AR Afrika Team 2

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Abstract (Andreea)

What did the original inhabitants of Eastern Canada live on? Where does the street in the background of the Mona Lisa lead? Museums and exhibitions, adventure parks and city tours – all are full of information that is impossible to take in all at once and understand. At the same time, not every visitor wants to take part in guided tours - some prefer to learn and explore their own individual pace.

Our device, with its headphones and wireless receiver, always knows where it is in the museum, and can independently call up information relevant for that location in the language of the individual visitor's choosing. The result: knowledge reaches the mind through the ear – easily and directly.

The device that we propose is a product based on the smart phone technology, using an application for the guidance in the museum. Your visitors will learn more about the exhibits than with other information systems, all with great ease and comfort. Our device functions safely both indoors and outdoors

The device is as flexible as your exhibition needs it to be. You can change the records of the artifacts at any time, incorporate multimedia presentations, and you can introduce different types of games for children in order to make the visit of the guests more enjoyable. The visitors can select the level of information that is more suitable for him or her. This device offers different programs and levels of information to children and adults; in this way you can provide special recordings that suit an advanced level of knowledge: all of this in the language of the individual visitor's choice.

You can also provide your blind and visually impaired visitors with information tailored to their specific needs – and, at the same time, make a sensitive contribution to and provide support for the concept of accessibility. Our device thus plays its first trump card at the beginning: your guest is immediately surprised and flattered by the innovative, individually tailored service that you provide

Our device allows your guest to enjoy your exhibition at their own pace and in their own way. They feel both informed and enabled to enjoy the experience, and never feel constrained to a pre-set route. In fact, the opposite is true: visitors structure the tour themselves, in accordance with their own preferences. Whether they want to stay a little longer in front of a particular exhibit, play a specific piece of audio over and over, start playing a game connected to the exhibit, or view the map.

Unlike other audio systems, our device also enables you to offer guided tours using an avatar, that is not only guiding you through the museum, it also offers a lot of other alternatives, like rich multimedia and social activities in the online community: without disturbing the participants of other guided tours.

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1. Introduction (Alex)

1.1 The Plan

1.1.1 The Assignment

Over the past eight weeks, our group has been working toward creating an augmented reality (AR) system for the Afrika Museum in Berg en Dal, Netherlands. The museum has four goals: extending the user experience to those with visual disabilities, making the museum a "cool" place for people ages 18-30 years old, creating a community of those interested in Africa and allowing those people to create content, and working with the digital rights issues. All of these goals, our group has set out to meet.

1.1.2 Our Design

The design of our AR system mainly focuses on the goals of making the museum a "cool" place for people in the targeted age group of 18-30 and extending access to the visually impaired. Our vision is that a person who walks into the museum can download and install an application with an interactive Avatar onto their smart phone. From there, the AR system helps the user experience the museum's many exhibits at a pace of the user's choosing. In developing this application we have taken into account the four communication modes: Visual, Audio, Action, and Haptic. Extensive research has been done into what should be done to include all four modes in our design.

The design that we have created involves the user installing the application either through a QR code that is on the wall upon entering the museum or by asking the receptionist at the desk to install the application for them. Once this is done, the user can access the application, choose their settings, and then choose whether they want to do a guided tour or wander through the museum on their own.

Within the application is an interactive Avatar that the user can interact with in order to gain more layers of information on different artifacts. We have created the application this way because one of the main problems expressed by the museum was that they could only put so much information on the information plaques that are next to each exhibit. In some cases, there are no information plaques, just the artwork for viewing. Our system will also let the user choose what information, and how much information they want to access on each artifact, rather than presenting it all at once. GPS technology will also be incorporated into our design in order to allow the system to figure out where the user is in order for the interactive Avatar to interact with users.

We have also done research in how to make our design more accessible to the visually impaired. A lot of the accessibility issues are solved in our system by relying more on the other four senses. We have incorporated a way for people to feel on their screens, and have also included a system of directing people using a system of varying temperatures. The main focus of our system has shifted into the sense of hearing and touching rather than sight for the visually impaired.

Overall, our system has taken into account the needs of users that have been derived from user studies and design principles and ideas that are based on literature research. The rest of this report details the user studies, their results and the requirements for the prototype based on those results, our diagrams and flowcharts for the system, our prototype and how it works, the user evaluations on the prototypes, and a conclusion on what the museum should do for the future in order to meet its four goals.

1.2 Employed Methods of Research

AR Afrika is being developed for a number of reasons including extending the user experience of the Afrika Museum to the visually impaired, making the museum a "cooler" place for audiences in the age group ranging from 18-30 years of age. It is also being developed in order to help the museum attract more guests to its indoor exhibits. The current situation is that most of the museum guests attend the outdoor exhibits and not the indoor exhibits. So one of the main goals is to attract those outdoor guests into the indoor exhibits.

1.2.1 Deployed System

In order to create a user-centered design for the AR Afrika system we conducted a series of surveys and user studies. The survey focused on questions that asked about museum attendance, what people expected in a museum, and what would encourage them to attend a museum and visit the many exhibits.

Meanwhile, the user studies focused on the system itself and asked the users what features they would want in a system.

1.2.2. Overall Objectives

The objectives of this project include designing an intuitive system, an enjoyable user experience, and a system that is highly interactive. Designing an intuitive system, or a system that is easy for users to understand and figure out is a difficult one.

An enjoyable user experience for us means that the user will have an experience at the museum that will be productive and memorable. We want a system that is interactive, engages the user's interests, and keeps them wanting more.

1.2.3 Measurement for Success

Determining a way of understanding whether or not our new system meets the goals is very important to know whether we have succeeded. In order to do this, we have decided to first design a prototype according to the literature research and user studies. From there we will test the prototype with user tests and heuristic tests writing the results and analyzing them to see whether the system has met its intended goals. By comparing the results to the intended goals, we will be able to see whether we know if our new system has succeeded in meeting the design goals that we have set.

