tour is a specialized CD player in which the CD is held permanently into place and cannot be removed without the use of a screwdriver or similar tool. Although the CD is sealed within the player, the transparent CD player lid allows the written text of the CD to be seen. The CD is labeled with the date of August 2000, which is the date of the most recent information available to the visitors through this tour. The Arts Communication & Technology Ltd. manufactures the CD player

device, called the "Gallery Guide™." The device itself is heavy and a bit bulky, although it does have a strap so the visitor can carry the player on his shoulder. The display screen on the play has enough room for two lines of text, which are usually the exhibit number and the exhibit name. There is also an icon representing the volume level, which can be controlled by the user. The device itself is also equipped with Braille on the numerical buttons for vision-impaired visitors. Although the visually impaired visitor would be able to select what program he or she wants, the user would not be able to see or find the small green or black dots that signify which exhibits have an audio track. The most effective way for a visually impaired visitor to tour the museum would be to accompany a sighted person, who could point out which exhibits have audio available.

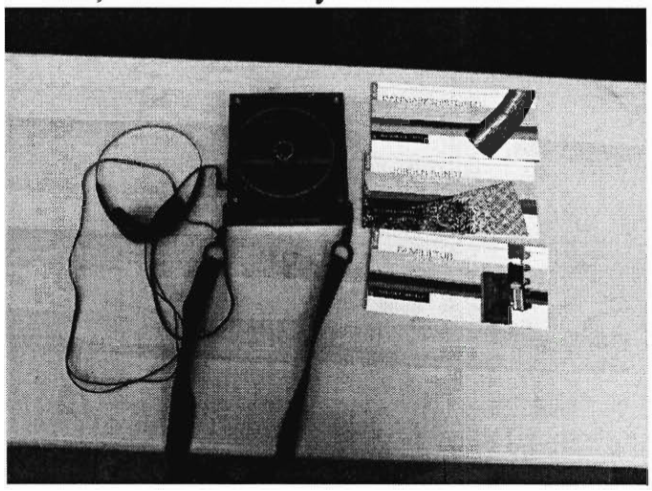


Figure 3. National Museum Audio Tour Hardware

The team spoke with a museum employee, Dorthe Langkilde, who was able to give additional information regarding the audio tour system. She supplied a list including all the audio tour exhibits, the exhibit numbers, and which exhibitions that contained the audio tour sites.

5.4.3 Naturhistorisk Museum

The Naturhistorisk Museum (Natural History Museum) is located in Århus, Denmark, and the team was able to talk to the curator, Henrik Sell. The Naturhistorisk Museum has implemented an information distribution system that gives the user supplementary information. All the text on the traditional signs is in Danish, and the information is very brief, so this device also provides translations of the text into English. The explanations next to the displayed items give the visitor a better understanding of the object, animal, artifact, or archeological find. The sign may describe the history of the object or relay interesting facts regarding the animals. If the visitor is not interested in reading the information about each exhibit, touring each exhibition can take less than ten minutes.

Henrik Sell explained many aspects of his museum's new information system, and his personal view on the system was positive and in favor of its usage in the museum setting. He described both the advantages and disadvantages of the system, but in the end he stressed that it was an improvement in the way the museum can be experienced.

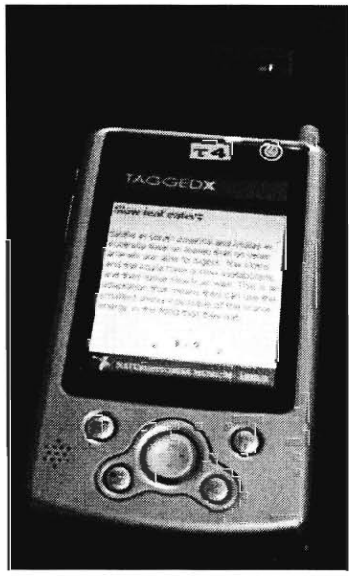


Figure 4. Natural History Museum PDA

The system hardware includes a PDA (Personal Data Assistant), a built in RFID (Radio Frequency Identification) reader, and a wireless LAN connection to a central server, which is located within the museum. The hardware components are sponsored entirely by the technology provider Fujitsu-Siemans.

The system software is a program called "TaggedX" which was developed by a software company established by the students who had previously worked on this project with the museum. The company, called Cordura (Appendix A2), specifically designed the software for museum use. Within the museum at each site in the exhibition, there is a marker denoting a "tagged" location. The marker is a small red dot on corners of the text signs that are already in place. Attached to the back side of each marked sign is an RFID tag, which is about the size of a credit card, but paper thin. Since the signs are opaque, the visitors cannot see the tags. Each PDA is equipped with an external RFID reader. When this reader is swiped across the red marker, a few inches (or about ten centimeters) from the tag, the reader blinks and then a message is displayed that the information specific to that tag is being accessed. About three to five seconds after the tag is "read", the information for that site is displayed. This process can take longer, but usually no longer than ten seconds after swiping the tag. The reason it takes a few seconds to display the tagged site's information is because the PDA downloads all the information from the server. No information is stored on the PDA itself. The fact that the user has to physically swipe the reader over an exhibit to read the information prevents the users from spending all their time at the museum in a corner going through all the information available on the PDA. Having all of the information

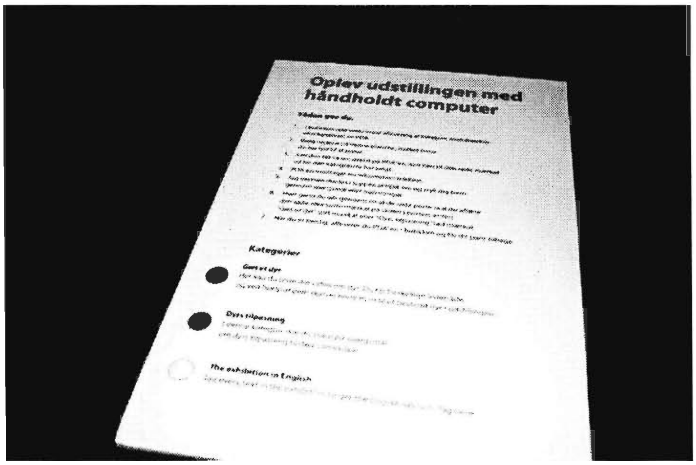


Figure 5. Natural History Museum Instruction Sign

stored on the PDA would make the RFID tagging unnecessary, but would also make it easier for the students to lose themselves in the gadget and only "tour" the museum through the PDA information instead of viewing the actual museum exhibits.

The displayed information will vary depending on the program selected at the start of the tour. The software allows for three different programs by which to tour the exhibition. One program is a straight translation of the Danish text on the signs to English text. This is a helpful tool for English speaking visitors wishing to explore the museum. The second program is an educational setting for school children. This setting encourages the children to explore the museum in depth by answering questions displayed on the PDA screen. The questions may ask the student to find a particular animal meeting the described characteristics. Once the correct animal is found, the program may ask questions specific to that animal. The third program is a game setting. It is similar to the educational program with questions displayed needing to be answered by locating the correct animal and swiping that tag. Both the educational and game programs are available only in Danish text.

The information available at each tagged location may vary. Every site has text-based information to read, but some of the sites also have images, sounds, videos, or even videos with sounds. The videos especially bring the exhibits to life. The educational and game settings allow the individual holding the PDA to thoroughly explore the exhibition, and spend more time learning about each exhibit. Although a significant focus is placed on the device that must be carried around, it also requires the visitor to look at the exhibits in order to find the correct answer in the game and educational modes. In the case of the English translation setting, the PDA can be kept in the visitor's pocket until he

finds an exhibit for which he wishes to know more. It is not necessary to swipe every sign. This allows the visitor to decide where he wants to go in the exhibition and which exhibit signs he wants to read.

The system was first fully incorporated within the Naturhistorisk museum in June of 2004 for a special exhibition about flying animals. This integration was after a significant development process that began in the autumn of 2003. The system started as a project for students from the university. The students worked for three months and developed a very simplified version of the current system. After the students developed the proposal for a system called "TaggedX," the museum continued the project by requesting funds from the government.

The museum was able to proceed after receiving 250,000 DKK (43,100 USD) from the Danish government, and the initial phases of development could begin. The information for each site needed to be developed, edited to fit the space allowance, and uploaded to the server. The process of writing and uploading the information was the most labor intensive and time consuming. The museum server has a web-based interface that can be accessed anywhere by the museum personnel. The information can be easily edited, altered, or deleted altogether. Also, if additional media files become available, such as sounds and videos, they can also be uploaded to the server via the web link. The information upload is a continuous process, as the museum gets new exhibits, or wants to just put in new data about the sites. Since the initial testing phase, other exhibitions have been added to the system. The current exhibition for which the system is available is entitled "Life Forms." The total number of tagged sites is not known exactly, but Henrik

estimated between three hundred and five hundred sites of information are available on the server.

In order for the visitors to use the system, they must obtain a PDA unit at the museum front desk. If the requesting individual is a private visitor, he must leave a deposit in the form of a driver's license or another form of ID at the front desk, and then receive his ID back when he returns the PDA. The school groups are not required to leave a deposit. Although there have been a few incidences of PDAs getting broken during the tours, there have not been any cases of theft of the devices. This is encouraging for the system to continue being a free service to museum visitors.

The orientation to using the equipment includes reading a sign that explains how to operate the PDA and use the system within the museum, and then selecting one of the three modes available to the visitor for touring the exhibition. Henrik recalled that different sub-groups of the visitor population approach this process differently. It is usual for the school students to not read the sign at all, and after choosing a touring mode, they are able to operate the PDA without much guidance. Older individuals spend time reading the sign, but still remain confused about how to use the equipment.

The museum currently has eight PDAs programmed with the software and available for use to visitors. The amount of time any one visitor spends touring with the PDA varies, but the time usually averages around one half-hour before the device is returned to the front desk. The PDA is then available for the next visitor given that the battery is charged enough. The PDA's must be charged after every half-hour of usage. Charging usually takes about one hour. During the time that the PDA is charging it is unavailable for the visitors. Since only about ten percent of the visitors request the

system for touring, there has not been a problem with individual visitors not getting the opportunity to use the PDA tour.

During the testing phase, the museum conducted several very informal focus groups for students to discuss what they thought of the system. There were about ten test classes that were allowed to tour the museum with the devices. Each class had an average of twenty-four students, so a few students had to share each PDA since there were not enough for each student to use his own. The applications available to the students included question and answer games, a variety of themes chosen by the teacher prior to the museum visit, a simple English translation mode, and a dictionary in order to get additional information about an exhibit by tagging it. Following their visit through the exhibition with the PDAs, the classes were involved in focus group discussions during which they candidly and openly explained their opinions of the system.

The focus groups that were conducted were very informal, about half an hour long and discussion based. There were two museum employees, along with four students to analyze how the system worked. The museum employees had a set list of questions, but allowed the discussion to be about what the students thought. Eventually all the questions were answered. The way the museum made sure the students were willing to answer the questions and stay for the extra half-hour was by supplying them with soda and chips. There were no teachers involved in these discussions, it was purely student based. The discussions were very dynamic, and the two museum employees were struggling to write their notes as fast as the students were talking. Their discussions led to a few changes in the functionality of the PDAs.

Location tracking and logging hit counter data is possible with this system; however, the programming for this operation is not currently active. This would be valuable information to the museum for tracking the sites that are read and those that are not as popular. If the site logging operation were made active, there would be no need to inform the visitors of such activity, since it would only be able to tell which sites were visited and not exactly where the visitor goes during their time in the museum. Another feature of the system is a useful tool for students who need to extend their museum experience and bring information back into the classroom. At the end of their museum tour, students can give their e-mail address to the museum employee at the front desk to get a username and password. This information will allow the students to access a website online to review the exhibits they visited at the museum. The information will show the students the route they took through the museum, will display any information they downloaded to their PDA, and will remain available online for a few months after the initial museum visit.

Henrik also discussed the future improvements he hopes to make to the system. One of his ideas was to include a few Bluetooth headsets. Bluetooth headsets are wireless audio headphones, which, in this case, would receive a signal directly from the display unit. He stated that it would be perfect for school groups, as two or three headphones could be connected to one PDA. The students would all hear the same thing at the same time. He hopes that this modification will inspire the students to converse about what they have just heard.

Seeing the Naturhistorisk museum's system in operation gave a better understanding of how the general public reacts to the opportunity to use a portable

information display unit. While the technology used there is not the same technology as that being implemented at the Frilandsmuseet, the systems are comparable enough that the experience of Henrik Sell was invaluable.

5.4.4 Global Positioning System

The Global Positioning System, or GPS, is an array of satellites and ground control stations which work in concert with military and civilian receivers to provide precise position, time, and navigational information. The system is used by people and organizations around the world, and has become more and more common as receivers become more compact and affordable. Receivers are available from various sources in a variety of price ranges, ranging from a unit as small as a wristwatch to large military receivers mounted in equipment that requires a high degree of accuracy, e.g. a nuclear missile submarine.

The most widely known system of GPS is the NAVSTAR (NAVigation System with Timing And Ranging) system developed and operated by the United States Department of Defense, managed jointly by an interagency board but mostly under the auspices of the U.S. Air Force Space Command. The system consists of three segments, space, control, and user ("NAVSTAR").

The space part of the system consists of 24 operational satellites orbiting the Earth in six orbital planes at 60-degree angles (four satellites per orbit), inclined at 55 degrees from the Equator at a height of approximately 3730 meters. These satellites orbit once every 12 hours, coming to the same position at the same time each sidereal day, and thus by standard time each satellite appears four minutes earlier each day ("NAVSTAR"). The first of these satellites was launched in 1978, and the constellation was completed in

1994. The graphic shown at left depicts the general configuration of the orbiting satellite constellation. There are actually 52 satellites, but some have been decommissioned for various reasons. The first eleven, the Block I satellites, were the testing phase of the system, and those have been retired. More satellites have been launched as the older ones reach the end of their design service lives, approximately seven and a half years. The older satellites contain four atomic clocks, two rubidium and two cesium, and these are used selectively as their maintenance and accuracy conditions change. The newer Block II-R satellites have three rubidium clocks. All satellites are repositioned yearly to correct for any drift ("USNO").

The control part of the system includes five Monitor Stations in Hawaii, Kwajalein Atoll in the Pacific, Ascension Island in the Atlantic, Diego Garcia in the Persian Gulf, and Colorado Springs, Colorado. There are also three ground antennas at Ascension, Diego, and Kwajalein. The Master Control Station is located at Schriever Air Force Base at Colorado Springs. The control system maintains the position and timing of the satellites, synchronizing them to the master clock at the U.S. Naval Observatory in Maryland ("USNO").

The third part of the system is the user segment, the individual receivers used by military and civilians all over the world. Before May of 2000, civilian users could not receive the most accurate signals from the NAVSTAR satellites. For national security reasons, the civilian channel, the Standard Positioning Service, was deliberately made inaccurate (100 meters laterally, 156 meters in elevation). The Precise Positioning Service, which was available only to military users, was made available to all civilian users by President Clinton. This service is significantly more accurate (22 meters

laterally, 28 meters in elevation) ("USNO"). With the use of the Coast Guard's DGPS (Differential GPS) radio correction service, which is projected to be available everywhere in the U.S. by the end of 2005, the accuracy of the NAVSTAR GPS system is resolved down to one to three meters ("National DGPS").

Conceptually, the GPS system functions in the following manner. A GPS receiver acquires a line-of-sight signal from the NAVSTAR constellation. Using signals from four satellites, the system can triangulate the position horizontally and vertically of the user by precisely timing how long the signal takes to get to the receiver from the satellite. Theoretically, there should be at least six NAVSTAR satellites in sight of any position on the planet. Unfortunately, the system does not function if the receiver is indoors or is otherwise obscured from the view of the satellites ("Global Positioning System Overview").

5.5 *Interviews*

The team set up and conducted interviews with its liaison, the Euman Company, the National Cultural Heritage Agency, employees at other museums with technology based tour systems, and employees and some patrons of Frilandsmuseet. A few of the individuals interviewed were knowledgeable about the new system, but the team also set up interviews which targeted naïve subjects. These interviews provided information and a variety of opinions on the proposed implementation of the Life-Pilot system.

5.5.1 Project IT Manager and Team Liaison – Klaus Støttrup Jensen

Klaus Jensen, the IT project manager and the team's liaison at Frilandsmuseet, was interviewed prior to project work in Denmark. The

information acquired from Klaus prepared the team for what to expect at the museum and gave the team an initial direction for project work.

Klaus Støttrup, a consultant for all the museums in Denmark, has the primary project of overseeing the implementation of the Life-Pilot system for the Nordic Handscape project at Frilandsmuseet, as well as the nationwide application. Klaus detailed that the Denmark has the most advanced solution of all the countries involved in the Handscape program. Other countries are using "palm pilot" and text messaging based information services. Denmark looked to one of the more advanced Danish technology firms, Euman, to develop a system incorporating mobile cell phones, GPS locator devices, and centralized information servers.

At the time of the interview in early February, Klaus detailed the status of the system. The compilation of information was almost complete. The process of putting information into the system servers was in progress. Information about roughly fifty of the museum's outdoor exhibits was being uploaded in tables one at a time into the system. The museum expected to have a test-version ready in mid-March of 2005. In order to accelerate the implementation of the system, the information and displays on the phones will be presented only in Danish for the mock-up version. The system was not likely to be fully functional until beyond the team's stay in Denmark, but Klaus assured that several applications in the system would be working, and, therefore it would be possible to perform user tests. Full-scale user testing would not be a possibility, so consequently some aspects of the project ended up more theoretical. It is projected that the full-scale system will be implemented by mid-June.