2. Context of use (Alex)

2.1 User Surveys and Studies

In the beginning stages of our research we did a number of activities to understand the context of use of our system including conducting surveys, user studies, and doing a wordle exercise. Who wants to use it? How would it be used? What features are important for our system to have? To figure out all of these questions we developed two user surveys that were distributed via the Internet. We also created a user study that we used to interview several people and get their perspectives on what they would want in an AR system for the Afrika museum.

2.1.1 The tests

User surveys were conducted at the beginning of the research process. Our group developed a questionnaire focusing on whether people have even been to a museum, how often they've been to a museum, what they would want in a museum to encourage them to go more often, and what the people expect when they attend a museum. In total there were a group of 43 people who responded to our online survey about the museums. Most of them were of the ages of 18-30 years. The second survey was created in order to understand whether people go to museums in groups or alone, and whether they would participate in an online community.

We also conducted user studies on ten people. The study focused on the system itself and the four different communication modes, and what people wanted to be included in the system. Some of the questions included whether they wanted a mute function, the ability

to speak into the phone and have the system respond, and whether they wanted to use their phone as a motion controller to name a few. In total, there were ten people who were interviewed with our user study.

2.1.2 Results and discussion

2.1.2.1 User survey results and discussion

User survey results focused more on general system requirements rather than the system design requirements. 43 people responded to the survey and provided answers to the 11 questions of the survey. Most of the 43 people who answered our survey were in the age group from 18-30 years of age. From our user survey results were gathered and analyzed. 67 percent of the survey takers told us that they expected to "have fun" and "have an experience" when they went to a museum. These results mean that any system that is developed must provide information to the user about the museum artifacts through a manner that engages the user by interacting with them.

Another result includes reasons why people have not gone to a museum in general. One of our hypotheses was for this problem was that the people in this age group might not be interested in going to a museum. The hypothesis proved to be correct as shown by the 32 percent of participants who stated they had not been to a museum because they were not interested. 17 percent of the users also stated that they had no time to go to a museum. In developing a system to attract more guests to the indoor exhibits, which is one of the goals of the museum, we have to make sure that the system will catch the interest of the users. Advertising will be a must in order to attract more guests to the museum. An interesting system that interacts with the users may also make the museum interesting enough to the point where people will actually make time in their schedules to go and experience the many exhibits of African Art and Culture.

The second survey had results that were quite conclusive about whether people would participate in an online community and whether they went to a museum in groups or alone. Out of the 18 people that were surveyed for this second survey the 16 said they went with family or friends. This was an overwhelming result and aided us in the decision on whether to include a group mode in our system. As for whether the people wanted to participate in the museum's online community, 12 out of 18 said they would participate in an online community. Hence, another decision about whether to even create an online community for the museum was answered. The full results of the user surveys are in the appendix. Results discussed here were the results that were of most value in designing the system based on the goals that have been set in place both by our team and the museum: attracting more guests into the indoor museum, and making the museum a "cooler" place for people 18-30 years of age.

2.1.2.2 User Interviews

The most frequent method of evaluation is to interview focus groups. It provides valuable information about user satisfaction and problems that could happen during the

functionality that might need rethinking. User Interview is a commonly used technique in user-centered design projects although it is not statistical, and can cost quite a bit, it helps designers to gather information directly and clearly, which is a must for setting up design requirements and later design evaluation criteria.(Abras, Maloney-Krichmar, & Preece, 2004)

An interview usually involves one interviewer speaking to one participant. It can be done by talking directly to the user at key points in the project to make sure the design will deliver upon their requirements, for example start with telling the design project's background introduction. It will contribute to requirements gathering and specification, understanding and specifying the context of use, specifying the user and organizational requirements. It will also help with design and evaluation, producing designs and prototype, carrying out user-based assessment. The advantages of an interview are that a participant's unique point of view can be explored in detail. In addition, any misunderstandings between the interviewer and the participant are likely to be quickly identified and addressed. The output of an interview is almost exclusively non-statistical, this means information gathered from interviews needs to be carefully compared and analyzed by designers.

In order to generate ideas towards museum visiting, to help develop the design concepts, some open interviews were conducted with people from our target group that had different backgrounds. As there is already plenty information from the online survey, the purpose of doing interviews is mainly about generating additional ideas as a supplement for creating design concepts later.

Because of the time limitation, only five interviews were conducted. In this case, the answers from each person are quite distinguishable. This means, the answers given in the interviews this time will not be used for setting design criteria but will only be used to help generate design concepts.

Here are some ideas generated from the interviews.

1. The most important reason for people to go visit a museum is what the content of the museum is. Whether the current exhibition suits for the visitor's interest largely results in whether the visitor would like to go to the museum.
2. Special theme, together with special exhibition, device, activities, etc. will always be a very good promotion for a museum.
3. People know some of the interaction devices helping with museum visiting but not everyone shows great interest towards using it.
4. Regards to the interaction design device, the usage of providing practical information is the most preferred. Practical information includes such as route suggestion, extra information explanation etc.
5. When considering a visit to a museum, most people want to learn more about the culture through information and media. However, it was expressed that games could be useful for aiding children in learning about the African culture.
6. People prefer simple design but which can create experiencing the reality.

7. There are wishes of having more fun and entertainment in the museum; game playing can be a good solution towards such kind of wishes.

The full report of user interview with more details can be found in Appendix.

2.1.2.3 User study results and discussion

While the user surveys focused more on asking questions about museums, the user studies focused on questions regarding the overall system design and what requirements should be put in place for the system that our group was developing. The study covered questions based on the four communication modes of audio, visual, action, and haptic mode. In total ten people were interviewed, and the full results of the study are listed in the appendix, but some of the results will be discussed here.

When asked about whether the users would like to have a system that they could speak into and have the system respond to them, eight out of ten said yes. With such an overwhelming response, we decided to make a system requirement of the ability to speaking into the system and having it respond back.

Other user requirements that were drawn from the results of the user study included having a cartoon Avatar, the ability to use the mobile phone as a motion controller, having dark text on a light background, and having the ability to feel different textures on the phone screen.

Eight out of ten people stated that they would want to have more of a cartoon Avatar rather than a realistic Avatar. Our group hypothesis had been the other way around. We thought that the Avatar should be more realistic rather than a cartoon. However, some of the interviewees stated that for their children they would want a cartoon and for them they would want a more realistic Avatar. Therefore, our hypothesis was not completely wrong.

The ability to use the phone as a motion controller was favored by eight out of ten people. Our group was also thinking of incorporating gestures into the application with the mobile phone as the mediator between the gestures and motions that the users would use and the system.

Five our of our eight participants who replied to the question of whether to have dark text on a light background or light text on a dark background replied that they wanted the former. The argument is still out there among designers but it seems it is really a matter of preference. Our studies show though that most people want a dark text on a light background.

One of the features we were thinking of including in our design was the ability to feel different textures on the screen. These textures would not only be a unique feature to have on our system but we hypothesized that it would make our system more accessible to the people who are visually impaired. In any case, the result of the question of whether people

wanted this feature was that seven out of ten people said yes, they would like to have the ability to have different textures on their screen. The specifics on how this feature would be implemented will be discussed later in chapter five under the haptic mode. Overall, it was a promising result for our team.

Many of our system requirements were drawn from the user study results. The ones listed above are just a sample of some of the unique and important features that our group believes will enable our design to become more interesting to users.

2.2 User Groups (ALEX)

When one designs a new system one must figure out the potential user groups of the system. One also needs to know what the users will do, why they would even want to use the system, and what their experience and expertise with the system in question is. Lastly, any other stakeholders of the system must be identified.

Based on the museum's set goals the main user groups for our system have been determined to be people in the age group of 18-30 years and people with visual disabilities. Other stakeholders for the AR Afrika system that we are developing would include the Museum curators, staff, investors in the museum, and the guests that attend the museum.

2.2.1 Age groups 18-30

People in the age range from 18-30 years are one of the target groups for our system. The museum wanted a way of making the museum "cooler" for people in this age group and the AR system that we are developing is specifically geared towards achieving that goal. This age group as revealed from the user surveys does not typically attend museums very often. Some of the reasons included distance and that they are simply not interested. Hence, we have to take into account many of the other aspects that the user studies and user surveys revealed in order to target this group and attract them to the Afrika museum.

2.2.1.1 Tasks

People in this age range would most likely attend the outdoor museum as indicated by the curator during our brief meeting with him. About 60 percent of the people attend the outdoor museum but not the indoor. Most people in this age group don't even attend the museum.

To solve this problem, our system would make it so that the user would tour the African art and culture presented in the museum using the AR system. They would interact with the Avatar that we have developed for the system and learn about the culture via games, or information media.

2.2.1.2 Reason to use the system

The reason for people in the ages of 18-30 to use our system would be to have a more interactive and engaging experience in the museum. They would be able to actively participate in their learning and choose what materials they would want to learn about. The targeted audience would even be able to play games if they wanted to learn about various aspects of the African culture.

2.2.1.3 Expertise and Experience required

Users in this group would simply need a smart phone and know how to use it. For this study, we are operating under the assumption that everyone has a smart phone and knows how to use it. We are also assuming that all of the smart phones have the appropriate features in order to run our system. Other things that people in this group would need to know are some possible simple gestures that would help with controlling the interface during some games and some basic functions such as zooming in and out of pictures and videos.

2.2.2 People with visual disability

Another important target group for the museum are the people with visual disabilities. We read a great deal of literature about the accessibility issues of the visually impaired and have taken the issues into account. This group includes all of those who have trouble seeing objects and the environment around them. It is not just focused on the people who are blind.

2.2.2.1 Tasks

The audience of the visually impaired would use the system using their sense of hearing and touch. This target group would focus more on speaking to the system and having the system respond to them via audio methods rather than through visual methods.

2.2.2.2 Reason to use the system

A reason for the visually impaired to use the system would be to gain access to different layers of information that would not be accessible to them through any other means in the museum. The system would also be the best way for them to learn about the African culture and exhibits since the museum does not have braille plaques next to the exhibits. Using the system would also allow the person more independence. They would not have to ask a friend or family member to describe an object to them. Instead, the visually impaired person would have the system describe the artifacts to them.

2.2.2.3 Expertise and Experience required

Those with visual disabilities should know that our system requires a smart phone. The person should also know how to operate a smart phone to some degree. In addition, the system would be geared towards them. So options and menu selections would be available to them via sonic and tactile methods. The Avatar would speak to them and there would be different textures on the screen so that the user knows what they have just selected.

2.2.3 Other stakeholders involved

Other stakeholders in our system include the museum curators, staff, investors and staff. The curators and museum staff are the stakeholders that will be updating the system with exhibit updates, information updates, and event updates. Therefore, a system that is easy-to-use and is not too technical would be helpful for these two groups.

All three stakeholders would like to see more people attend the Afrika Museum and so a system that is interactive, interesting, and attracts guests is a must.

2.3 Wordle exercise and Mood board

Wordle is an online system where you can copay and paste huge bodies of text and it will extract the most repeated words. We used this as a brainstorming, pre-design activity. Our group conducted a brainstorm of ideas for what we wanted in our system and entered the ideas into the wordle. The results of the wordle showed us that a lot of our ideas focused on Reality, Technologies, and Sound. The completed wordle is shown in the appendix.