The museum plans to have ten to twenty Life-Pilot units for use in trial testing with museum visitors. Even though the museum is closed in late autumn and during the winter, it handles approximately 150,000 visitors per year, which equals roughly 1,000 patrons per day. The museum visitor demographic consists mostly of school groups, but parents with children, as well as elderly individuals, also visit the museum on a regular basis. The museum will be offering this mobile phone tour service free of charge to the museum patrons, as the local telephone companies only charge 150 DKK (25 USD) per month. If the visitors have a Symbion 6 cell phone, they can use their own. However, even though roughly 450,000 of these phones are used in Denmark, the Life-Pilot application costs approximately 290 DKK (50 USD) to install into a phone, so it is unlikely that any patrons will select to use their personal phones for the testing phase of the system.

The GPS modules, which automatically trigger the Life-Pilot unit to receive specific site information, are projected to have an accuracy of about two to five meters. This accuracy limitation may create problems in highly concentrated exhibit areas. There will also be museum-specific applications for creating personalized tours and intelligent maps that the user can click to receive additional information. Information of more use to the museum staff and inspectors than the patrons includes geographical hit-counters for each cultural environment, including buildings and landscapes, and other hit-counters for accessed information about historical figures, exhibits, and events.

Additional elements of the Life-Pilot system are aimed at student groups for educational purposes. Students from ages of about twelve to sixteen spend anywhere from three to four hours touring the museum sites and learning about Danish cultural

history. The teachers integrate the visits with classroom studies, and the new Life-Pilot system will enhance this. During their tour around the museum, the students will be able to take pictures of the sites, as well as record messages into the phone. The system will be enabled with a feature allowing this data to be saved. Later, when the students return to the classroom, they can download their saved information from any computer with internet access. Klaus hopes that the information that the students receive from the mobile phones will help them answer questions and find specific themes that their teachers assign to them. For the trial testing, since there will only be about ten to twenty mobile phones, two students may have to share a device. Klaus suggested that it would not be feasible for more than two students to share a phone.

Since there is a need to collect input from the users of the Life-Pilot system, Klaus suggested several options. He said that the museum employees, responsible for assisting the patrons throughout the museum, would be able to provide information about the visitor population. Also, once the system is functional discussions with the museum patrons, both student groups and general visitors, will provide details about their experience with the system. He stressed that there may be a communication problem due to a language barrier, but indirect discussions with the teachers may be an option.

Outside of work at the museum, Klaus informed the team that an additional project was also currently in the planning stages involving the Danish Ministry of Culture and sites around Denmark of cultural history interest. The Ministry of Culture project is more oriented for tourists visiting the country with its information about 170,000 historical and industrial landmarks around Denmark

5.5.2 Euman - Jacob Fjellerad

Jacob Fjellerad is an employee of the Euman Company. Jacob is involved in the software programming and client information uploading. Euman provides of the Life-Pilot software that is installed on each mobile phone unit to be used in the Frilandsmuseet project, as well as the Ministry of Culture's Denmark sites project. Other simultaneous projects involving the Euman software include the Roskilde Viking Ship Museum and the tourist information applications for the Århus tourist organization. Both projects are also still in the planning stages.

The Life-Pilot software on the phones connects through a wireless network to a server owned by Euman, and then redirects connection to the museum specific information server. The company is able to log select data about a user's geographic location. The company could also monitor the services and data viewed by each user. Discussions and plans for tracing this information are currently underway between Euman officials.

When using the phone, users could mistakenly hit the red button on the right side of the phone. Doing so will cancel the loaded Life-Pilot software and return the user to the phone's local operating system. Prevention of this particular problem is unknown at the moment. Jacob explained that the phones could be programmed for a "data only" setting plan. This setup would not allow the user to make outgoing voice calls or SMS text messages. The museum would be interested in limiting the phones in this way, so as to allow the visitors to access only the information that can be downloaded from the servers.

When using the phone in tandem with the GPS unit, the phone must enable its Bluetooth transmitter/receiver. This has a slight negative affect on the phone battery life. The current phone is set up for a wired headset in case users cannot hear the speaker. There are no plans for using a Bluetooth headset. To expand the available platforms, Euman is currently experimenting with other PDA devices running the pocket PC operating system. Their plan is to have the software available on these devices within one year. However, no specific solutions for indoor GPS usage have been developed.

5.5.3 The National Cultural Heritage Agency - Claus Dam

Claus Dam is the senior advisor for the documentation department of The National Cultural Heritage Agency. He has been intensely involved in the Nordic Handscape project as it applies to Denmark, the Ministry of Culture, and Danish museums, including Frilandsmuseet. The Heritage department administers all the national database records, and has been responsible for the data model. Nokia, or another provider, will supply about one hundred cell phones at no cost to the Ministry. The software platform used is Euman's Life-Pilot on a Symbion 6 platform, a standard platform for cell phones in Europe.

Using some of their own data within the heritage department, the program has been developed for use of MMS text messaging with locating positions of protected buildings, called Gudhjem, and even using a location based service supplied by Euman for sites of actual excavation, called "Black Earth". The demonstration will be developed for the Ministry of Culture and will use a map interface. There will be an alert to mark the location of an important site, and a prompt for more information will be available.

The system currently being planned accesses data from two national databases. One is the database of ancient monuments, which has roughly 160,000-recorded sites. The other database is for commemorative monuments that have national importance. The records for this database have been uploaded to a website interface at http://www.monument.dk. The use of mapping software for this database requires a subscription for online publishing. The Life-Pilot software is required to present this information on the cell-phones. The last uploaded data set included the Danish museums, which lists daily hours, as well as the exhibition descriptions.

When the information is edited for display on the cell phones, there is a significant limit to what can be shown per exhibit. The information for the 160,000 ancient monument records cannot be edited for this purpose, so Euman will truncate the data in order to fit the allowed space. The information can later be updated or revised by individuals, such as Claus Dam, on a web-enabled interface. Each exhibit will have a limit of about two to thee screens of text. At the current time, there is not a variety of multimedia available for each exhibit. There are very few photos, although the museum applications may include photo files. Information regarding the museums is located at http://dmol.dk. The museum personnel will have access to update the museum specific exhibit displayed information, as well as access to filter unnecessary information about random archeological finds. The Viking Ship Museum has left all records unfiltered. This will allow for information to be displayed regarding any records within the area of the Viking Ship Museum. The records are filed under different types, so, for example, some records may show up on the cell-phone display as a "surface artifact," when the museum visitor walks over the location.

There is no visible horizon for the possibilities of this technology, but with the current developments, and observations on what could effectively be improved, the technology is certain to become more streamlined in the years to come. A future upgrade could consist of a condensed, pre-installed software program available from some if not all cell-phone service providers. One generic system for all cell-phone use will make software distribution economically feasible, whereas, currently, it is not possible to approach several different companies with the same software application. Companies would rather have a unique feature, instead of one that all the other companies have as well. Instead of having the cell phone and the GPS device existing as two completely separate units, one composite hardware unit including a cell-phone with an internal GPS mechanism would make the handling of the device less cumbersome. Another current limitation of the cell-phone system includes the size of the display screen. With a larger screen, more information, and other multimedia components could easily be displayed. As the system and the software become more widely known and incorporated into the programming of cell-phones, more individuals will have access to the applications and features the system offers when traveling to cultural sites or museums.

Museums are a natural setting for such a development in information distribution. If the GPS enabled systems could combine with indoor RFID, or similar alternative technology, any organization could feasibly incorporate an information dissemination system such as the Euman Life-Pilot software. However, there are limitations to the use of the cell-phone technology within a museum setting. Most notable among these limitations is the number of cell-phone units the museum has available for distribution to visitors. One museum in Iceland has developed a system for the National Gallery. This

museum was able to obtain thirty cell-phones from a provider. This number would sufficiently allow for school groups to use the system with each student having access to a cell-phone, instead of sharing between two or even three students, which presently compromises the learning experience.

The information uploaded for use at Frilandsmuseet is geared more for school children, since a significant population of the visitors is young groups of students. The target audience dictates the presentation of the information. Simple language, many visual aids, and interactive applications would capture the interest of the students more than plain, in-depth text. The use of the national records project is not geared for any particular audience and contains key information regarding the sites. The system would be very advantageous for professionals in the field, especially archeologists, to log when they have found a new site.

Overall, the system in use by Claus Dam and his organization is very impressive, but all agree that there is still much further to go before it becomes anything more than a professional tool. This system differs significantly from that proposed for the museum, but seeing the large extension of the system gave an indication of where and how this project would develop.

5.5.4 Frilandsmuseet Architect - Niels Erik Jensen

Niels Erik Jensen is the architect for Frilandsmuseet; his primary responsibilities are overseeing the care and upkeep of the buildings on the museum grounds. He ensures that the buildings are properly transported and preserved in their new location at the museum. The latest addition to the museum is a new development including historical

building and structures from the 1850's to the 1950's. Niels must find the houses, farms, and other historical buildings throughout Denmark, or what used to be Denmark, that fit this time period. The important aspect of the transitions is the placement and organization of the buildings within the museum. Niels makes certain that the buildings fit together as a whole to represent that period of history.

Niels Erik's involvement with the Nordic Handscape project began many years before the current project. Two similar endeavors never left the proposal phases. These previous projects were not very different from the current Nordic Handscape development, but those projects only included the aspect of just the Nationalmuseet. On the other hand, the new idea includes all of Denmark, creating a nationwide museum experience. The current project is following the same layout as the prior attempts with the added improvement that the data will be all encompassing for the country of Denmark.

Although affecting the timeline for the project, the delays and problems have not caused Niels Erik to waver in his plans. He has seen the whole undertaking as a process, which will change with time and move at different rates through each section of the development. Preparing the traditional vocal communication mobile system for a new function in multimedia information transfer requires the process to also encounter difficulties along that road to the final goal. Every project has a timeline, but as the development progresses after a few months time, the whole project may need to be shifted to another platform. Another view of the system is required before further development can take place. As always, funding becomes an serious roadblock in some instances. Since Euman is a private firm, they require that their expenses be covered. In

this case, although the Nordic Council funds them for this particular project, Euman took on more work than the funding can support. Niels Erik explained that each of the five countries (Denmark, Sweden, Norway, Finland, and Iceland) involved in the Nordic Handscape project received equal amounts of funding. No additional grants have been given to Denmark despite the fact that the Danish project has made the most progress.

In response to prompts about the visitor population, Niels Erik described the distinction among the different segments. There is a large gap between certain groups in the understanding of, as well as the need for, technology. The younger generations have grown up with every form of technology at their disposal, and they have come to depend on it, as well as having grown accustom to it, as a source of information. The older generations are exactly the opposite. The exceptions are present in each group, but on a whole, Niels Erik insists that the children are the ones who are and will be the most interested in the introduction of a modern age instrument into a traditional environment. They will be the ones who will immediately know how to use the devices and will want to use them as an information resource. The gap between the young generation and the old is, in Niels' opinion, far too great to reach them all simultaneously. It is today's youth who will see the next developments in technology as it expands and improves. He even described himself as someone who would not be interested in using the mobile phone system. He owns a phone for making phone calls and that is all the functions he performs on it. He did, however, explain that individuals who travel and explore the countryside would find the system useful and even come to rely on it to guide them across the landscape. Anyone who is interested in technology, regardless of age, will be attracted to this device as a source for information.

For the pilot-test segment of the project development, Niels Erik is extremely interested in the public opinion. He will want focus groups of all ages and interests to respond to the developed technology. The broad age groups will help define the specific user groups who will find the new gadget exciting, and those who will not want to bother. Students, children, and elder individuals will all have an opinion of the system, whether it is positive or negative. Niels Erik understands the considerable dedication required to carry out discussions and focus groups in order to get a significant response. The single problem he mentioned for non-Danish discussion proctors is the language barrier and the confusion this causes for the Danish population of museum visitors.

Niels has a simple vision for the final outcome for the project. He wishes to be able to supply up-to-the-minute exhibit information and daily changes to the museum visitors and the general public. He wants these devices to provide the stories of the exhibits. Museum patrons often approach him with questions regarding why the museum does not have a story for one exhibit or another. He explained that all the traditional methods such as signs around the museum, guidebooks, storytellers, tour guides can all do a job. This new facet of the museum, however, will constantly have new information, being updated overnight with additional records. The devices will not require training, a script, time to learn the new information, nor a reprint of static data. As soon as the data is uploaded, it will be instantly available through the mobile phone. This is Niels Erik's vision, a non-stationary source of data available to those visiting "his" museum. He believes that this presents the crucial issue for the overall success for using the system with the public community.

5.5.5 Frilandsmuseet Assistant Curator - Rikke Ruhe

Rikke Ruhe is one of the curators, as well as public relations specialist, for Frilandsmuseet. She supervises the museum's special collections, including research and acquisition. She also supervises and maintains the museum website. She is a member of several boards in the National Museum hierarchy, and deals with what she terms "collection politics", which is the management of the collections to suit the needs of all interested parties.

The Frilandsmuseet has been recently undergoing many changes with regards not only to the information system, but also major changes in policy and management. There is a plan now in consideration at the Ministry of Culture to make the Frilandsmuseet completely free of charge to visitors, which profoundly affects the logistics of the organization. According to Rikke, the major changes that would occur under this new policy would be that the local residents would increasingly visit the museum, and the museum would change from mainly a historical and educational venue to a park-like atmosphere where people walk their dogs. Unfortunately, this increase in traffic would probably necessitate additional grounds maintenance staff to ensure proper preservation and cleanliness of the museum grounds. If admission is free, the overhead for running the evolved museum would be endangered, and more private funding would be required.

Rikke Ruhe was involved in the process of instituting the Nordic Handscape project at the Frilandsmuseet from its inception, formulating some of the basic tenets of the project and, with colleagues, choosing the informational content of the system. According to Rikke, the basic concept of an electronic information distribution system is much older than the Nordic Handscape project, but previous projects involved electronic

guidebooks rather than the interactive, "intelligent" system being instituted currently. Due to lack of funding, the initial projects failed, and not until the current Nordic Handscape project was the idea reintroduced. Largely responsible for including Frilandsmuseet in the larger Denmark project was Klaus Støttrup Jensen, the overall project's IT manager.

One of the major problems for all personnel closely tied to the project's process has been the timetable, which has been extended and modified many times. Originally the system was to be fully in place by April of 2005, but at the time of this report (May 2005) the date for full implementation has been pushed back by months. The first functional Life-Pilot mobile phone and GPS unit arrived online on April 15th, and the information uploads from Euman to the servers did not occur until much later.

Another development at Frilandsmuseet is a system of signs at the entrances to each of the buildings to supply the visitors with some information regarding the houses, farms, and structures. Currently, there are no signs directly on the buildings or on the insides describing anything about the particular artifacts, the time period, or the architecture. There are only small, unobtrusive signs denoting a number for each building. The numbers, which are located on one side of the buildings, correspond to the ones in the tour guide and the museum. Other than the numbered signs, the museum contains only one test information sign, which is located near the center of the museum grounds in an area of high traffic flow. The new signs will be made of metal, and will be approximately two feet high and three feet wide. The plaques are brown with white and yellow text, and they are placed low to the ground, a good height for children. The information on the signs will include textual information regarding the original location,

how the building was constructed, the history of the original inhabitants, and the purposes of the type of building, whether it be for farming, housing livestock, or simply for housing a family. The content of each sign will be printed in Danish, white text, and English, yellow text. This ongoing project is funded by a private 1.6 million Danish DKK (275,800 USD) grant. All new projects at Frilandsmuseet are funded in this way, since government funding and the profit from entrance fee only allow the museum to subsist, but not to grow.

The curator's opinion on the mobile phone system was highly favorable. She specifically cited the multimedia capabilities and the promise of new teaching tools as highlights of the system. While she described herself as rather "old school" when it comes to touring museums, she postulated that if she were a teacher, she would be much more interested in using the system. She determined that the unit was well designed and simple to operate. One of the points touched on was preparation of the museum staff, especially the front desk staff, to answer questions about and to troubleshoot the mobile phone units. At this point the idea was raised to have a short technical manual available to the support personnel allowing the system to have maximum up time for visitors.

Acting in her Public Relations capacity, Rikke said that once the system is online the museum will advertise about it in print, as well as directly informing the local schools, about the new educational opportunity the system will offer.

5.5.6 Frilandsmuseet Employee - Boum Pyudiah

Boum Pyudiah is a living history specialist, event coordinator, mill expert, and statistician at Frilandsmuseet. His main job is to coordinate the special events at the museum that are designed to improve museum attendance. He organizes music, dance,

theatre, and other cultural events, which help to attract more visitors that might not come to the museum otherwise.

Boum presented the team with the museum's attendance statistics and how they were measured. The museum last year had an official attendance of 150,000 people from opening day a week before the Easter holiday and closing in October. Boum expected that attendance this year will top 170,000. Boum described these figures as conservative, for the reason that the computerized attendance counters at the entrances do not always count everyone entering. On one occasion, Boum manually hand-counted a day's traffic through the front gate, and thereby found an error of nearly four hundred more people compared to the gate counter figure.

Some experimentation with the entrance fees had been done in recent years. In 2003, the museum had completely free admission everyday for two months. In 2004, the admission was half-price for the entire fiscal year. In 2005, the museum budget allowed only free admission on Wednesdays. Boum described the situation, recounting that most of the visitors who came to the museum on discounted days were not aware that there was a discount until they were told directly by the admissions personnel. Since the reduced admission was not well advertised, it was not successful at drawing additional visitors, nor could its effect on attendance be measured.

Boum described that the average visitor spends roughly half a day looking at the exhibits and walking around the grounds. Many of the visitors, especially the locals, find the museum peaceful and relaxing, and generally spend even more time at the museum. Many of the residents living close to the museum enjoy the grounds more often because a

large number of them are "Friends of the Museum" and support the museum with yearly dues. This status allows them free admission to the museum at all times.

Boum, like others in his organization, was very concerned by the plans to make the museum free. For 2005, the museum received clearance to use the collected admission as additional capital to the government funding. Having the admission fee allowed the museum to achieve goals, do additional maintenance, and plan for future projects. Without that profit the museum will still be able to subsist, but will have a much more difficult time growing beyond it's current status or even improving what it already has to offer.

The team requested Boum, as a naïve witness of the proposed system, to evaluate aspects of the system that could be described or shown at the time of the interview. The team demonstrated the mobile phone unit abilities to Boum, and received a very favorable response in return. He had used audio tours before, but this was his first exposure to this type of information medium. He was eager to "brush off the museum dust" inherent in the traditional museum experience and employ new ways to interest the visitors, especially the young adult age group. The younger visitors, those from about ten years to eighteen years old, he believed, will be taken in by the system. He believed that this age group, with which he has extensive experience, will immediately take to the system and use it to its utmost capabilities. He also suggested that an addition could be made to the system for a children's scavenger hunt in which they would have to find the information on a subject by seeing a building or talking to the performing museum staff. His perceptions of the proposed system, on the whole, were very favorable.

5.5.7 Frilandsmuseet Main Entrance Employee - Berit Heine

Berit Heine is one of a few employees who work at the reception desk of Frilandsmuseet. She and her coworkers share the job of manning the two entrances of the museum. Every six days she is rotated to the other end of the museum where there is another visitor entrance to the museum grounds. Her primary responsibilities include selling admission tickets, selling gift shop items, and supplying visitors with answers to questions regarding the museum. The guidebook is also offered at the main desk for visitors to purchase.

Berit maintains that once the new signs are implemented around the museum grounds this will help to better inform the visitors about the facts regarding the museum buildings. Currently the main desk employees must know everything about the museum because the visitors approach them, as well as the many museum guards, for information. She believes also that a new technology-based form of information distribution, such as through the proposed Life-Pilot mobile phone system, would be advantageous for the museum to use. The best groups with which to approach to use the technology would be teachers and students, and possibly those who return for multiple visits. She explained that it would depend on the visitor, the user's age, and the inclination for that person to want to use the technology. Older individuals, according to Berit, would not be as interested in using the technology because it may be too difficult for them to operate or read. She expressed that people with young children would be not be interested in the system unless the children were old enough to understand the information the parents or caretaker would be delivering to them from the mobile phone. Most likely the children would not be interested, and it would be too much for the adults to both pay attention to

the mobile phone and look after the children at the same time. She predicts school-aged children would be the most interested in using the devices to explore the museum.

Berit has herself used an audio tour designed for a museum in France. She greatly enjoyed the tour and felt it improved her enjoyment and appreciation of the museum. In regards to Frilandsmuseet, she believes the information system would be great for tourists, especially if it was able to offer the textual and audio information in the tourist's native language. Since many visitors to Frilandsmuseet are of French or Italian origin, a system with multi-language capabilities would present the best options for these individuals since there are presently no guidebooks or guided tours available in French or Italian.

Berit, who had only minimally been informed of the broad functions for the proposed Life-Pilot technology system, will eventually have a larger role in the whole process. Once the system has been fully upgraded, established and implemented within the museum daily routines, she and the others working at the entrances to the museum will need to handle the distribution and collection of the mobile phones and GPS units. It will also be necessary for her to either hand out instructions for use, or inform the visitors verbally. Should there be any technical difficulties; the visitors may approach the employees at the entrances, in which case a trouble-shooting manual should be available to the museum staff in order to supply the visitors with the necessary assistance. Berit maintained that having a manual at the desk would be advantageous, but if the visitors were also supplied with instructions for use and a tutorial for problem solving any difficulties, this would be a better solution.

Overall, Berit seemed positive about including the new technology into the museum and deemed it a very good idea for students and for keeping the visitors informed when they are out in the museum grounds. Her only serious objection was the possibility of theft and damage to the hardware. She agreed that a system involving a deposit would be a good solution. She also insisted that if someone were to ask her a question about the museum, she would rather talk with the visitor than just hand out the Life-Pilot device. Her attitude toward the device is that it may be a little too much to deal with when a simple conversation with a visitor would be more than satisfactory.

5.5.8 Frilandsmuseet Entertainment Staff

Around the museum grounds there are displays of culture, historical techniques, and entertainment. With the bicentennial birthday of H.C. Andersen this year, his life and works have been incorporated into several aspects of the museum. One particular display involved an employee of the museum dressed in a costume from an H.C. Andersen fairytale. The show, acted out in a small, outdoor "stage," targeted small children. This particular show was entirely in Danish. Following the display, the sole actress of the performance supplied details regarding her role within the museum as well as her opinions of the proposed new technology system.

She began with explaining that she was a hired actress, and had no other connections or roles within the museum itself. The show that she was performing was solely in Danish, but she informed the team that during the summer months there are shows in other languages, as well as shows comprised only of mimed actions, so everyone could enjoy them.

When asked about her appreciation for the museum and how technology may affect it, she replied that she found the museum itself to be extremely peaceful and quiet. It was a place anyone could go to relax and enjoy the outdoors. She suggested that most people go to the museum, not to learn about the exhibited buildings, but to get away from the city and appreciate the rural environment of the museum.

She has used audio tour devices at other museums and agreed that they increased her appreciation for the museum exhibits, but she insisted that she would not be interested in using any tour technology at this museum. As for the new Life-Pilot system, she has been informed of the broad capabilities of the system as they are to function at the museum. She also heard a piece on a public radio station about the Life-Pilot system and its proposed implementation for use around Denmark. The radio program described the technology as a system that would allow a person to be walking the Danish countryside and would notify the user when an object or site of interest was nearby. Instantaneous information given to the user through the medium of the mobile phone would depict the history or story of the tagged location. The actress quite liked this idea.

Although the new technology would not affect her particular role within the museum, she also knew that it would not compete with her performances for visitor attention. She was not sure who exactly might be interested in using such devices at the museum, and concluded that it depends highly on the age of the individual and the reason he is visiting the museum. She decided that children may be interested in using it, but may be easily distracted if the information or activities available on the device are not engaging enough. Families with very small children would not be interested in using the

devices because the children would not be interested in the information and the parents would be too busy watching their kids.

Her concluding thoughts involved her suspicion that the devices may be broken easily. Especially in the hands of small children, the mobile phones are not tough enough to withstand rough treatment. Overall, she believes it would be a good addition to the museum since it introduces an exciting and engaging new medium with which to explore the museum. She averred that it was very much better than the printed guidebook, which she found dull and unappealing to read while walking the museum grounds.

5.5.9 Museum Visitors

Introducing a new concept to people without having something concrete or solid to back descriptions and explanations produces uncertainties, uninformed opinions, and possible misunderstandings. Visitors to Frilandsmuseet are no different. A middle-aged man and woman approached during their time at the museum prompted some alterations to the intended plan of action for the interview. The visitors invited questioning because they were stationary sitting on a bench, and had no children with them.

The couple, whose names were not obtained, seemed to be of middle age between about 45-55 years old. They are local residents, living not more than five miles away, who frequent the museum often, once or twice a week. They are both Friends of Frilandsmuseet, which gets them into the museum for free. The main reason they return to the museum so often is to simply enjoy the area and relax in the peaceful environment. At the time that they were approached, they were sitting on a bench just outside of a 1700s cottage-style family house and enjoying the beautiful weather.

When asked if they wished to learn about the exhibited buildings around the museum, the gentleman responded that he had purchased the Danish text guidebook from the gift-shop. He stated that he enjoyed using the guidebook, and also that it was helpful for acquiring information and was easy to use. He also maintained that the map in the back of the guide provided adequate information about the layout of the grounds and that he could easily locate himself on the printed map.

When provided with details and an example of what the new Life-Pilot system would offer, two different responses were returned. The woman seemed highly in favor of the device and expressed eager interest in using such a device for touring the museum. The man, however, seemed indifferent to the technology, and said that although he would be comfortable using the mobile phone and GPS unit, he would not wish to use it once it is in full working order at the museum. The woman explained that a device like that would be very helpful for getting the most out of the museum. Even if a visitor purchases a guidebook, important sites could be overlooked or the visitor could miss information signs entirely if they are not directly pointed out. The Life-Pilot software would be able to tell a visitor where a site is and if he is approaching a site of interest. It would be easier to use than the guidebook and could also include other aspects of the museum not printed in the guidebook. Sites throughout the museum unknown as exhibits would be defined to the visitor simply by being bringing the Life-Pilot enabled phone within range of an exhibit.

5.6 Survey Implementation

Due to the delayed progress of the technology implementation within the museum, user tests of the system, at the time of the team's project, was not an option.

Without available functioning technology, visitor questioning became a difficult task for the team. Questions too specific to the technology could not be answered, and questions too vague about a theoretical concept would leave the visitors confused and without a detailed understanding of the proposed system. The visitor population segments also posed a problem with communication. The youngest visitors were not interested and did not have the attention for discussing something they could not see, and the same happened with individuals who are not interested in technology, mainly the older adult population group. Individuals overseeing small children also did not have the time to listen to an American student explain a new type of technology and then fill out a survey. Many visitors regardless of age became confused as to why an English speaking, non-Danish student was speaking to them about a proposed system for a Danish location. The remaining populations of museum visitors included students of the ages of ten to fifteen and middle-aged adults without children.

The team developed a survey based on an original proposed questionnaire for individuals who had not yet visited the museum or experienced the new system. The questionnaire was originally planned for usage on a webpage to attract visitors to the museum and to use the new system. The survey presented the system as a theoretical concept, and requested responses on how the visitor would feel about using such a system. The team needed to obtain responses from visitors regarding general interest and purpose for the new system.

Once the team established the purpose of communication with the visitors, general questionnaires were posed to a select population of the museum. Every questionnaire was prefaced with a description of the Life-Pilot system and an explanation

of the purpose of the survey. After a general introduction to the system was described, the individual was asked if the system prompted any interest for the possibility of a future touring option. Regardless of a positive or a negative response, the team requested that a brief survey be filled out.

Survey data was then entered into an access databank and sorted by age and whether or not the responses were positive or negative towards using the technology. The results were represented graphically and although not conclusive about the actual percentages of each subgroup interested in the technology, did reveal that there was, in fact, interest in the proposed technology. The number of those surveyed who gave a positive reflection on the described theoretical system greatly outweighed those who thought negatively of it.

5.6.1 Visitor Questionnaire English Version

Is this your first time at Frilandsmuseet? Yes / No

If yes: How did you learn about the museum?
What was your primary purpose for coming to the museum?

If no: How often do you visit?
Are you a 'Friend of the Museum'? Yes / No
Is there a specific reason you returned?

Have you purchase a guidebook from the gift shop? Yes / No

If yes, what is you opinion of the guidebook?

Do you own a mobile phone for business or personal use? Yes / No
If yes, what type of phone is it?

If no, have you previously used a mobile phone? Yes / No

What is your preferred method for touring a museum?
Self-guided with museum map/guidebook
Personal Tour Guide
Group Tour
Audio-tour
Other: _____

Would you be interested in touring a museum using a mobile phone enabled with GPS technology? Yes / No

Do you think that a device such as a mobile phone enabled with GPS and linked to a large information server could supplement and enhance your current experience here? Yes / No

When the system is ready, would you be interested in testing the Life-Pilot mobile phone information system at Frilandsmuseet? Yes / No

Do you have any additional comments or concerns regarding this new technology?

[Age : Under 10 10-15 16-25 26-40 41-64 65+]

5.6.2 Visitor Questionnaire Danish Version

Er dette Deres første besøg på Frilandsmuseet? Ja ___ Nej___

Hvis ja: Hvordan har De hørt om museet?
Hvad på museet har Deres største interesse?

Hvis nej: Hvor ofte kommer De på museet?
Er De medlem af Frilandsmuseets venner? Ja ___ Nej___
Er der en særlig årsag til, at De kommer?

Har De købt en guide-bog i informationens butik? Ja ___ Nej___

Hvis ja, hvad synes De om den?

Ejer De en mobiltelefon – enten privat eller via Deres arbejde? Ja ___ Nej___

Hvis ja, hvilken type?
Hvis nej: Kan De benytte en mobiltelefon?

Hvordan kan De bedst lide at færdes på et museum?
Gå på egen hånd evt. med en guidebog
Med en omviser i en mindre, privat gruppe
I offentlig omvisning – altså i en større gruppe
Audio-tur (med et head-set og en walkman)
Andet:_____

Er De interesseret i at få informationer om museets seværdigheder via en mobiltelefon opkoblet til GPS teknologien? Ja ___ Nej___

Tror De, at en sådan GPS-telefon – koblet til en server med en meget omfattende informations-mængdre – kunne være et godt supplement og forbedre Deres museums-oplevelse? Ja ___ Nej___

Har De lyst til at teste "Life-Pilot" som er sådan et informations-system her på Frilandsmuseet, når systemet er færdigudviklet? Ja ___ Nej___

Har De yderligere kommentarer til en sådan ny teknologi?

[Alder : Under 10 10-15 16-25 26-40 41-64 65+]

5.7 *Describing the System*

In order to hold the interest and attention of the visitors the personnel responsible for the surveys and focus groups should follow the below listed suggestions:

- Keep the explanations short and rid of technical details
- Explain what the product will be able to do, not how the product works
- Elaborate on technical aspects only if the information is requested
- Present the system in layman's terms, avoiding unfamiliar acronyms
- Compare the product with familiar objects, such as regular mobile phones

5.7.1 Example System Explanation

The Life-Pilot program is a new addition to the repertoire of available visitor services at Frilandsmuseet. The service, which will remain free for use to all visitors of the museum and will enable the visitors to access a wide breadth of information and data regarding the museum exhibits and events. The information will be presented on the mobile phone display screen in several forms of multimedia, including text, audio, and video. Upon an encounter with an exhibit on the museum grounds, these sources of information specific for that site will be automatically available on the phone. Additional features of the system include a built-in camera and recording microphone. The visitors have the option of using such features and saving the picture and sound captures to an internet website, which will be available even after leaving the museum grounds. Also available on the phone are a wide variety of maps that will track one's position with the aid of satellite communication. Individuals within a large group can also utilize a

tracking feature for locating others within the group. The primary feature of the Life-Pilot program is to provide a supplement of information to the visitors as the museum is explored.

5.7.2 Additional Technical Information

If requested by the visitors, the technical topics described below may be added to the initial system explanation.

- GPS connection - a connection with satellites which provides the user with information about his location on the earth to within a few meters.
- Bluetooth technology - a wireless communications technology that allows a device to be located within ten feet of a receiver and communicate with another Bluetooth enabled device.
- Central information servers - the central computer that Euman controls provide the data storage for all of the site information.
- Data downloading process - when the user selects an item in the phone service, it must download data from the central servers. This process is accomplished via Global packet radio service (GPRS) (Appendix D5).
- Expansion of the system to include the entirety of Denmark - a system for Life-Pilot users to be able to use their phone to view content about historical, cultural and archeological sites all throughout the country.

5.7.3 System Functionality Requirements

Before visitors are allowed to use the system, the following requirements must be explained and subsequently observed or performed by the visitors.

- The mobile phone and GPS receiver must both be turned on.
- The two devices need to be within one or two meter range of each other.
- The center LED light must be blinking to indicate a strong satellite connection.
- Life-Pilot software must be accessed and the required service must be activated.
- The GPS receiver must be positioned horizontally (GPS logo up-wards).
- Nothing should obstruct the GPS unit's direct view of the sky.
    - It cannot be placed in a pocket or held within a closed hand.
    - The strap or clip should be utilized with the device positioned near the visitor's shoulder.
    - The system will not work if the GPS satellite connection is obstructed.

5.8 *Operational instructions*

Several options can be utilized in communicating to the visitors the details about the system operational protocol. Depending on the experience the visitors have with similar technology, the time and depth of explanation will vary. It may be necessary to have a few sources available to the visitors.

5.8.1 Possible Sources

The reference materials for displaying the operation instructions for the Life-Pilot system include the following: individual user manuals for each visitor using the system, posted sign with textual and/or diagram-based instructions near the mobile phone distribution station, verbal instructions from an employee knowledgeable about the workings of the system, a short video presentation describing and showing how to

operate the devices, or an additional user instruction guide application programmed directly into the phone for users to access on their own.

Each of these methods will require varying amounts of preparation, costs, and time. There should be at least two sources of instruction available to the visitors using the Life-Pilot system. The suggested sources of instruction include a posted sign with text and diagrams near the system distribution site and an individual who is knowledgeable about the system to clarify for those visitors who are confused. The individual could be one of the employees manning the front desk or a person with the sole responsibility of overseeing the distribution, instruction, and collection of the system. Regardless of the method chosen for instructing the visitors, a detailed user's manual with troubleshooting guide should be available at the system distribution station as a reference to the employee responsible for the handling of the system devices.