The mood board was another brainstorm activity that we did. A mood board can be described as a picture collage that represents the mood an object creates. In terms of the system that we needed to develop we created a mood board that represented how we wanted the user to feel when they use our system. We included a lot of pictures of Africa that centered on the African culture and its people in the board. The completed mood board is shown in the appendix.

3. Analysis of Requirements

3.2 Requirements

3.2.1 User Requirements (Gil and Alex)

3.2.1.1 Requirement 1:

The system auto-updates itself.
Description: The system must be able to update the system itself to provide any new features that may be added in the future.
Rationale: Literature states "A good technology is an invisible one." (Junior, 2010)
Fit criterion: Anytime the user comes back to the museum; the user will get an automatic update of the newest version of the software.

3.2.1.2 Requirement 2:

The system contains accessibility tools for the visually impaired.
Description: The system must contain tools that are helpful enough so the visually impaired people get most of the information displayed for the non-visually impaired people.
Rationale: One of the museum's goals is to increase the accessibility of the museum for the visually impaired according with the presenter's speech.
Fit criterion: The system is able to help users with visual disability by using its tools.

3.2.1.3 Requirement 3:

The system is able to read the content to the user.
Description: The system must be able to read the content to the user, if he/she chooses the system to do so.
Rationale: Afrika Museum showed a special interest in making information accessible to people with visual disability.
Fit criterion: The user is able to understand the information without reading the text.

3.2.1.4 Requirement 4:

The system provides additional information on the pieces.
Description: The system must offer user access to additional information if existent.
Rationale: Museum curator expressed an interest in displaying multiple layers of information on objects that is not currently possible with what they have.

Fit criterion: For some objects that the museum contains the user may retrieve additional information only if this is available.

3.2.1.5 Requirement 5:

The system operates in people's smart phones.
Description: The system must be capable to operate in mobile devices.
Rationale: User studies showed that people owned different phones, not just an iPhone or Android phone.
Fit criterion: The system runs on multiple smart phones devices.

3.2.1.6 Requirement 6:

The system gives users updates on Museum events and special themes
Description: The system notifies the user of the messages that the staff at the museum may want to give.
Rationale: 67 percent of survey takers said that Special themes at the museum would encourage them to go.
Fit criterion: The user receives the messages.

3.2.1.7 Requirement 7:

The system enables the user to have a tour guide within the museum.
Description: The user may choose to be guided by the system in a tour.
Rationale: User surveys showed that 62 percent of survey takers wanted tours. Providing a tour guide using our system enables this interactivity to exist.
Fit criterion: The user who wants to use this tool follows successfully a tour within the museum.

3.2.1.8 Requirement 8:

The system enables the user to have a interactive exhibits within the museum.
Description: The user may choose to see interactive exhibitions if they are available.
Rationale: User surveys showed that 67% of people said interactive exhibits would encourage them to come to a museum
Fit criterion: The user who wants to use this tool is able to enjoy of interactive exhibitions.

3.2.1.9 Requirement 9:

The system enables the user to navigate to a particular piece.
Description: The user may choose to go to a particular piece of interest while being guided by the system.
Rationale: Nine out of ten people from the user study say that they want the system to ask them once what they want to do and then give them directions on how to achieve what they want to do.
Fit criterion: The user is able to reach to a particular piece of interest guided by the system.

3.2.1.10 Requirement 10:

The system enables groups of users to be guided together.
Description: The users that come in groups or individual users who want to join may travel in packs through the museum while being guided by the system.
Rationale: User studies showed that 16 out of 18 people who replied in a survey prefer to go to a museum in a group rather than alone.
Fit criterion: A group of users are able to travel together while the system presents the same tour to the whole group of users.

3.2.1.11 Requirement 11:

The system enables the user to play games.
Description: The user may choose to play games managed by the system of the museum.
Rationale: User studies showed that most people wanted some type of games for the tour.
Fit criterion: The user is able to play the game of his/her choice during his visit to the museum.

3.2.1.12 Requirement 12:

The system enables the user to save their game scores.
Description: The system is able to save the scores of the user for his/her next visit.
Rationale: User studies showed that people would want the game scores to be saved and posted but they want to be notified of the posting before hand.
Fit criterion: The user is able to use his previous scores if existent in his visit to the museum.

3.2.1.13 Requirement 13:

The system is able to remember the user preferences.
Description: The system is able to remember the user preferences from the previous visits to the museum if existent.
Rationale: 13 out of 16 people said they would want the system to remember their preferences.
Fit criterion: The system remembers the user preferences of the user.

3.2.1.14 Requirement 14:

The system enables the user to choose a language.
Description: The user may choose the system's language of his/her choice if available.
Rationale: User studies showed that most people considered that choosing a language was an important feature that they wanted.
Fit criterion: The user is capable of interacting with the system in his/her preferred language if available.

3.2.2 Functional (Gil)

- The system auto-updates itself.
- The system is able to read the content to the user.
- The system provides additional information on the pieces.
- The system gives users updates on distinct messages that the museum may produce.
- The system enables the user to have a tour guide within the museum.
- The system enables the user to have a interactive exhibits within the museum.
- The system enables groups of users to be guided together.
- The system enables the user to navigate to a particular piece.
- The system enables the user to save their game scores.
- The system is able to remember the user preferences.
- The system enables the user to choose a language.

3.2.3 Non-Functional (Gil)

- The system operates in people's smart phones.
- The system contains accessibility tools for the visually impaired.
- The system enables the user to play games.