5.9 Distribution and Collection

The process of distributing and collecting the mobile phone should be simple and quick. The employees responsible for introducing the devices to the visitors should be well informed and knowledgeable regarding all aspects of the functionality of the system. Preparing the visitors should be a simple task and not a hindrance or burden to the visitors or the employees. The visitors should be able to obtain the system and enter the museum grounds with minimal delay due to the process of obtaining the system.

Frilandsmuseet has a unique layout. In addition to including roughly one hundred twenty acres of land, there are also two main entrances to the museum grounds. Since visitors have the option of entering and exiting through either gate, it will be necessary to eventually have phone stations at both locations. The major requirement for the staff at

the gates is that they be capable of explaining the visitors how the phones function and how to navigate the applications. An additional necessity for the employees is a user manual or troubleshooting guide for rectifying any possible difficulties that the visitors may encounter with the system. The manual, which will be supplied from Euman, should be located at both phone stations and, if an appropriate size for carrying, supplied to the visitor with the devices in case of any difficulty while they are out in the expansive grounds of the museum.

The main entrance to the museum requires visitors to walk into the main building and through the gift shop where the admission tickets, museum maps, and guidebooks are available. The entrance usually has at least two employees working at any one time. Behind the main desk there is ample space for a supply of phones and chargers. However, the alternate entrance to the museum, near Brede Værks, is only a small booth large enough for one staff member to sit and collect the entrance fee. There is an electricity supply to the booth, so the phones and chargers could be kept in the booth. However, there may be a shortage of space in which to store the devices.

Each available unit should be designated with a number not only for inventory purposes, but also to increase the efficiency for noting the return of the devices and placing them into the correct battery charging stations. The stations for returning the units should be the same as the distribution stations. Prior to exiting the museum grounds the visitors can simply revisit to the same location where they received the devices. When it becomes an available option, the visitors should be informed that each entrance to the museum has a Life-Pilot station, and they can return the borrowed system devices at either location.

Once the system is in full operation, if the museum wanted to offer the system to all visitors, it would be necessary to supply the phones at both entrances. In this case, a charging station will be required at both locations to ensure the phones and GPS modules are ready whenever the visitors request to use the system. For the purposes of the pilot-testing phase of the project, only a phone supply at the main entrance will be necessary, since the bulk of the visitor population enters the museum through the gift shop entrance. Visitors at the alternate entrance interested in the system will be redirected to the main entrance. This will be necessary only during the testing phase of the project while there is a limited supply of phones and while the museum still desires feedback. During this phase, the phones should be distributed from one location only; to ensure the visitors return the phones and provide feedback via questionnaires or focus group participation.

During the testing phase of the project, the museum should not require a monetary deposit to use the service. The visitor should supply a form of collateral, such as a credit card or a driver's license, only to ensure that the devices are returned to the museum. Once the system has been fully implemented and phones are available at both entrances, the users should be able to place a monetary deposit, take out a phone for use, and receive the deposit back upon return of the phone unit to either entrance. A deposit should be required for use of the system by general museum visitors. In the case of school groups, a deposit will not be required from the students since the teachers responsible for the group will ensure all devices will be returned. The deposit will not be a fee for using the system, but rather as collateral for the unit's proper return. Since the museum wants to ensure that the Life-Pilot system will be a free service to its visitors, the museum must

clearly advertise and state that the deposit will be returned to the system users upon return of the devices.

5.10 Marketing

In the main entrance, a sign should be either placed on the counter or hung from the ceiling indicating that this free service is available. This will inform naïve visitors that such a system is available for use. Especially during the pilot testing phase, the advertising should also indicate that people who are willing to answer a short questionnaire following their museum visit will be rewarded. The reward could include anything from a free small item from the museum gift shop or entry into a raffle for one larger prize. After the patrons have completed a questionnaire, they will have the option of entering their names into a raffle for a prize, such as an iPod, a free phone and Life-Pilot software, a gift certificate for a dinner, or a free ticket for one of the other Danish National Museums. This reward will entice people to test the system and provide the museum with a source of user information and feedback on the quality of the system.

Additionally, advertising could be accomplished through the local school systems. If a school is informed that the devices are available, the teachers may integrate a larger unit on the museum and Danish culture within the curriculum. School groups will provide an good source of feedback to the museum since the students can be required to use the devices and to give feedback about the system. The student groups will also be an excellent source for focus group subjects given that the teachers and the school encourage the students to participate in the discussions.

5.11 User Feedback

The object of the user testing will be to obtain feedback and information regarding the functionality of the device within the confines of Frilandsmuseet. Although the system will be scaled up for use throughout the entire country of Denmark, it is necessary to monitor and test the system in a controlled environment in order to receive feedback from the user groups.

5.11.1 Waiver Release Form

Prior to using the Life-Pilot system, the visitors will be required to sign a release form. This waiver will ensure that the visitors understand that information about their usage of the system, as well as their whereabouts in the museum, will be collected and analyzed.

5.11.2 Tracking Information

The users will have the phones for an extended period of time as they tour the museum. During this time they will be able to access all available applications on the Life-Pilot system through the Nokia mobile phone. They should be allowed to go anywhere on the museum grounds. If the phone and GPS units are fully charged, the battery life for each device should allow for three to four hours of continuous usage. The information, which would be worth noting for statistical purposes, would include which applications were accessed during the tour, which sites throughout the museum were visited, and how much time the visitors actively spent on the phone.

5.11.3 On-Phone Survey

During the tour and usage of the system, it would be advantageous to include a separate program allowing the user to supply feedback to the overall system. This format would allow the users to complete the survey at their own pace. The questions must be presented in multiple-choice formats and no written responses required due to the difficulty of typing on the phone keypad. Once completed, the responses will be uploaded from the phone to the server, and compiled with all other responses from other users. The benefits of this method will include no need for paperwork, no need for data entry, and automatic information cataloguing. This software, if not already available, will need to be written and programmed into the phone.

5.11.4 Paper & Pencil Questionnaires

Questionnaires can be administered to the patrons on-site directly following their museum tour, or in the case of student groups, several copies will be offered for the teachers to administer to the students upon return to the classroom. This off-site method will be especially helpful in obtaining information regarding the proposed Internet link where the students can upload and save data from their Life-Pilot devices for later retrieval. The project group will request that these questionnaires provided to the teachers be returned within a specified amount of time. To ensure a quick response time, large museum-addressed, stamped envelopes will be included with the questionnaires.

The paper survey will include both multiple choice and free response questions. The survey should be used as a prompt to promote active thinking about the program applications, and elicit detailed opinions from the users. This survey method, although allowing for the greatest amount of detail, will require time to enter the data onto a

computer for analysis. Whereas this method may not require as much preliminary preparation and costs, it will be a matter of time consuming data compilation and manually comparing responses.

Initial questions should obtain demographic information about the visitors including age, gender, occupation, and level of education. The questions will attempt to ascertain the visitors' overall feeling about the system, what they liked about the system, how the system improved their museum experience, and whether or not the system had any problems. Although the survey-takers will be provided the opportunity to give a brief qualitative response, the survey will require mainly quantitative evaluation and will include closed-ended questions. Based on a set scale, visitors will be asked to rate their comfort level using the system, ease of use, system reliability and accuracy, and their overall impression of the system's informational content. (Appendix G4)

5.11.5 Computer-based Survey

A computer or kiosk station can be placed on-site where the Life-Pilot devices are returned to the museum, and the team can request that the visitors take a few minutes to fill out the questionnaire electronically. The same questions could be presented to the visitors as the paper version. This method would allow for automatic data compilation and facilitate analysis. Using a computer would remove the need for paper and data entry.

5.11.6 Reward

Upon completion of the survey, the users would be rewarded for having aided the project and presented their opinions and, also, will have the opportunity to enter a raffle.

Since it will be used in advertising and promotion of the system, it is expected that the reward will entice the visitors to participate in the pilot tests and give feedback regarding the system.

5.11.7 Focus Group

Before touring the museum with the mobile phone unit, the visitors will be informed of the opportunity to participate in the survey and focus group discussion sessions following their museum tour. Informing visitors initially will allow them time to decide whether they want to participate, and possibly pay more attention to the functions and capabilities of the system in order to come to a well-educated opinion.

All visitors who use the system will be asked to participate in focus groups after they complete the initial user survey. In order to entice participation and keep the group members focused, rewards in the form of drinks and food should be available. These focus group discussions will be set up by user segment separating the visitor population into three subgroups: students, families, and adults without children. The students of greatest interest to the pilot testing will be between the ages of eleven and fifteen. The time allotment for each discussion session should be no more than one half-hour. Every focus group should consist of no more than five or six individuals, and there should be a comfortable environment to encourage conversation.

The mediator will be needed to keep the focus group members on topics revolving around the visitors' experience with the Life-Pilot system. The issues of greatest importance to the product evaluator will be to expand on the ideas presented in the questionnaires. These concepts include issues about the usability, convenience, information quality and quantity, and the performance of all the multimedia including the

text, sounds, and videos. The visitors will be prompted to discuss how they used the phone to enhance their experience at the museum and also which applications within the software were the most useful and engaging. (Appendix G5)

Through the discussions, additional issues can be brought up which were not present on the questionnaires. A major interest to the project managers and the programmers at the technology provider will be any technical difficulties caused by defects in the software. If the users can pinpoint how the device falters in function, this could aid in repairing the application problem.

The foremost benefit desired as an outcome of the focus groups will be whether or not the devices interested the users enough that they would be interested in using the system outside the confines of the museum. The primary goal of the project is to create a museum that encompasses the whole of Denmark. If project personnel informed the users of this up-scaled application of the technology, it would be worth noting if this function further piqued the interest of those museum visitors who enjoy traveling.

5.12 Pilot Testing Cost & Benefit Analysis

Pilot testing of the Life-Pilot system will create another cost in the museum budget. The money spent on the testing must be recouped in order to make the project successful. The team has compiled a simple cost analysis to show what is needed to withstand the costs of the system testing.

5.12.1 Assumptions and Costing

To do a valid analysis, assumptions must be determined regarding the data. This analysis is only possible under the assumption that the museum admission remains intact.

It would be impossible to balance the costs of the pilot-testing program without a steady income from the admission fee paid by visitors.

The one-time cost will include the expenses for an initial set of fifteen phones for use in museum pilot tests. Each phone with a GPS unit costs about 2500 DKK (430 USD) and the Life-Pilot application software package for each phone is 300 DKK (52 USD). The preliminary costs the museum must make the initial investment to run a pilot test with fifteen phones will equal 42,000 DKK (7,240 USD). Since this value is assumed as a one-time cost, it cannot be factored into the monthly expenses and will not appear in any of the following analysis.

The monthly expenses of the pilot testing focus groups will be the values examined for the final analysis. The wage cost for an hour of an employee labor is assumed at 100 DKK (17.25 USD). Refreshments for the users will cost about 50 DKK (8.60 USD) per session. The visitors will be volunteering their time, so this is not a noteworthy cost. Each pilot test conducted will, in turn, cost 150 DKK (25.85 USD). If one assumes that the museum completes six of these pilot test focus groups in one month, the total cost for the pilot testing becomes 900 DKK (155 USD) per month. The cost of the Life-Pilot server and phone service is 6500 DKK (1,120 USD) per month. This totals to about 7300 DKK (1,260 USD) per month in operating expense.

The revenue acquired by the museum is solely from the admission fee paid by the visitors at the entrance to the museum. Government funds do not allow for expenses beyond employee salaries, museum grounds upkeep, and minimal museum maintenance. The museum admission fee at the time of this project was set at 50 DKK (8.60 USD) per adult visitor and 40 DKK (6.90 USD) for pensioners, students, and individuals in groups

of at least ten people. Children under sixteen years old enjoy the museum free of charge. Every visitor is granted gratis admittance on Wednesdays.

5.12.2 Expenses and Revenue

The numerical analysis in Table 2 is a representation of the approximate monthly Life-Pilot expenses and visitor revenue per month.

	# People	Admission	Revenue	1% increase	2% increase	5% increase
Adults	3787	kr 50.00	kr 189,350.00	kr 191,243.50	kr 193,137.00	kr 198,817.50
Students	245	kr 40.00	kr 9,800.00	kr 9,898.00	kr 9,996.00	kr 10,290.00
Groups (10+)	34	kr 40.00	kr 1,360.00	kr 1,373.60	kr 1,387.20	kr 1,428.00
Pensioners	777	kr 40.00	kr 31,080.00	kr 31,390.80	kr 31,701.60	kr 32,634.00
Under 16	5205	kr 0.00	kr 0.00	kr 0.00	kr 0.00	kr 0.00
Guest of club m	2920	kr 0.00	kr 0.00	kr 0.00	kr 0.00	kr 0.00
Free	1564	kr 0.00	kr 0.00	kr 0.00	kr 0.00	kr 0.00
Museum club/F	670	kr 0.00	kr 0.00	kr 0.00	kr 0.00	kr 0.00
Self-teaching -a	123	kr 0.00	kr 0.00	kr 0.00	kr 0.00	kr 0.00
- Children	5205	kr 0.00	kr 0.00	kr 0.00	kr 0.00	kr 0.00
- Kinderg.	321	kr 0.00	kr 0.00	kr 0.00	kr 0.00	kr 0.00
- Middle sc	46	kr 0.00	kr 0.00	kr 0.00	kr 0.00	kr 0.00
- School	91	kr 0.00	kr 0.00	kr 0.00	kr 0.00	kr 0.00
Summer Camp	15	kr 263.33	kr 3,950.00	kr 3,989.50	kr 4,029.00	kr 4,147.50
		Total	kr 235,540.00	kr 237,895.40	kr 240,250.80	kr 247,317.00

One Time Costs

	Quantity	Price	Total
Phones	15	kr 2,500.00	kr 37,500.00
Software	15	kr 300.00	kr 4,500.00
		Total	kr 42,000.00

Monthly Costs

	Quantity	Price	Total
Server	1	kr 4,166.67	kr 4,166.67
Phone Service	15	kr 150.00	kr 2,250.00
Pilot Test Cost	6	kr 150.00	kr 900.00
		Total	kr 7,316.67

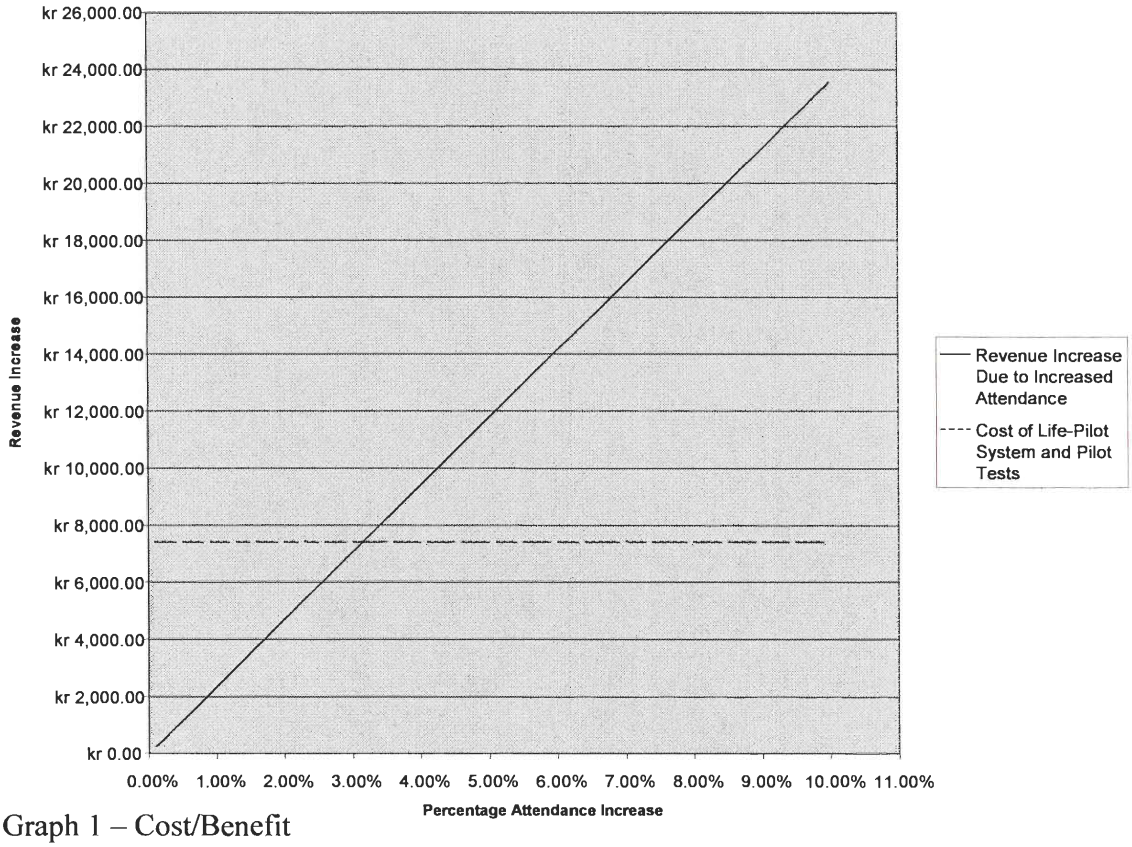
Overall Profits (Monthly)

	Regular	1% increase	2% increase	5% increase
Income	kr 235,540.00	kr 237,895.40	kr 240,250.80	kr 247,317.00
Increase	kr 0.00	kr 2,355.40	kr 4,710.80	kr 11,777.00
System Cost	kr 7,316.67	kr 7,316.67	kr 7,316.67	kr 7,316.67
Net	-kr 7,316.67	-kr 4,961.27	-kr 2,605.87	kr 4,460.33

Table 2. Attendance, revenue, and expenses for one month

5.12.3 Benefits

The benefit of the user pilot testing is mainly in the increase in attendance. If the users who pilot test the system enjoy using it, and spread word about the system, attendance may increase. The graph representation below presents a simple percentage increase of attendance. The horizontal line shows the fixed cost of the system on a monthly basis. The sloped line represents the change in revenue due to a given percentage increase in attendance. According to this graphical analysis in Graph 1, if museum attendance increases by about three percent, costs and revenue will break even on the investment of the monthly system testing costs, that is, the break-even point is a three percent increase in attendance.