3.2.3 Statutory or Legislative Requirements

3.2.3.1 Logistic Requirements (Gil)

a. The museum must provide armbands for the user safety.
Description: The museum provides armbands to prevent the user from throwing away the device by accident.
Rationale: User studies showed that while they would like the idea to have a motion controller device to interact with, they are concerned with the possibility of accidentally throwing it into the air.
Fit criterion: The user is unable to drop or throw his device while using the armband.

b. The museum provides a space to play games.
Description: The museum provides a space within it to have interactive games

Rationale: User studies showed that there is certain attraction among them to be able to play instructive games while in the museum.
Fit criterion: A selected group of users actually use this space for such activity.

c. The museum is equipped with touch screen surfaces
Description: The museum will have touch screen surfaces for the users to interact with
Rationale: User surveys showed that 62 percent of people wanted interactive exhibits. These touch surfaces could not only be used as game surfaces and access points to the online community, but can also be used at some exhibits.
Fit criterion: The majority of users interact with such devices.

3.2.3.2 Legislative Requirements (Gil)

- The museum staff is able to indicate the system which content can be displayed and which content cannot be displayed in the system
Description: The museum staff can tag the content between copyrighted content that is not supposed to be displayed in the user device and the content (copyrighted or not) that can be displayed in the user device without infringing any author's right.
Rationale: The museum showed a special interest into being able to manage copyrighted content without infringing copyrights.
Fit criterion: The staff can successfully tag the content so the system discriminates between content that can be displayed and content that can't be displayed.

3.2.4 Design Specific Requirements (All team)

These requirements were developed after user studies were done and after simple design was made.

3.2.4.1 Audio Specific Requirements (All team)

- Ability to mute sound.
- The option to wear headphones.
- The option to have background music.
- The ability to determine the voice of the avatar.
- The user should be able to select the language at the very beginning.

3.2.4.2 Visual Specific Requirements (All team)

- The screen should always avoid having dark background with light texts.
- The system should have subtitles by default.
- The screen should always show only one avatar at a time.
- The user should be able to select the gender of the Avatar.
- The avatar should have a cartoon look.
- The avatar should be an Adult.
- The user should be able to customize the look of the Avatar.
- The screen must have only 3 options in the Wheel Menu.

- The menu must have Map, Home and Settings as the default options.
- The menu must be a rotating wheel.

3.2.4.3 Action Specific Requirements (All team)

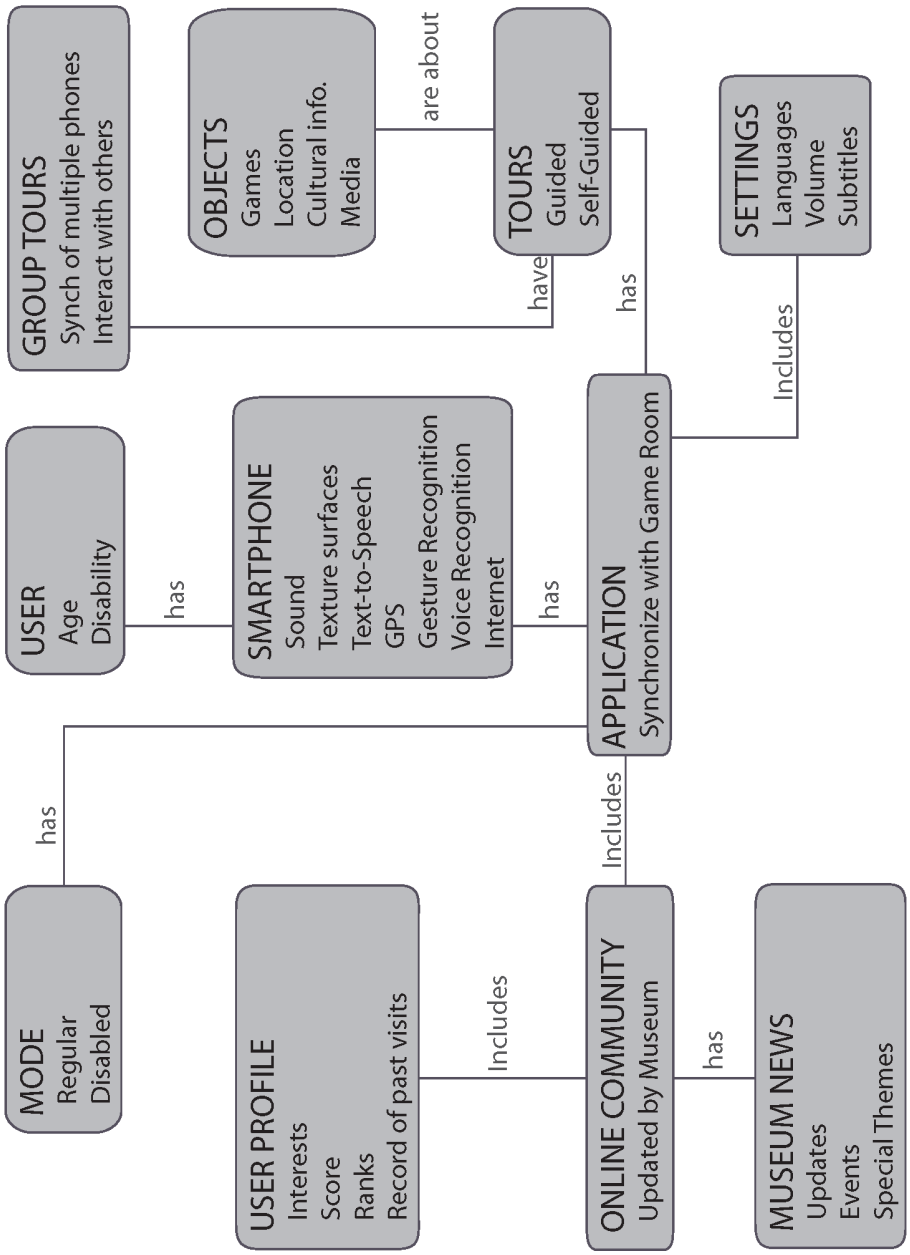
- The device must be able to be used as a motion controller
- The device should incorporate simple gestures that are easy to remember
- The device should be able to track where the user is going in the museum
- The user should be able to walk up to an object and have the system respond
- The system should be able to read the behaviors and mood of the user and respond accordingly

3.2.4.4 Haptic Specific Requirements (All team)

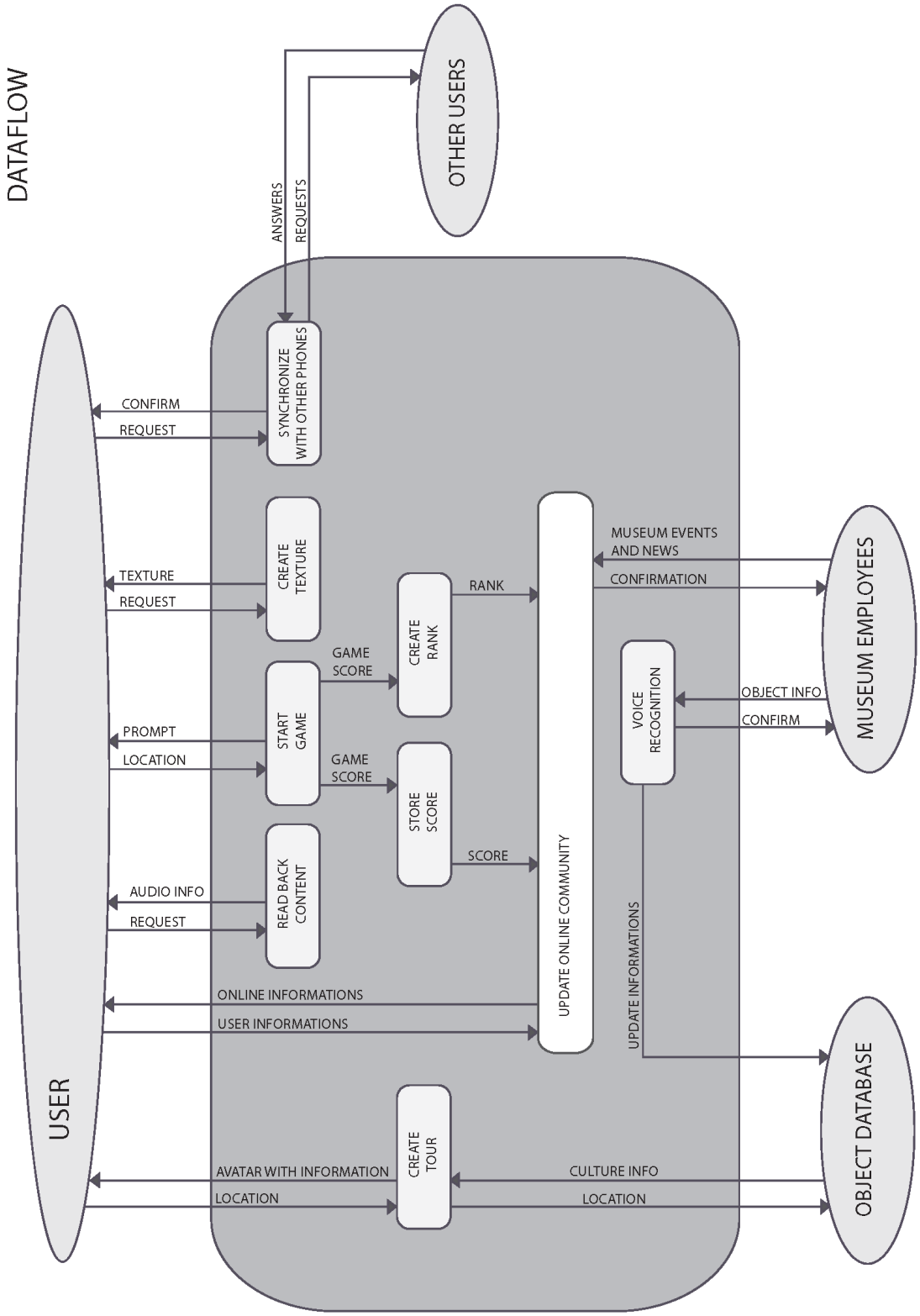
- The device should vibrate upon notifications by default.
- The device must be able to provide a variety of textures on the screen.
- The device will have temperature functionality only for the disability mode.
- Vibrations for the menu must be off by default.

4. Models

4.1 Entity Relationship Diagram (Alex and Luca)



4.2 Data Flow Diagram (Alex and Luca)



4.3 Transaction Schemes (Alex)

Name	User Tour location
Agents	Application, User, GPS
Data	User location
Initiative	User
Constraints	The boundaries of the museum property
Prompt	User moves

Name	Application tour information
Agents	Application, User
Data	Tour information via the Avatar
Initiative	Application
Constraints	Amount of information that can be read aloud or put on the screen
Prompt	Application sends information back to user

Name	Object information request
Agents	Object database, and Application
Data	Object information
Initiative	Application
Constraints	1. Size of the servers 2. Number of exhibits in museum 3. Skill of museum employees with technology 4. Amount of exhibits with information
Prompt	Application sends information request to object database

Name	Object Cultural Info Reply
Agents	Application and Object database
Data	Object cultural information
Initiative	Object Database
Constraints	1. Amount of Bandwidth available 2. Whether an object even has information on it
Prompt	Object database sends information to application.