Graph 1 – Cost/Benefit

5.13 System Advantages and Disadvantages

There will be numerous advantages to the system, but disadvantages will also be present with the implementation of the system within the environment of the museum.

5.13.1 Advantages

- Eliminates necessity for large signs which detract from the natural setting
- Gives visitors information not easily obtained by questioning museum personnel/guides – audiovisuals
- Allows museum personnel/guides to have more time to field questions which cannot be answered by system
- Helps museum performers stay in character, since questions regarding modern times can be answered by system instead of performers
- Allows visitor to make their own way around museum and see what they want to see unhindered by guides/tours
- Reduces congestion at sites by having many questions answered at once by system instead of one at a time by museum performers/guides
- Reduces chance of visitors becoming lost on grounds
- Keeps attention of younger visitors who might be bored by normal tours
- System can keep record of site statistics – popularity
- Museum personnel can also use system for their own reference
- "Saving" features of system allow visitors to relive museum experience at home

5.13.2 Disadvantages

- System is discordant with museum environment – modern equipment does not belong in historic environment – anachronistic
- Some visitors, esp. younger, attracted to system as video game instead of informational tool – will not get pure experience
- Increases operating overhead of museum
- Museum personnel esp. performers will be ignored while visitors look at system
- Requires adaptation of personnel to new information – better informed visitors will ask different questions
- Visitors will attempt to ask performers about system – difficult to maintain character
- New issues such as theft and damages to system components will stress IT services – may require onsite tech assistance
- System elements may periodically fail, causing disappointment of visitors
- System may be too complicated or new for comfort of some visitors
- Display interface may have visibility problems esp. in direct sun
- Visitors may be disturbed by "Big Brother" element of GPS tracking

5.14 Nationwide Extendibility

The Life-Pilot software is being used at Frilandsmuseet as a pilot project for a nationwide application where a user will be able to use the entire country of Denmark as a one museum without boundaries. Individuals who own cell phones installed with the Life-Pilot software will be able to view historic and cultural sites all over the country as they travel. The sites will be displayed on the phone screen as they are approached. If the phone user is interested and wants access to more information, the site can be selected and additional data will be downloaded to the phone.

The nationwide program will be costly, so possible additional funding could come from many different sources. The users could be required to pay per "hit" on a site. In other words, if a site were selected that the user wants to see more information about, he would have to pay a small fee to view that information. The fee would represent the convenience charge for receiving the information immediately.

A second way this project could be funded is if the users paid a monthly or yearly service fee for "unlimited" site views. If they paid a monthly fee, the users could view as many sites as they want during that particular month. Some users might like the freedom of being able to view as many sites as they wish without worrying about paying extra each time they access information.

Another way this could be funded is allowing users to pre-pay for their site views. A user could pay for one hundred views and when that limit is breached, any additional accessed information would be at an extra charge. This is how most wireless telephone companies in the United States charge their customers, on both cell phone minute usage and text messaging plans.

The GPS information system via mobile phone interface is infinitely extendable. The same software that is used to deliver information about historic sites could be used to distribute up-to-date information about news, events, and other impending situations. For example, traffic information, along with railway and bus conditions, could all be handled via the Life-Pilot network and would be immediately available to all software subscribers.

5.15 Managing Change

Within every organization there is always an ingrained level of expected values. An organization is built on a foundation of norms and structure based on traditions. When a new principle is introduced into the set system, there is a necessary process for integrating the change so that it too can become a part of the recognized structure. Some elements of the organization may not be as willing to change as others, since not every part of a system can be convinced that the change will be good for the overall structure. The most difficult aspect to managing an alteration in an organization's set ways is finding a way to present the change to the system as an improvement to an already well-grounded establishment. When this management is set within the confines of the Danish open air museum and regards a new development in communication with the museum visitors, the primary targets for ameliorating the change process include both the museum employees and the visitors. In both cases, the age and experience of the subjects matters not. The employees could be celebrating their forty-year jubilee or could have just been hired the previous week. The visitors could be members of the museum 'Friends' club and walk the grounds on a weekly or even daily basis or the visit could be a first time experience at Frilandsmuseet. No matter the status of the individuals' experience with

the museum, opinions regarding changes to the standards and traditions typically accepted within a museum will vary from person to person. The seven steps to achieving a smooth management of change include persuasion, modeling, expectancy, selective re-enforcement, coercion, organizational restructuring, and participation (Nevis, Lancourt, and Vassallo).

The first phase to encouraging implementation of a change is persuading the necessary members of an organization to see that the change is something worthwhile and, possibly, even something that would enrich the experiences already available. The experiences available to the museum members are traditional ones that everyone understands and accepts. Visiting a museum involves arriving at the location, paying the entrance fee if necessary, and entering the building or, in the case of Frilandsmuseet, the museum's outdoor grounds to experience the world within the museum boundaries. If the visitors can be persuaded that a new method of experiencing the museum exhibits is an improvement on traditional methods, then they will be more open to actually using the new system. The same principle applies to the museum employees. Those who are set in the traditional ways of the museum will not bring about the necessary changes for introducing the new system in a positive light to the visitors. The employees need to be interested in the new method in order for the change to seem acceptable to the visitors. However, persuading the employees may not be as difficult as persuading the visitors. The employees will be required to take on the responsibility as part of the job stipulations. The organization can stipulate that the employees present the new addition to the traditional setting in a positive and interesting way. The more interested the

employees are toward exploring the new system, the more an appeal will develop from the customer base.

After the change has been presented, the next step is to show exactly how the new system works within the confines of what the audience already understands. If the system is modeled and prepared in such a way that there is minimal confusion or uncertainty, then the targeted population will be willing to try it themselves. The best way to model something completely new is to compare it to similar systems that are universally known and familiar. The more comfortable an individual is with something new, the more accepting he becomes to using it. The new information system at Frilandsmuseet should be modeled after the traditional forms of touring the museum, as well as introducing it as an everyday device, the cell phone, with which most of the population is currently very comfortable. The usage of the device can be presented through detailed instructions, but the actual modeling of the system must remain as simple and understandable as possible. The natural behavior of every human being is to be afraid of something that is different. This behavior is not conducive to trying something new, even when it is an improvement on the current available methods.

After the new system is explained and has been accepted by the target groups, a plan of expected results should be given as a rubric for how the device should operate. Besides the expectations for the device, the system users themselves should be instructed on what they are expected to accomplish through the use of the system. If the users are aware of how they are expected to interact with the system, then they know what exactly is available to them. The museum employees should also be supplied with a series of

expectancies by which they, as ambassadors to the museum visitors for the new system, should abide.

Selective re-enforcement and coercion are the next principles that take effect once the users have agreed to use the system. Re-enforcement can be in the form of rewards or other encouragement. The employees can be easily coerced through an increased wage or benefits package. The visitors would need some other form of re-enforcement, especially when the museum will require feedback from the system users. Persuading people to try something new and then take the time to respond about the experience is never an easy task. Part of the persuasion process should include an incentive for the visitors to get back from the whole operation. Rewards always make good incentives.

After the users and the employees have fulfilled the requirements of the outlined expectancies, and the organization has received feedback on the new system, the next phase is a process of organizational restructuring. When the new system is fully implemented within the structure of the museum, the organization itself will need to undergo some alterations to completely integrate the system. Adjusting job descriptions and responsibilities is a large part of this change. Making sure everyone understands the place the new system has within the organization will allow for a clearly defined and accepted environment.

Only when the environment is comfortable and well defined will the members of the museum willfully participate in the organizational changes. The goal of introducing a change within an organization is to achieve the state in which all members participate in the new addition as if it were a part of the previously defined structure system.

6.0 Conclusions and Recommendations

The team has conducted research through observation, investigation into other museums, investigation into alternative technology, interviews, and pilot surveys. The data gathered from these methods has given the team enough data to recomend a course of action for the museum.

The team conducted pilot interviews, to gauge which user groups would be most interested in the technology. Individulas under the age of ten were no interviewed, and everyone over the age of 65 who were approached had no desire to use the technology. Individuals with multiple responsibilities (e.g. parents, teachers) do not have the time to respond to the survey. However, if the interviewer is willing to walk along with the respondent may be willing to comment on the system. There were mixed reviews of the system for all other age groups, with the striking exception being the 10-15 year old age group, who were all very excited about this technology.

The team has concluded that during the pilot testing phase, the phones should be stationed at the main entrance only. If users are allowed to return the phone to one entrance only, the process of interviewing the users will be much easier. After the visitor has used the device during his visit to the museum, a staff member will be there to greet him when he returns the device and will follow a set list of questions prepared by the team in order to collect data.

This addition to the museum repertoire of available vistor services will be a significant change for the visitors and staff alike. Accordingly, organizational change methods described in the discussion will be necessary to have the greatest success for the complete system integration within the museum environment.

7.0 Works Cited

America Museum of the Moving Image, accessed 2-6-05 (http://www.ammi.org/site/extrapages/edoctext.html).

BAE Rokar. Accessed 2-6-05. (http://www.rokar.com).

Berg, Bruce L. *Qualitative Research Methods for the Social Sciences.* Pearson Education, Inc.: Boston, 2004.

Brooks, Arianne H., Timothy R. Moloy, and Matthew J. Oldmixon. "Museum Visitor Survey System." Interactive Qualifying Project. Worcester Polytechnic Institute, 2002.

Burke, Kristin and Yasinsac, Alec, The Ramifications of E911, Florida State University, (http://www.cs.fsu.edu/research/reports/TR-030404.pdf).

Cheverst, Keith, Nigel Davies, Keith Mitchell, Adrian Friday, and Christos Efstratiou. "Developing a Context-aware Electronic Tourist Guide: Some Issues and Experiences." Distributed Multimedia Research Group, Department of Computing, Lancaster University.

Cordura website, accessed 2-6-05 (http://www.cordura.dk).

"Galileo." European Space Agency website. Accessed 2-6-05. (http://www.esa.int/esaNA/galileo.html).

Garmin. Accessed 2-6-05. (http://www.garmin.com).

"Global Positioning System Overview." Accessed 2-6-05. (http://www.colorado.edu/geography/gcraft/notes/gps/gps_f.html).

"Global Positioning System (GPS)." JPL Mission and Spacecraft Library. Accessed 2-6-05. (http://samadhi.jpl.nasa.gov/msl/Programs/gps.html).

"GLONASS." *Encyclopedia Astronautica.* Accessed 2-6-05.(http://www.astronautix.com/craft/glonass.htm).

"GLONASS." JPL Mission and Spacecraft Library. Accessed 2-6-05. (http://samadhi.jpl.nasa.gov/msl/QuickLooks/glonassQL.html).

"GLONASS." *Space and Tech Database*. Accessed 2-6-05. (http://www.spaceandtech.com/spacedata/constellations/glonass_consum.shtml)

Hsi, Sherry, "Evaluation of Electronic Guidebook Mobile Web Resources." 7-19-02, Accessed 2-6-05. (http://www.exploratorium.edu/guidebook/eguide_exec_summary_02.pdf).

Husson, Van. "GLONASS." International Laser Ranging Service website. Accessed 2-6-05. (http://ilrs.gsfc.nasa.gov/satellite_missions/list_of_satellites/glonass/).

Kelly, Lynda. "Focus Groups." *Museum Methods*. Australian Museum Audience Research Centre, October 2001. (www.amonline.net.au/amarc/pdf/research/focusgps.pdf).

Magellan. Accessed 2-6-05. (http://www.magellangps.com).

Mech, L. David and Shannon M Barber. "A Critique of Wildlife Radio-Tracking and Its Use in National Parks." University of Minnesota, 6 February 2002. (http://www.npwrc.usgs.gov/resource/2002/radiotrk/radiotrk.pdf).

Mouritsen, Lone and Caroline Osborne. *The Rough Guide to Copenhagen.* Rough Guides: New York, 2004.

"National DGPS." US Coast Guard Navigation Center website. Accessed 2-6-05. (http://www.navcen.uscg.gov/ndgps/default.htm).

National Museum website. Accessed 3-31-05. (http://www.nationalmuseet.dk).

"NAVSTAR." *Encyclopedia Astronautica.* Accessed 2-6-05. (http://www.astronautix.com/project/navstar.htm).

Nevis, Edwin, Joan E. Lancourt, and Helen C. Vassallo. *Intentional Revolutions: A Seven-Point Strategy for Transforming Organizations*. Jossey-Bass Inc. Publishers: San Fransisco, 1996.

OnStar Corporation. 2-6-05. (http://www.onstar.com).

Pedersen, Mikkel Venborg, Jane Rowley and Niels Erik Jensen. *Guide: The Open Air Museum.* Sorgenfri Tryk A/S, Denmark: 2002.

"Question Bank." Museums, Libraries and Archives Council: London, 2004. (http://www.inspiringlearningforall.gov.uk/uploads/Question%20Bank.pdf).

Raj, Des. *The Design of Sample Surveys*. New York: McGraw-Hill, Inc., 1972.

Raytheon. Accessed 2-6-05. (http://www.raytheon.com).

Rice, Clifford G. "Mountain Goat Research in the Washington Cascade Mountains." 10 December 2003. (http://wdfw.wa.gov/science/articles/mtn_goats/mtn_goat_prog_rpt.pdf).

Skougaard, Mette. "The Ostenfeld Farm at the Open Air Museum; Aspects of the Role of Folk Museums in Conflicts of National Heritage." *Nordisk Museologi.* 1995: 23-32. (http://www.nordiskmuseologi.com/www/nm/952/Skougaard.html).

"Snow Removal." Howard County, MD Government. Accessed February 6, 2005 (http://www.co.ho.md.us/dpw/dpw%5Fsnowremoval.htm),

Talking Street. Accessed 2-6-05. (https://www.talkingstreet.com/).

Thales Navigation. Accessed 2-6-05. (http://www.thalesnavigation.com).

Trimble. Accessed 2-6-05. (http://www.trimble.com).

"USNO NAVSTAR Global Positoning System." USNO website. Accessed 2-6-05. (http://tycho.usno.navy.mil/gpsinfo.html).

Viking Ship Museum Official website. Accessed 2-5-05. (http://www.vikingeskibsmuseet.dk/default.asp?contentSection=2).

8.0 Appendices

A. Other Museum Technologies

The team continued literature research on additional technology to expand beyond application at Frilandsmuseet.

A1 The GUIDE system

Another major academic project with many parallels to this project is the GUIDE system devised by Lancaster University in England. The GUIDE system consists of a context-aware tourist guide installed on a handheld tablet PC. The GUIDE system determines its own location by means of wireless communication with servers located all around the city of Lancaster. The GUIDE development team initially planned to use a GPS system to determine location, but "adopted this approach ...for two reasons. Firstly, the approach requires no additional hardware and secondly because in a built up area it is often not possible to 'see' a sufficient number of satellites to obtain accurate positioning. However, using this approach does result in a lower resolution of positioning information" (Cheverst et al 3).

The GUIDE system is designed to emulate an internet browser with an interactive help system similar to that of Microsoft's "Paper Clip". Users did not have any problem with that aspect of the interface, but the software required some refinement for other usability issues.

Initial field trials of the GUIDE system consisted of testing by sixty museum visitors with a wide variation in age. Those under twenty "seemed to revel in the technology"

and explored much further into the database than their seniors, but all found the technology useful and believed that their experience was all the better for its use (Cheverst et al, 7).

The GUIDE group stated that useful lessons learned from implementing this resource were that the information given should not be of a size greater than what the average user can absorb quickly, and that the system should have the utmost flexibility, giving the user quality, not just quantity, and giving them freedom to choose any option.

A2 Cordura

Cordura is a web development company based out of Århus, Denmark. The company not only specializes in creating custom websites, but also other software products, such as TaggedX. This product was first developed by Århus university students for a thesis project, and has since become commercially available. Originally developed for the Natural History Museum in Århus, the system is now installed within the featured exhibition of the museum. Authorized museum officials have access to a web-based interface to change information or introduce new exhibit data when the featured exhibition changes. The system was first fully incorporated within the Natural History Museum in June of 2004 for a special exhibition about winged animals. This integration was after a significant development process that began in the autumn of 2003 (Cordura).

TaggedX, a museum tour guide system, enables a museum visitor to obtain more information, including multimedia items, such as picture and video files related to the exhibits. The system hardware includes a PDA (Personal Data Assistant), a built in RFID (Radio Frequency Identification) reader, and a wireless LAN connection to a central

server, which is located within the museum. Within the museum at each site in the exhibition, there is a marker denoting a "tagged" location. The marker is a small red dot on corners of the text signs that are already in place next to exhibits. Attached to the back side of each marked sign is an RFID tag, which is about the size of a credit card. Since the signs are opaque, the visitors cannot see the tags. Each PDA is equipped with an external RFID reader. When this reader is swiped less than ten centimeters from the red marker, the reader on the PDA blinks. Within a few seconds, a message appears stating that the information specific to that tag is being accessed. About three to five seconds after the tag is "read," the information for that site is displayed on the PDA screen. This process can take longer, but usually no longer than ten seconds after swiping the tag. The reason it takes a few seconds to display the tagged site's information is because the PDA downloads all the information from the server. No information is stored on the PDA itself.