Name	Sending of User info
Agents	User, Application, Online Community
Data	User information
Initiative	Application
Constraints	Privacy concerns on what information should be revealed
Prompt	Application asks if the User wants to go to join the online community

Name	Online information sent to user
Agents	Application, Online Community, User
Data	Museum events, special events, and information from User profile
Initiative	Application
Constraints	How much text can be put on the screen Type of info the user wants
Prompt	Online community pushes Alerts

Name	Updating Online Community
Agents	Online Community, Application, Museum Employees
Data	Museum Events, News, Special Themes
Initiative	Museum Employees
Constraints	Technological Skills of Museum Employees
Prompt	Application asks for information that needs to be updated

Name	Confirmation of Online Community Update
Agents	Museum Employees, Online Community, Application
Data	Confirmation feedback
Initiative	Application
Constraints	Length of time employees are willing to wait for information
Prompt	Window alert with confirmation

Name	Updating Object Information
Agents	Museum Employees, Application
Data	Object information
Initiative	Museum Employees
Constraints	1. Skills of Museum employees 2. What objects have information
Prompt	Museum Employees send information to application

Name	Updating Object databases
Agents	Application, Object database
Data	Object information
Initiative	Application
Constraints	Size of databases
Prompt	Application sends information to Databases

Name	Text-to-Speech request
Agents	User, Application
Data	Object info, User request
Initiative	User
Constraints	1. Rate at which person can understand the words being spoken 2. Volume
Prompt	User asks phone for text-to-speech

Name	Text-to-Speech feedback
Agents	User, Application
Data	Object information being read
Initiative	Application
Constraints	1. Rate at which person can understand the words being spoken 2. Volume
Prompt	Application reads the information about the object that is on the screen

Name	Starting a game
Agents	User, Application, Online Community
Data	Object information, Game information
Initiative	Application
Constraints	1. Attention span of users 2. Age of users 3. Operational capacity of phone
Prompt	Application asks if user wants to play a game

Name	Playing a game
Agents	User, Application, Online Community
Data	Object information, game information
Initiative	User
Constraints	1. User attention span 2. Age of user 3. Operational capacity of phone
Prompt	Prompts within the game

Name	Texture Screen creation request
Agents	Application, Phone, Users
Data	Object information
Initiative	User
Constraints	Size of screen, number of textures that a person can feel on a phone
Prompt	User asks phone to create textures

Name	Phone screen texture creation
Agents	User, Phone, User,
Data	Object information
Initiative	Application
Constraints	Size of Screen The number of textures that can be created
Prompt	Application sends information to phone to create a texture on the screen

Name	Synchronization of Phone with others
Agents	Users, Phone, Application, Wi-Fi Connection
Data	User information, phone information
Initiative	Application
Constraints	Number of users that can synch at one time Size of group
Prompt	Application asks if user wants to join a group

Name	Other users synchronize their phones with others
Agents	Users, Phone, Application, Wi-Fi Connection
Data	User information, phone information
Initiative	Application
Constraints	Number of users that can synch at one time Size of group
Prompt	Application sends other users synch notification

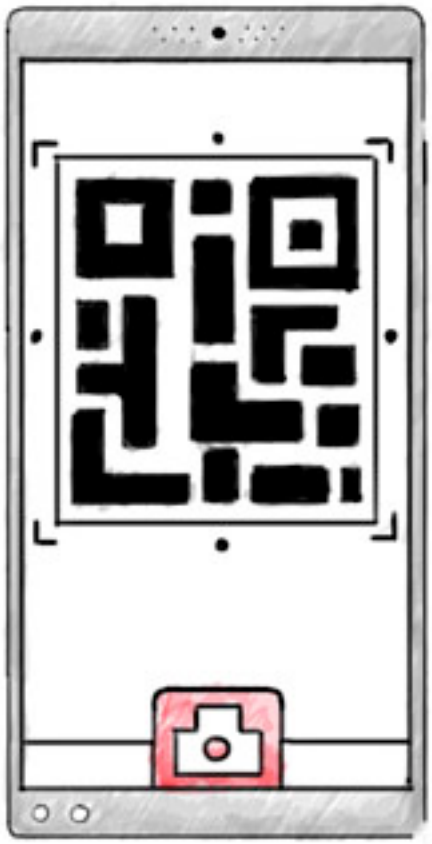
Name	Synchronization of Phone with others
Agents	Users, Phone, Application, Wi-Fi Connection
Data	User information, phone information
Initiative	Application
Constraints	Number of users that can synch at one time Size of group
Prompt	Application sends notification to other users

Name	Synchronize confirmation for others
Agents	Users, Phone, Application, Wi-Fi Connection
Data	User information, phone information
Initiative	Other users
Constraints	Number of users that can synch at one time Size of group
Prompt	Other users confirm group synchronization request
Name	User synchronization confirmation
Agents	Users, Phone, Application, Wi-Fi Connection
Data	User information, phone information
Initiative	Application
Constraints	Number of users that can synch at one time Size of group
Prompt	Phone sends synchronization confirmation to user's screen

5. Design Solutions

5.1 Prototype (Gil)

5.1.1 Prototype Screens (Gil)



Download and Installation of the App: The user is scanning a QR Code from the main wall of the museum (the most visible preferably) in order to start the automated installation process. At this stage, the help desk assistant may assist the user.

*

Loading: The default-loading screen that the application is going to show whenever it's processing data or information in large amounts. It's likely to appear upon the complete launch of the application.

*

Language Selection: This is the first option that the user gets to choose from. The application contains several languages to choose from. Therefore, the user is required to define his or her language of preference.

*

Welcome: The user gets to know for the first time the Avatar and its functions in this screen. It's worth noting that this is just a approximation of how it could look. s Dialogs, icons and the aspect in general could and will change in the final version of the software.

*

Instructions of usage: Once presented, the Avatar will start explaining how the Graphic User Interface works and what functions the user may find here. It's worth noting that this is just a graphical approximation of how could the final version of the software may look.