Cordura also runs a separate company called Cell Point. This company is operated out of Copenhagen and also provides location based services. Some of the products include notification systems for appointments via SMS text messaging, cell phone notification of house alarms, and many other services (Cordura).

B. Global Positioning System (GPS)

The Global Positioning System, or GPS, is an array of satellites and ground control stations which work in concert with military and civilian receivers to provide precise position, time, and navigational information. The system is used by people and organizations around the world, and has become more and more common as receivers become more compact and affordable. Receivers are available from various sources in a variety of price ranges, ranging from a unit as small as a wristwatch to large military receivers mounted in equipment that requires a high degree of accuracy, e.g. a nuclear missile submarine.

B1 NAVSTAR (United States System)

The most widely known system of GPS is the NAVSTAR (NAVigation System with Timing And Ranging) system developed and operated by the United States Department of Defense, managed jointly by an interagency board but mostly under the auspices of the U.S. Air Force Space Command. The system consists of three segments, space, control, and user ("NAVSTAR").

The space part of the system consists of 24 operational satellites orbiting the Earth in six orbital planes at 60-degree angles (four satellites per orbit), inclined at 55 degrees from the Equator at a height of approximately 3730 meters. These satellites orbit once every 12 hours, coming to the same position at the same time each sidereal day, and thus by standard time each satellite appears four minutes earlier each day ("NAVSTAR"). The first of these satellites was launched in 1978, and the constellation was completed in 1994. The graphic shown at left depicts the general configuration of the orbiting satellite

constellation. There are actually 52 satellites, but some have been decommissioned for various reasons. The first eleven, the Block I satellites, were the testing phase of the system, and those have been retired. More satellites have been launched as the older ones reach the end of their design service lives, approximately seven and a half years. The older satellites contain four atomic clocks, two rubidium and two cesium, and these are used selectively as their maintenance and accuracy conditions change. The newer Block II-R satellites have three rubidium clocks. All satellites are repositioned yearly to correct for any drift ("USNO").

The control part of the system includes five Monitor Stations in Hawaii, Kwajalein Atoll in the Pacific, Ascension Island in the Atlantic, Diego Garcia in the Persian Gulf, and Colorado Springs, Colorado. There are also three ground antennas at Ascension, Diego, and Kwajalein. The Master Control Station is located at Schriever Air Force Base at Colorado Springs. The control system maintains the position and timing of the satellites, synchronizing them to the master clock at the U.S. Naval Observatory in Maryland ("USNO").

The third part of the system is the user segment, the individual receivers used by military and civilians all over the world. Before May of 2000, civilian users could not receive the most accurate signals from the NAVSTAR satellites. For national security reasons, the civilian channel, the Standard Positioning Service, was deliberately made inaccurate (100 meters laterally, 156 meters in elevation). The Precise Positioning Service, which was available only to military users, was made available to all civilian users by President Clinton. This service is significantly more accurate (22 meters laterally, 28 meters in elevation) ("USNO"). With the use of the Coast Guard's DGPS

(Differential GPS) radio correction service, which is projected to be available everywhere in the U.S. by the end of 2005, the accuracy of the NAVSTAR GPS system is resolved down to one to three meters ("National DGPS").

Conceptually, the GPS system functions in the following manner. A GPS receiver acquires a line-of-sight signal from the NAVSTAR constellation. Using signals from four satellites, the system can triangulate the position horizontally and vertically of the user by precisely timing how long the signal takes to get to the receiver from the satellite. Theoretically, there should be at least six NAVSTAR satellites in sight of any position on the planet. Unfortunately, the system does not function if the receiver is indoors or is otherwise obscured from the view of the satellites ("Global Positioning System Overview").

B2 GLONASS (Russian System)

In addition to the U.S. NAVSTAR GPS system, there is another system in operation, the Russian GLONASS (GLObal'naya NAvigatsionnaya Sputnikovaya Sistema). GLONASS is remarkably similar to NAVSTAR in construction, theory, and operation. GLONASS has 21 operational satellites in three planes 120-degrees apart. These satellites orbit closer to the surface and more quickly than NAVSTAR. The first satellite was launched in 1982, and the system was completed in 1996, but operational capability was achieved in September 1993. The system is controlled from Moscow with tracking stations across Russia. GLONASS has a two-channel system comparable to NAVSTAR, with comparable resolutions, although the higher resolution channel of GLONASS is still restricted to military personnel use only ("GLONASS" JPL).

Both NAVSTAR and GLONASS are continually being modernized. Newer design satellites are currently being launched, with completely new systems, GLONASS-M and GPS-III, in progress for both countries ("Global Positioning System" JPL).

B3 Galileo (European Union System)

The European Union (EU) is now developing its own system, Galileo, to supplement and harmonize GPS around the world. The projected system is to be completed in 2008, with the first satellites being launched in 2005. The system will be similar to NAVSTAR and GLONASS, with 27 of its own operational satellites. The system will, however, be able to synthesize data from NAVSTAR and GLONASS satellites to supplement its own data. The satellites are expected to be launched by Russian space vehicles ("Galileo").

B4 GPS Manufacturers

There are many companies that supply GPS receivers, their hardware and their software. The two best known providers are Garmin and Magellan. Garmin produces receivers for personal use in handheld devices, automobile navigation, and marine navigation. Garmin systems include Personal Data Assistant units, the only ones of their kind on the market (Garmin). Magellan, a division of Thales Navigation, makes receivers for land navigation use, especially handheld devices (Magellan).

Thales Navigation, Trimble Navigation, BAE Rokar, Raytheon, and several other companies make GPS receivers for industrial and military applications. Thales specializes in surveying units, Trimble in construction applications, and BAE Rokar and Raytheon in military receivers (Thales, Trimble, BAE, Raytheon).

Boeing, in cooperation with several other government contractors, builds the GPS satellites in the NAVSTAR system ("NAVSTAR"). GLONASS satellites are built by NPO-PM ("GLONASS" JPL). Galileo satellites will be manufactured by Eurely, a consortium formed by Alcatel (French), Finmeccanica (Italy), AENA and Hispasat (Spain) ("Galileo").

B5 GPS Uses

The Global Positioning System has four main purposes: navigation, triangulation, topographic surveying, and precision timing ("USNO").

The first and foremost use of GPS is navigation. A specialized receiver acquires a position fix and can propose a route from that point to the desired destination programmed by the user. In air and seaborne navigation this is a fairly easy proposition. On land, however, the system must be programmed with further information on what roads are available, the limits of each, and projected length of time until arrival. Many models of these navigation receivers are available, and some are now factory-installed in luxury automobiles ("Global Positioning System Overview").

The second purpose of GPS is positioning and tracking. As the resolution of GPS increases, it can be more effectively employed in the fields of search and rescue. Further uses include person tracking (used in house-arrest or work-release prison programs), vehicle tracking (used for fleet vehicles, stolen vehicles, and package shipping vehicles), and pet tracking (used for finding lost or stolen pets) ("Global Positioning System Overview").

A third use of GPS is topographic surveying. A GPS equipped surveyor can use his exact position, horizontally and vertically, to not only make a map or properly place a

building component, but also to create a three-dimensional model of the topography of the area (Thales).

Finally, GPS can be used for precision timing. With resolution on the nanosecond scale, all GPS satellites are synchronized, and all GPS receivers can obtain this information ("USNO").

B6 Interview with GPS expert

William R. Michalson, an associate professor of Electrical and Computer Engineering at WPI was interviewed on February 23, 2005 for roughly one quarter-hour. Professor Michalson received his doctorate from WPI and is a specialist in the field of Global Positioning Systems. He directs the Satellite Navigation Laboratory at WPI.

The interview with Professor Michalson achieved several goals. The team sought to understand in more detail the concepts of GPS, its functions, and its limitations as they apply to the project. The team learned new information about the NAVSTAR system and its complementary systems, Differential GPS (DGPS) or the Wide Area Augmentation System (WAAS), which significantly improve the resolution of the GPS system by modeling the atmospheric phenomena at the time and using that model to determine and correct the error present. These systems are only available in the continental United States at present, but a similar system, the European Geostationary Navigation Overlay Service (EGNOS) will soon be available in Europe.

The team also discussed with Michalson aspects of the Bluetooth technology which might be useful in discriminating between exhibits that are close together, where GPS alone would have overlapping error patterns with adjacent exhibits, confusing the system. He proposed some ideas on making more extensive use of the Bluetooth, placing

transmitters at strategic locations throughout the site to better locate the Life-Pilot unit while in use. The discussion involved proposed power needs and problems of system obtrusiveness into the period nature of the museum. The team plans to more formally propose this system modification at some time in the future.

C. Location Linked Services

Location linked services improve quality of life in many respects. In an emergency, precise position information is critical, and these services give an unparalleled advantage. Other services, such as navigation, resource location, and tracking are greatly enhanced with location linked capabilities.

C1 OnStar System

Location linked services play a major role in today's society. Many cars come equipped with built-in GPS systems. General Motors Corporation has introduced a system called OnStar, which uses a combination of sensors placed inside and outside the car, in addition to GPS and cellular antennas to communicate with a centrally located service center. The sensor arrays on the car continuously monitor for problems with the vehicle. In the event of an accident or airbag deployment, the service center is automatically contacted. The car's location, along with what types of alarms went off, is transmitted to the service center for required action. (OnStar).

C2 GPS Animal Tracking

In 1994, Lotek Engineering, Inc. was the first company to display an operational animal tracking system based on GPS technology. The company's focus in the design of the collars was to make them as unobtrusive to the animal as possible. Collars with full GPS location monitoring, and the capability to download the data gathered from a remote location now weigh as little as 600 grams (Mech 27,28,31). This method has been used to study mountain goats throughout the Cascade Range in Washington State (Rice 7-8).

This data becomes very useful when the National Park Service wishes to track the movement of a particular type of endangered animal.

C3 Nearest Resource Locator

Many US citizens have GPS systems installed in their vehicles for the purposes of navigation and resource location. These GPS systems determine the user's current location, and allow the user to find any nearby resources they may need. A receiver such as the Garmin iQue sorts this data by categories, and gives voice guided directions to the user when a destination is selected.

C4 Public Works Tracking

Location linked services are now being used to track public works vehicles. During major snowstorms, cities can monitor their snowplows and sanders via GPS devices installed in the trucks. During a snowstorm, residents of Howard County in Maryland are able to view an online map of which roads have been treated. This system can even visually pinpoint the current location of a plow vehicle ("Snow Removal").

D. Data Transmission

Where hardwired communication is impractical, wireless technology solutions can be employed to circumvent this problem.

D1 Bluetooth

Bluetooth is a wireless technology that connects electronic. Consumers began to see Bluetooth in action when Toshiba began selling Bluetooth-enabled personal computer (PC) cards through its website in September 2000. Other vendors have followed with Bluetooth-enabled devices ranging from PDAs to mobile phones.

Bluetooth technology uses radio signals to send information from one Bluetooth device to another through the air. For example, if a user is trying to transfer a computer's address book to a PDA, first the data in an address book is translated into a language that the PDA can understand and transmit via conduit. The data goes through the conduit to the Bluetooth device. The Bluetooth device is made up of a base-band processor, a radio, and an antenna. The base-band processor transfers the data into signals that the radio can understand, and the radio puts out signals in a frequency (2.4 gigahertz) that the antenna transmits through the air to another antenna on another Bluetooth device within thirty feet. The other device receives the data and processes it in reverse order.

D2 Radio Frequency Identification (RFID)

Radio Frequency Identification (RFID) units consist of two parts, an RFID tag and a reader. The RFID tag is a passive device that sits and waits for a signal from a reader. The tag is not self-powered. The tag is activated only when it comes within range of the magnetic field of the reader. The tag then sends its entire memory contents

to the reader. When the reader receives this information, it runs an analysis program to be sure the information received is valid.

This technology is commonly used in systems such as the EZ-Pass toll system on U.S. toll highways. When a vehicle comes into range of the toll booth by driving through the designated lane, the RFID tag in the car sends the vehicle's information to the toll booth's reader, which records the passage and charges the correct bank or charge account accordingly.

Another use of this technology is a "smart chip" embedded in the ignition key of some cars. Many newer cars will not start unless a specific RFID key is used. There is a reader located right next to the keyhole in the car, and the reader will not allow the car to start until it receives data from the correct key.

D3 Infrared (IR)

Both Bluetooth and RFID have the capability of transmitting through barriers such as walls. In certain circumstances this is necessary, but when it is not, a line of sight option may be acceptable. Infrared is a line of sight form of data transmission that uses light to communicate. Infrared light is not visible to the human eye, but infrared devices can be made which "see" the infrared wavelengths. Communication via infrared data transmission occurs by using a Morse code-like signal.

Many common devices today use infrared technology. A television remote control is a very basic instance of infrared communication. The technology is also used in PDAs for wireless transfer of addresses or other data. This is called "beaming" the information. Some night vision equipment uses infrared light to look for "hot spots"

which usually denote a person or animal. In an infrared image hotter areas are denoted with brighter colors, such as red and yellow.

D4 802.11 b/g (Wireless Networking)

802.11b and 802.11g are two versions of wireless data communication technologies, which, like Bluetooth and RFID, can penetrate walls. This form of transmission is purely radio signals. These signals are much like talking on two-way radios, but at a much higher data rate. The frequency range that is used by 802.11b/g is 2.4 GHz, whereas the radios usually operate around 49mhz (.049 GHz). This technology is common in personal computers. Most new laptops produced today have this technology. A laptop user can often go to a public location where a wireless transmitter is in use and "pick up" a signal for internet access.

Security with this sort of system is a significant issue. Wireless access is valuable, and keeping unauthorized users out is a high priority. Most wireless access points have the option of using a 128-bit encryption key. Without this key, an unauthorized user will not be able to use the access point.

D5 General Packet Radio Service (GPRS)

General Packet Radio Service is a technology that allows one's cellular phone to transfer data at moderate speeds. The technology is built into many phones, and it allows internet access to the phone. This technology is similar to 802.11 b/g, but since it is used with a cellular phone signal it has a much longer range.

E. US Implementation of Location Based Services

United States-based implementations of location based services are plentiful. The knowledge of a person's location is useful not only for the distribution of relevant information, but for a person's safety as well.

E1 E911 - National

In 1998, the Federal Communications Commission implemented the first phase of a system called E911, or Enhanced 911. American telephones will connect with an emergency operator when the number 911 is dialed in any telephone nationwide. In the first phase of the E911 system, when a mobile telephone is used to dial 911, the phone connects to an emergency operator and transmits the location of the closest cell tower site to which the phone is connected. This gives an indication of the general area where the caller is located. The second phase of the E911 project, which is to be completed by the end of 2005, will enable a position of within 50-300 meters of the caller to be sent to the 911 operator. This process will be done using the timed difference of signal arrival at the cell tower sites. When three or more cell towers are within range, the location can be triangulated by using the distance away from each tower, a method similar to how GPS triangulates with satellites (Burke).

E2 The Exploratorium – San Francisco, CA

The Exploratorium is located in downtown San Francisco, CA. It is filled with hundred of hands-on exhibits dedicated to the public understanding of science, art, and human perception. The museum allows a visitor to check out a handheld device and

explore the exhibits in any order. This "nomadic" type of setting fits well in a large open-space museum such as the Exploratorium.

One of the interesting features of this museum's information system is the ability for the users to "save" exhibits. On the handheld device, the users can add an exhibit to their "my Exploratorium" pages. The users can even take photos with a built in camera and save these images to their pages. When they are done with their visit, patrons simply return the handheld device to the registration area and leave. Once the visitors return to their homes they are able to log on to the Exploratorium website and gain access to all of the information they saved on the handheld device. (Hsi)

The technologies used in the museum include RFID, Infrared, 802.11 wireless networking, remotely triggered digital cameras, and personalized web services. The results of a study conducted reveal some interesting data. While the users liked the ability to interact with an exhibit via the handheld, they felt a sense of isolation and were concerned that it interfered with personal interaction with the physical exhibit (Hsi).

E3 eDocent™ - American Museum of Moving Image - New York City

The American Museum of Moving Image located in New York City has implemented a system called eDocent, where visitors to the museum can browse text, audio, video and photos about objects in the museum. A docent is a museum-industry term referring to a knowledgeable person who serves as a guide. The system has many of the same features as the Exploratorium, but also allows for the users to email links about exhibits from the handheld device (American Museum of the Moving Image).

E4 Talking Street – Boston and New York City

Downtown Boston is equipped with a unique location based service. While not as technologically advanced as the services that "know" where the user is, the Boston tour provides a great amount of information. The users walk around the city with a map printed out from the company's website. The map has numbered locations where the tourists can stop. When the users reach one of these locations, they use their own cell phones to call the Talking Street service. The service then gives information about the place being visited. Steven Tyler, a prominent American rock musician and a Boston native, narrates the Boston portion of the Talking Street service. The Talking Street tour also has locations in Washington DC, Lower Manhattan, and the Lower East side of New York City, each narrated by a notable celebrity (Talking Street).

F. Data Collection

Techniques for gathering information vary widely in effectiveness, depending on the situation and the type of data being collected. When surveying a population of people and asking for a public opinion, it is necessary for the researchers to develop a quick and concise method of obtaining information. Previous research by other groups on such topics proves invaluable to find the best ways to survey a particular population. Methods of study once reserved for academic social research have been increasingly applied to the museum world in recent years. In the following sub-sections interviews, focus groups, surveys, and electronic questionnaires will be defined and described for use within the museum setting.

F1 Interviewing

"Interviewing may be defined simply as a conversation with a purpose. Specifically, the purpose is to gather information" (Berg 75). Personal interviews are time consuming and each one requires in-depth preparation. When attempting to obtain information from many individuals regarding a specific research topic, single interviews may create more of a burden in regards to time management. When one is in need of information from a single individual, such as a company representative who might have more knowledge in regards to the research topic, a personal interview is most likely the best way to probe the subject and gain access to the needed material. The approach to these interviews should be highly structured with pre-designed questions and a format to provide for straightforward question and answer sessions. Responses acquired from these

one-on-one interactions will help the team formulate further questions to direct at the primary users of the museum's new information distribution system.

F2 Surveying

Paper surveys can provide well-rounded data as long as the desired population is willing to participate. "The objectives of the survey must be spelled out clearly along with the manner in which the results are going to be used" (Raj 112). If the target population knows that their input will be used in productive and important ways, which could possibly benefit them in the future, they will be more likely to allow their lives to be interrupted for a few minutes. The setup of a survey should allow for quick distribution, a succinct description of the reason for the questions, and easy to follow system for responses, whether it is simply "yes or no" answer options or another defined rating system.

Visitor surveys are common at museums. This is especially true when the institution has implemented something new and is seeking to obtain the patron population opinions of different aspects of the addition. In general, museums wish to know that visitors are satisfied with their experience and if anything needs improvement or alteration to increase satisfaction. The Museums, Libraries and Archives Council in London has compiled a large bank of questions and prompts developed by various authors to find evidence of learning within organizations ("Question Bank"). Referencing these questions regarding education and learning will be especially useful in gaining feedback from school groups and teachers visiting the museum.

F3 Electronic Questionnaires

Computer-based interaction and response is, in many ways, the best method to collect and manage data. Prior practice of this systematic approach to data collection was applied at the Danish National Museum in 2002 during a study regarding effective and efficient museum visitor surveying. This project concluded, "there are more advantages than disadvantages to the computer administration of surveys" (Brooks 14). The benefits are not only limited to the automatic capabilities of the computer program, including immediate data entry and scoring, but also will not use excessive amounts of paper or require the team to manually organize the data. The Danish National Museum project not only discovered that the "respondents enjoy completing a computerized questionnaire more than a paper and pencil version," but also that the process for analyzing the paper and pencil surveys did not need to be altered for electronic results (14). For the Frilandsmuseet project, the electronic questionnaire will be offered at the same location as the paper surveys, and use will be based on whether the visitors are comfortable with operating the computer for the purposes of the survey. Further off-site internet-based data collection means will be solely based on website traffic and email responses.

F4 Focus Groups

"The focus group may be defined as an interview style designed for small groups. Using this approach, researchers strive to learn through discussion about conscious, semiconscious, and unconscious psychological and socio-cultural characteristics and processes among various groups" (Berg 123). Isolating specific sub-groups of the target population can prove to be extremely beneficial when these groups are allowed to discuss and compare experiences amongst each other. This research method will also permit

extended conversations and personal opinions regarding any issues presented on the questionnaires. According to the Australian Museum Audience Research Centre, focus groups within the museum can be functional on several different levels regarding evaluation and visitor research. The group assessments range from "front-end" to "formative" to "summative" evaluation studies. The front-end studies are reserved for attaining expectations, attitudes, and preconceptions about the museum topic presented. Formative groups evaluate user response to "mock-ups, design plans, content, themes and specific exhibits, texts," as well as any other museum interactive technologies. The summative evaluation is used to research whether the material was sufficiently comprehended, as well as overall visitor satisfaction and learning (Kelly 1). A guide of discussion prompts is necessary to keep the conversation oriented to the topics of interest to the facilitator of the evaluation. The guide should follow standard interviewing techniques involving introductory conversations, discussion of the overall concepts of the evaluation, and then eventually allowing the group to generate feedback on specific issues and concerns. For the duration of the group exercise, "it is a good idea to use stimulus material such as floor plans, photographs of objects, real objects, draft text/labels, mock-ups of advertisements, and so on, to give people something concrete" on which to direct any comments (2).

For this museum, research by this method could involve groups of both the stakeholders for the new system and the everyday users of the Life-Pilot technology. The layout of these sessions should allow for more flowing discussion and opinion-based responses to the conversation prompts.

G. *Original Proposal Methodology*

In order to proceed with the mobile phone information dissemination project at Frilandsmuseet, the team has envisioned a probable scenario to prepare for work in Denmark. This section assumes that the system will be fully implemented at the time of arrival. The team's work will rely heavily on the ability to perform trial runs of the system with museum visitors and employees. The major tasks will involve testing and obtaining end-user opinions following visits to the museum utilizing the Life-Pilot device.

The possible methods to be employed for collecting information from museum visitors and employees will include text-based research, field research, interviews, on-site and off-site questionnaires, and focus groups. The usability of each method is determined by the available resources, the language barrier, system functionality, and time. By using as many of these methods as possible, the team hopes to present Frilandsmuseet with a complete impression of public satisfaction, as well as suggestions for permanent implementation.

G1 Text-Based Research

Team research conducted in the United States identified several institutions with similar systems to the one that implemented at Frilandsmuseet. Contacts with these museums and other tourist-oriented attractions provided insight into the operation of such technology. Special attention was given to the methods utilized by these institutions to distribute and collect their handheld information dissemination devices. This research was detailed previously in the Background Information chapter.

Research conducted at the museum will not only be geared toward validation of the system within the culture of the museum, but also improving the system as well. Research will involve company documentation and institution records and will focus on software and hardware solutions. Analysis of documentation from Euman will assist in this regard.

Further research the team intends to conduct while in Denmark will include examining all material received from interviews and questionnaires, exploring the subjects of the museum , and coordinating work at the Viking Ship Museum in Roskilde, as well as other sites under the Nordic Handscape project and sites under the auspices of the Danish Ministry of Culture.

G2 Field Research

Another course of action the team will utilize for orientation to the museum and the technology of the Life-Pilot system is field research. First on the team's agenda is to research the daily workings and dynamics of the museum. This will include analysis of common routes of visitor traffic, popularity of specific exhibits, and observation of museum demographics.

The optimal research technique enabling analysis of the Life-Pilot system will be to test run the technology under a variety of conditions. Since the system will be designed to perform in a specific manner, there will be a set of expected results, derived from the available documentation and assistance from Euman, against which to gauge the actual performance of the Life-Pilot software and mobile phone devices. Once the team, with the aid of the museum inspectors and system provider, has designed a rubric of performance criteria, field research involving museum employees, museum visitors, and

the team members will provide estimates on how closely the system functions to the desired level and quality of operation. The purpose of the user testing will be to assess the system in varying weather conditions, at increasing distances from the exhibits, in areas of high exhibit concentration, and while varying the number of concurrent users. This type of research will supply the team with information regarding the functionality of the overall system, and possible software or hardware problem areas, as well as where the system performs as expected.

Further field research will mainly be concerned with the observation of units in use. This can include visual monitoring of users around the museum, as well as system-provided data on what information items are accessed at each exhibit. This data would give a quantitative measurement of system dynamics.

G3 Interviews

The team intends to set up and conduct personal interviews with employees of the museum, the Euman Company (provider of the Life-Pilot system), the team liaison, and some of the museum patrons. These interviews will help gather information on use of the system to enhance the visitor experience.

The most readily available source of information about the museum's implementation of the Life-Pilot system is the project liaison, Klaus Jensen. Since Klaus has contact information for many of the museum and provider company employees, he is an invaluable resource.

Information gathered directly from general employees at the museum will consist of opinions on the integration of the Life-Pilot system into the daily workings of the museum. The museum inspectors highly involved in the system information base and

implementation will be able to supply the team with more specific data regarding the particulars of the system. The employees who work closely with the museum patrons will be a valuable link to the visitor base. The staff will enable better interaction with the patrons, especially in the cases where language differences become an obstacle.

The team also intends to connect with the Euman Company. Interaction with the provider will undoubtedly expand the team's knowledge about the technical aspects of Life-Pilot's implementation of the system at Frilandsmuseet. The Euman resources will allow a greater understanding of the system regarding the inner workings, as well as the limitations of the technologies.

Since a large proportion of the museum-going population is school groups, students will be the best group to test the system. Following their use of the system, students and their teachers will be invited for interviews regarding their experience. Because of possible language barriers, there may be a need to develop a Danish question list that the students can read and then write their responses for future translation. The interview sessions will be kept one-on-one, unless a translator is required. Any other visitors to the museum who test run the technology will also be asked to be involved in personal interviews following their experience. The student and general users might offer additional insight, a point of view not apparent to the team. The goal will be to obtain an evaluation of the general quality of the system.

The content for these interviews will be decided on a case-by-case basis while in Denmark based on initial orientation to the organizations and individuals involved. In general, the interviews will be a combination of structured questions and an opportunity for additional comments from the interviewee.

G4 Questionnaires

Questionnaires are another method to utilize for gathering information. This method will generate data representing the museum's entire visitor demographic. Every questionnaire will be clearly prefaced with a description of the Life-Pilot system and an explanation of the purpose of the survey. For this project, two types of questionnaires, paper surveys and web-based opinion polls, were considered.

Questionnaires can be administered to the patrons on-site directly following their museum tour, or in the case of student groups, several copies will be offered for the teachers to administer to the students upon return to the classroom. This off-site method will be especially helpful in obtaining information regarding the proposed internet link where the students can upload and save data from their Life-Pilot devices for later retrieval. The project group will request that these questionnaires provided to the teachers be returned within a specified amount of time. To ensure a quick response time, large museum-addressed, stamped envelopes will be included with the questionnaires.

The first questionnaire method, a simple visitor survey, involves text giving a general description of the system and questions asking the patrons for their opinions. The questions will attempt to ascertain their overall feeling about the system, what they liked about the system, how the system improved their museum experience, and whether or not the system had any problems. Although the survey-takers will be provided the opportunity to give a brief qualitative response, the survey will require mainly quantitative evaluation and will include closed-ended questions. Based on a set scale, visitors will be asked to rate their comfort level using the system, ease of use, system

reliability and accuracy, and their overall impression of the system's informational content.

This type of questionnaire can be administered to the patrons in one of three ways. (1) The questions can be presented to them on paper, and they can take the time to write their own responses. (2) The team members can ask the questions, and any responses can be recorded either on paper or electronically. (3) A computer can be placed on-site where the Life-Pilot devices are returned to the museum, and the team can request that the visitors take a few minutes to fill out the questionnaire electronically. The same questions will be presented to the visitors in all three situations. Any of the three methods of questionnaire delivery may not be used for final data collection. Each method will have a pilot test with the museum patron audience, and the technique that receives the highest response rate and proves most efficient will be continue to be implemented by the team.

The second questionnaire method considered is the internet-based poll. This would be of roughly the same format as the paper questionnaire distributed in the museum, but may include more questions and more space for qualitative responses. This type of survey may receive more input from internet users who have previously visited, or plan to visit, the museum. Since the team intends to make the survey available on the museum's website, general site traffic will have access to this survey. The site will present surveys for those who have and those who have not yet experienced the Life-Pilot system. The online-survey website address will also be given to those patrons willing to offer more input above and beyond the on-site questionnaire. Questions for the online

survey presented in this proposal will be formatted and coded for online access and team retrieval of responses.

The following pages include four possible surveys to acquire information from Frilandsmuseet visitors. These questionnaires will be presented in both English and Danish to facilitate communication with the museum patrons. Two of these surveys have already been translated into Danish. The translation directly follows its English version.

On-Site Visitor Questionnaire

Sex: M / F
Age: Under 10 10-18 18-25 25-35 35-55 55+

Students Only
Grade: 3 4 5 6 7 8 9 10 Other: ____

Did you share a mobile phone with another student? Yes / No
If Yes, would you rather have had your own? Yes / No
Why? _____

General Questions

Rate your general impression of the Life-Pilot system.
(1 = very poor, 2 = poor, 3 = average, 4 = good, 5 = excellent)

___ Overall system as a tour guide
___ Displayed information content
___ Ease of use
___ Reception
___ Correct exhibit information for each site
___ Display readability

Did you feel comfortable using this technology? Yes / No
If No, please explain why. _____

Did this system enhance your experience at the Open Air Museum? Yes / No

Did you encounter any technical problems during your mobile phone tour? Yes / No
If Yes, please explain what happened. _____
_____

Would you use this system again, either at the Open Air Museum or another museum?
Yes / No

Additional Comments:
_____
_____
_____

On-Site Spørge Skema

Sex: M / K
Alder: Under 10 10-18 18-25 25-35 35-55 55+

Kun for Skolebørn og Studerende
Klasse trin: 3 4 5 6 7 8 9 10 Audet:__

Delte du mobil telfon med en andeu? Ja / Nej
Hvis "ja," ville du hellere have haftdin egeu? Ja / Nej
Hvorfor? _____

Generelle Spørgsmål

Bedøm dit gennemgående indtryk af Life-Pilot systemet.
(1 = meget dårligt, 2 = dårligt, 3 = middel, 4 = godt, 5 = udmærket)

___ Systemet som helhed som tur guide
___ Vist information indhold
___ Nemt at bruge
___ Modtage kvalitet
___ Korrect udstillings information for hvert sted
___ Læsleighed af displayet

Var det nemt at bruge denne teknologi? Ja / Nej
Hvis svaret er nej, forklar venligst._____

Forbedrede dette system din oplevelse af Frilandsmuseet? Ja / Nej

Havde du tekniske problemer under din mobil telefon tur? Ja / Nej
Hvis "ja," forklar hvad der skete. _____
_____

Vil du vere villig til at bruge dette system igen, euteu på Frilandsmuseet eller på et audit museet? Ja / Nej

Yderligere kommentarer:
_____
_____
_____

Off-site Student Questionnaire

Sex: M / F Age: ____

Grade: 3 4 5 6 7 8 9 10 Other: ____

When did you visit the Open Air Museum? _____

Did you share a mobile phone with another student? Yes / No
If Yes, would you rather have had your own? Yes / No
Why? _____

How many exhibits did you visit at the museum? _____

Did the mobile phone display information for all of those exhibits? Yes / No
If No, which ones did not have information? _____
_____

Rate your general impression of the Life-Pilot system.
(1 = very poor, 2 = poor, 3 = average, 4 = very good, 5 = excellent)

___ Overall system as a tour guide
___ System information content
___ Ease of use
___ Reception
___ Correct exhibit information for each site
___ Display visibility

Did you use the feature that allows you to save images and sound clips? Yes / No
If Yes:
Was this feature easy to use on the mobile phone? Yes / No

Could you easily access this saved information on the internet? Yes / No

Did this information aid you in school assignments or discussions? Yes / No

Did you encounter any problems during your mobile phone tour? Yes / No
If Yes, please explain what happened. _____
_____

Would you use this system again, either at the Open Air Museum or another museum?
Yes / No

Additional Comments:_____
_____
_____

Off-site Skolebørn og Studerende Spørge Skema

Sex: M / K Age: ____

Klasse trin: 3 4 5 6 7 8 9 10 Audet: ____

Hvornår besøgte du Frilandsmuseet? _____

Delte du mobil telfon med en andeu? Ja / Nej
Hvis "ja," ville du hellere have haftdin egeu? Ja / Nej
Hvorfor? _____

Hvor mange udstillinger besøgte du på museet? _____

Viste mobil telefonen information for alle disse udstillinger? Ja / Nej
Hvia "nej," hvilke havde ikke information? _____
_____

Bedøm dit gennemgående indtryk af Life-Pilot systemet.
(1 = meget dårligt, 2 = dårligt, 3 = middel, 4 = godt, 5 = udmærket)

___ Systemet som helhed som tur guide
___ Vist information indhold
___ Nemt at bruge
___ Modtage kvalitet
___ Korrect udstillings information for hvert sted
___ Læsleighed af displayet

Brugte du den egenskab, som tillod dig af gemme billeder og lydklip? Ja / Nej
Hvia "ja":
Var denne egenskab neur at bruge på mobil telefonen? Ja / Nej

Var det nemt for dig at få fat på de gemte informationer via internettet? Ja / Nej

Hjalp disse informationer dig med skole opgaver eller diskussioner? Ja / Nej

Havde du tekniske problemer under din mobil telefon tur? Ja / Nej
Hvis "ja," forklar hvad der skete. _____
_____

Vil du vere villig til at bruge dette system igen, euteu på Frilandsmuseet eller på et audit museet? Ja / Nej

Yderligere kommentarer:_____
_____
_____

Internet-Based Survey for Users of the Life-Pilot System

Sex: M / F Age: ____

When did you visit the Open Air Museum? _____

Did you find that the Life-Pilot mobile-phone information system enhanced your museum experience? Explain.

Was the Life-Pilot system an acceptable tour guide for the Open Air Museum? Explain.

Are there any features that you would like to see implemented in this system?

If applicable, please describe any problems or difficulties you experienced with the Life-Pilot system while at the Open Air Museum.

Additional Comments:

Internet-Based Survey for Non-Users of the Life-Pilot System

Sex: M / F Age: ____

Have you previously visited the Open Air Museum? Yes / No
If Yes, when did you visit? _____
If No, when do you plan to visit the Open Air Museum? _____

Do you own a mobile phone for business or personal use? Yes / No
If No, have you previously used a mobile phone? Yes / No

What is your preferred method for touring a museum?
Self-guided with museum map
Personal Tour Guide
Group Tour
Audio-tour
Other: _____

Would you be interested in touring a museum using a mobile phone enabled with GPS technology? Yes / No

Do you think that a device such as a mobile phone enabled with GPS and linked to a large information server could enhance your museum experience? Yes / No

Would you be willing to test the Life-Pilot mobile phone information system at your next visit to the Open Air Museum? Yes / No

Additional Comments or Questions:

_____
_____
_____
_____

G5 Focus Groups

Focus groups may allow for the topics presented in the questionnaires to develop into more discussion-oriented information gathering sessions. This would provide a different dynamic, especially to the students who could interact with each other and develop a list of advantages and disadvantages to the Life-Pilot system. A problem with this type of setting would be any language barriers and a translator may be necessary. The focus groups, which will not exceed seven museum visitors, will be clusteered by age. In order to develop a basis of evaluation with an adequate amount of data, the group will seek to conduct at least four group sessions, as this is the recommended minimum starting point (Kelly 2).

Student groups will be asked to discuss how their general museum experience supplemented their classroom learning, how easy the devices were to use, and whether or not they felt the devices enhanced their experience and learning at the museum. Also, it might be advantageous to discuss with the students which system features they most enjoyed, which they thought were most useful for gathering and saving information, and which, if any, were problematic.

General museum visitors, especially those with technical experience, might be able to discuss particular details about the system. Brief discussions regarding the overall functionality of the system, the accuracy of the received information, and any technical or general system problems they found while using the mobile phone devices will be very useful. It will also be beneficial to discuss with the patrons whether or not they thought the system improved their museum experience and if they learned more due to the information received through the Life-Pilot equipment.

The two types of focus groups that the team plans to use at the Open Air Museum include groups of students and groups of general museum visitors. The prompts for students directed more toward educational purposes of the system. The prompts for general visitors may become more technology-based and specific to usage within the museum, depending on the technical knowledge of the individuals in the group.

Student Focus Group Discussion

How did the technology enhance your museum experience?

How did this technology supplement your classroom studies?

Did the Life-Pilot devices supply enough additional information regarding the exhibits you visited to enable you to complete any assignments given to you by your teacher?

Which features did you find the most useful as your toured the museum?

If you saved information files for later access, do you think this will aid in further discussion about the museum once you return to the classroom?

Is this a preferred method of learning?

Do you prefer this method of museum touring to traditional tour guides or headphone audio tours? Explain how it is better and/or worse.

General Focus Group Discussion

How did the technology enhance your museum experience?

Which features did you find the most useful as your toured the museum?

Do you prefer this method of museum touring to traditional tour guides or headphone audio tours? Explain how it is better and/or worse.

Within the confines of the Open Air Museum, how well do you think this type of technology meshes with the culture and atmosphere?

As you toured the museum, did you find the information you received was accurate based on your location? If ever, how often was it inaccurate?

While using the Life-Pilot devices, did you encounter any technical difficulties or problems with the programming?

Was this technique of museum touring beneficial to your learning more about the exhibits, than other, more traditional approaches?

Would you affirm the use of this technology within the museum setting or would you not recommend further implementation? Give clear reasoning for either response.

G6 Future Modifications

After system evaluation, there might still be room for improvements. These could include, but are not limited to, creating procedures for device distribution to and collection from the visitors, increases in available information, improvements in general accuracy, new and reengineered applications, and possible modifications to solve the problem of indoor usage.

The interface between the exhibit information and the museum visitors will be the mobile phone units that the museum will provide free of charge to the patrons. In order to monitor the use of the phones and decrease the chance of theft, a protocol for distributing the equipment is necessary to facilitate collecting the devices from the visitors before they depart the museum grounds. The patrons need to understand and acknowledge that they are responsible for any damage the devices incur, or, if the museum decides as such, that liability is solely that of the museum. The procedures for the general museum patrons should be different than the large school groups, which may have only one responsible adult for the whole group.

Increasing the information available to the users via the mobile phone units may be as easy as entering additional tables of data into the Life-Pilot servers. The content of this supplementary information could be based upon user input regarding areas of the museum exhibits that they felt the Life-Pilot system information was deficient.

Improving the accuracy of this location based service is vital to the success of the system. With the outdoor exhibits being so close to each other, it is important for the Life-Pilot unit to display the correct information. While the system accuracy is limited to the precision of the GPS units, there are other ways to "simulate" accuracy. As shown in

the diagram at the right, the locations of the exhibits stay the same from the top example to the bottom. In the top example, the location entered into the Life-Pilot system was the exact location of the exhibit. Due to the proximity of these exhibits to each other, there is a very large "overlap" area, noted in red. A user in this area could see either the data about exhibit A or exhibit B. To solve this challenge, the designer can program the location of the exhibit to be a few feet away from the actual exhibit. This would yield a smaller overlap zone, thus giving users fewer problems with seeing incorrect data. If there are three or more exhibits in a close area, the programmed locations can be strategically moved to create the fewest number of overlaps.

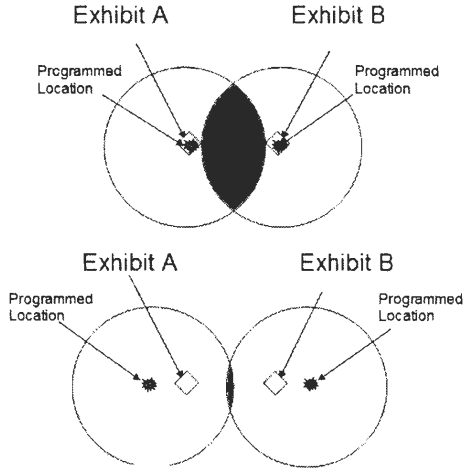


Figure 6. Accuracy Diagram

Further development of the features currently available to the users can be based on user feedback, as well as on test runs to search for program malfunctions. Any new applications will have to be decided upon by the museum and the technology provider. Input from the system testing visitors will be welcome. However, current programming and software may restrict the expansion of the system.

In order to advance the technology to include the museum's indoor exhibits, or simply for the technology to function while momentarily inside, the project group will rely heavily on the results of the similar technologies used at other museums. The systems at the Exploratorium and the Museum of the Moving Image both use RFID and infrared data transmission. These types of data transfer will offer Frilandsmuseet some

options and opportunities to adapt its GPS and Bluetooth system to include the indoor solutions as well.

H. Three-plan Methodology

In order to proceed with the mobile phone information dissemination project at Frilandsmuseet, the team has envisioned several scenarios to prepare for work in Denmark. Depending on the status of the system implementation at the time of arrival, the project will need to proceed in different ways. The three plans of action will be described in detail in subsequent sections. They will rely heavily on the ability to perform trial runs of the system with museum visitors and employees. If the system is limited to theoretical function, the goals of the project will be restricted to further academic research and defining public opinion regarding proposed implementation of this system. If the system is either mostly or fully functional, the tasks will involve more testing and obtaining end-user opinions following a visit to the museum with the Life-Pilot device.

The possible methods to be employed for collecting information from museum visitors and employees will include interviews, on-site and off-site questionnaires, focus groups, and field research and observations. The usability of each method is determined by the available resources, the language barrier, system functionality, and time. By using as many of these methods as possible, the team hopes to present Frilandsmuseet with a complete impression of public satisfaction, as well as suggestions for permanent implementation.

H1 Plan 1: Theoretical System

This section will describe the team's actions if the Life-Pilot system has not yet been implemented in the museum.

H1.1 Interviews

The team intends to set up and conduct personal interviews with employees of the museum, the Euman Company (provider of the Life-Pilot system), our liaison, and possibly some of the museum patrons. These interviews will help gather information on the proposed implementation of the system.

The most readily available source of information about the museum's implementation of the Life-Pilot system is the project liaison, Klaus Jensen. Since Klaus has contact information for many of the parties needed, he is an invaluable resource.

While interviewing the employees of the museum, our goal will be to introduce them to the mechanics of the Life-Pilot product and request their opinions on the implementation into the daily workings of the museum. The employees who work closely with the museum patrons will be a valuable link to the visitor base. The staff will enable better interaction with the patrons, especially in the cases where language differences become an obstacle.

The team also intends to connect with the Euman Company. Interaction with the provider will undoubtedly expand the team's knowledge about the particular implementation of the system at Frilandsmuseet. The Euman resources will allow a greater understanding of the system regarding the inner workings, as well as the limitations of the technologies.

The museum patrons are another possible source for interviews. Since the patrons are the people who will eventually be using the system, it is vital that their opinion is taken into consideration in the final implementation. The users might offer additional insight, a point of view not apparent to the team.

H1.2 Questionnaires

Questionnaires are another method our group intends to utilize for gathering information. This method will hopefully generate data representing the museum's entire visitor demographic. There are two types of questionnaires considered for use in this project, paper surveys and internet-based polls.

The first questionnaire method, a simple visitor survey, involves text giving a general description of the system and questions asking the patron for their opinion. The questions will attempt to ascertain their overall feeling about the system, what they would like to see in such a system, and how such a system could improve their museum experience.

The second questionnaire considered is the internet-based poll. This would be of roughly the same format as the paper questionnaire distributed in the museum, but may receive more input from internet users who have previously visited, or plan to visit, the museum. This method, however, is limited by the amount of traffic the museum's site receives.

H1.3 Text-Based Research

Team research conducted while still in the United States identified several institutions with similar systems to the one that will be implemented at Frilandsmuseet. Contacts with these museums and other tourist-oriented attractions provided insight into the operation of such technology. Special attention was given to the methods utilized by these institutions to distribute and collect their handheld information dissemination devices. This research was detailed previously in our Background Information chapter.

Further research the team intends to conduct while in Denmark will consist of examination of all material received from interviews and questionnaires, as well as research into the subjects of the museum itself, counterpart team work at the Viking Ship Museum in Roskilde, and other sites under the Nordic Handscape project, as well as the Ministry of Culture.

H1.4 Field Research

Another course of action the team has considered for the project is field research. Should the Life-Pilot system be inoperable, the team will be unable to perform trial testing. It will still be possible to research the daily workings and dynamics of the museum. This would include analysis of common routes of visitor traffic, popularity of specific exhibits, and observation of museum demographics. Other more technical research may include investigating GPS line-of-sight limitations and barriers and Bluetooth connectivity issues, as well as assisting museum personnel with the implementation of the system.

H2 Plan 2: Partially Functional System

In this section, the team will describe the necessary actions if the Life-Pilot system is available in partial operation. Under this condition, the system can be used for museum visitor trial runs. Most of the methods detailed in the previous section can also be implemented, but given the added functionality of the system, the team will be able to achieve more goals with regard to obtaining system information and visitor opinions. This is the condition expected at the time of the team's arrival on the project site.

H2.1 Interviews

In addition to the aforementioned contact with the project liaison, museum employees, and the technology provider, further data can be obtained from museum visitors. Since a large proportion of the museum-going population is school groups, students will be the best medium to test the system. During and following their use of the system, students and their teachers will be invited for interviews regarding their experience. Because of possible language barriers, there may be a need to develop a Danish question list that the students can read and then write their responses for future translation. The interview sessions will be kept one-on-one, unless a translator is required. Any other visitors to the museum who test run the technology will also be asked to be involved in personal interviews following their tour of the museum.

H2.2 Focus Groups

Along with personal interviews, focus groups may allow for more discussion-oriented sessions. This would provide a different dynamic, especially to the students who could interact with each other and develop a list of advantages and disadvantages to the Life-Pilot system. A problem with this type of setting would be due to the language difference. It would be difficult for the team to follow along with the students' discussions in Danish and therefore hinder analysis without additional translation from an outside party.

H2.3 Questionnaires

As previously mentioned, questionnaires are a less difficult and less time-consuming data collection method than personal interviewing. These surveys can be

administered to the patrons on-site directly following their museum tour, or in the case of student groups, several copies will be offered for the teachers to administer to the students upon return to the classroom. This off-site method will be especially helpful in obtaining information regarding the proposed internet link where the students can upload and save data from their Life-Pilot devices for later retrieval.

H2.4 Field Research

The optimal research technique enabling further analysis of the trial Life-Pilot system will be to test run the technology under a variety of conditions. Since the system will be designed to perform in a specific manner, there will be a set of expected results against which to gauge the actual performance of the Life-Pilot software and mobile phone devices. Once the team has designed a rubric of performance criteria, field research involving museum employees, museum visitors, and the team members will provide data on how closely the system functions to the desired operation. The purpose of the user testing will be to assess the system in varying weather conditions, at increasing distances from the exhibit, in areas of high exhibit concentration, and while varying the number of concurrent users. This type of research will supply the team with information regarding the functionality of the overall system, and possible software or hardware problem areas, as well as where the system performs as expected.

H3 Plan 3: Fully Functional System

If the Life-Pilot system is fully activated upon team arrival, the subjects and priorities of our research will change. Rather than concentrating on trial runs to determine system functionality, a priority under the conditions described in the last

section, the team will be able to observe the function of a fully operational system and to focus on details of the information distribution.

H3.1 Interviews

Interviews of the same groups outlined in the previous section will still be required, but the interview itself will have a different goal. The goal in this case will not be validation of system functionality, but rather an evaluation of the quality of the system.

H3.2 Questionnaires

The questionnaires distributed in the case with a fully operational system will be somewhat different than those detailed in the other sections. In this case the survey should ask for more qualitative evaluation. Questions regarding user comfort level, ease of system use, system reliability and accuracy, and overall impression of the system's informational content should be asked.

H3.3 Text-Based Research

Research conducted on a fully functional system will be geared more toward improving the system than validation of the system itself. Research will still involve the same documentation and institutions, but will focus on software rather than hardware solutions. Analysis of documentation from Euman will assist in this regard.

H3.4 Field Research

Field research in this case will mainly be concerned with the observation of units in use. This can include actual visual monitoring of users around the museum, as well as

system-provided data on what information items are accessed at each exhibit. This data would give a quantitative measurement of system dynamics.

H3.5 Future Modifications

After system evaluation at full capability, there might still be room for improvement. These could include but are not limited to increases in information available, new and reengineered applications, possible modifications to solve the problem of indoor usage, and improvements in general accuracy. Adding more information to the system may be as easy as entering it into the Life-Pilot servers. The content of this additional information could be based upon user input regarding what areas in the current information are lacking.

Improving the accuracy of this location based service is vital to the success of the system. With the outdoor exhibits being so close to each other, it is important for the cell phone to display the correct information. While the system accuracy is limited to the precision of the GPS units, there are other ways to "simulate" accuracy. In the Figure 7, you will see the locations of the exhibits stay the same from the top example to the bottom. In the top example, the location entered into the Life-Pilot system was the exact location of the exhibit. Due to the proximity of these exhibits to each other, there is a very large "overlap" area, noted in red. A user in this area could see either the data about exhibit A or exhibit B. To solve this, you can program the location of the

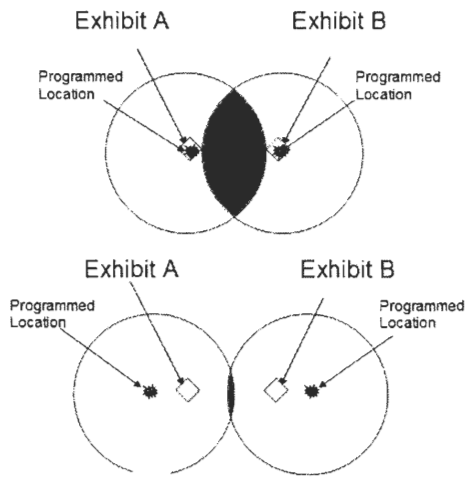


Figure 7. Accuracy Diagram

exhibit to be a few feet away from the actual exhibit. This would yield a smaller overlap zone, thus giving users fewer problems with seeing the incorrect data. If there are three or more exhibits in a close area, locations of the "programmed locations" can be moved around to create the least amount of overlaps.

I. Timeline

The project schedule for major methodology and deadlines.

Week	Accomplished Tasks
1 (3/14 – 3/18)	Denmark orientation Danish classes Museum orientation
2 (3/21 – 3/25)	Museum observation Initial presentation Interviews with Viking Museum team General document and field research
3 (3/28 – 4/1)	Other museum observations Research of alternate technology Advisor/Liaison meeting #1
4 (4/4 – 4/8)	National Cultural Heritage Dept. interview Natural History Museum interview & observe Additional research of technology Advisor/Liaison meeting #2
5 (4/11 – 4/15)	Project redirection meeting with liaison Technology sample obtained (limited apps.) Test phone applications Assistant curator interview Events coordinator and statistician interview Advisor/Liaison meeting #3 Museum research DUE Project Definition DUE Timeline DUE Staff survey questions DUE Crisis criteria DUE
6 (4/18 – 4/22)	Museum employee interviews Visitor survey and translation DUE Natural History Museum phone interview Euman phone interview Visitor interviews END of technology research
7 (4/25 – 4/29)	Survey visitors Museum architect interview Euman meeting for software upgrade END of data collection Revised methodology DUE Advisor/Liaison meeting #4
8 (5/2 – 5/6)	Layout Dist/Coll system Introduction, Background Info, Results, Discussion, Conclusion, Recommendations, & Appendix sections DUE Edit, revise, and finalize report Develop presentation
9 (5/9 – 5/10)	Finalize and practice presentation Final presentation (5/10, 2pm) Final report DUE