*

Group Settings: The user may define in this screen whether he/she comes alone, in a group or if he is going to create his/her other companions.

*

Joining a Group: If the user comes with other people but his/her group is already in the museum or if he/she decides to join a group. He/She may do it in this screen. It contains a list of all the available groups in the museum.

*

Creating a Group: The user may also decide to be the leader of a group. In this screen the user gets to decide the name of the group and a little emblem to identify them from other groups.

*

Visually Impaired Vs. Regular Vision: The user may choose at this point depending on his/her condition if he wants to use the tools available for Visually impaired People.

*

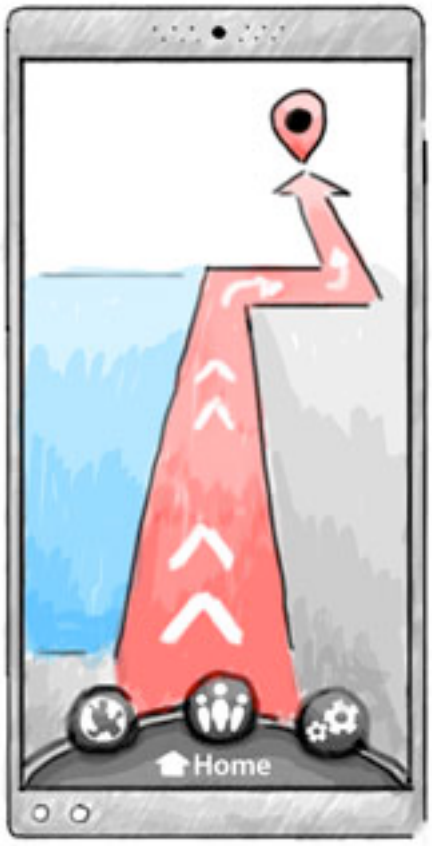
Settings: All the settings and preferences of the application are concentrated in here. In this section, the user may customize the app to his/her own preference. Due to its nature and the importance the user showed while doing the user studies this screen will be just one tap away in the menu from any screen marked with the DA sign within the application.

*

Online Community: This screen like settings will be able to be accessible from any part of the application. It contains all the recent events of the museum and what is happening in it: news, feedback, and announcements, user ranks. Due to its nature and the importance the museum showed while presenting their necessities this screen will be just one tap away in the menu from any screen where the wheel menu is available.

*

Games Vs. Culture | Self-Guided Vs. Tour: In this screen the user gets to choose between a tour-mode that is culture oriented and a self-guided mode that is game oriented. This, however, does not mean that the user won't get to play games in the culture mode or be able to read further information about a piece in the self-guided mode. This is the Home Screen; therefore, it's just one tap away in the menu from any screen where the wheel menu is available.



*

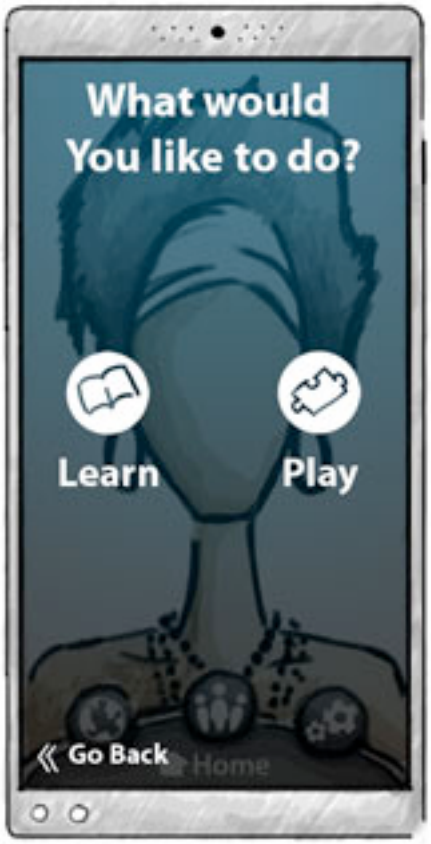
Navigation: The user gets some suggested paths he/she may take to reach for certain piece. This view of the map is based on the user position and the direction he/she should take to reach certain piece.

*

Contextual Avatar: In this screen the Avatar will dress up according to the context and present the information of the piece (The Avatar is the tour guide). The user may pause the avatar, just as he may skip to the next piece or go back to the previous one.

*

Default: This is the Avatar's default look. When there is nothing going on the Avatar will most likely look like this.



*

Information Vs. Games: The user gets this screen every time he/she approaches to an object if he/she is in the self-guided mode and not in the tour mode.

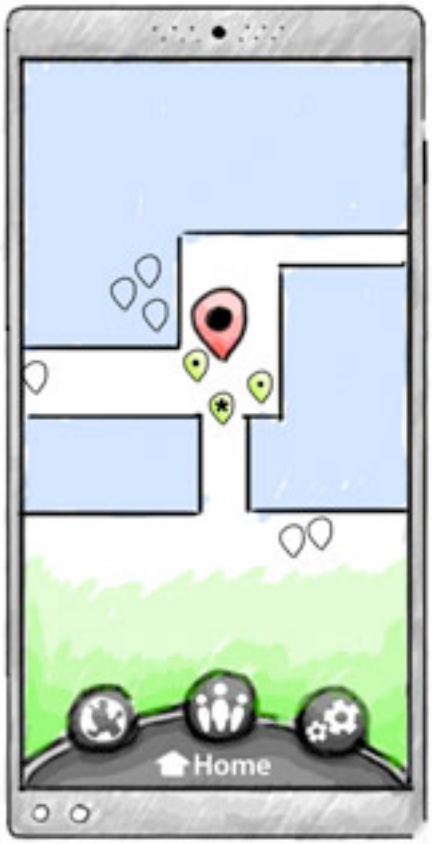
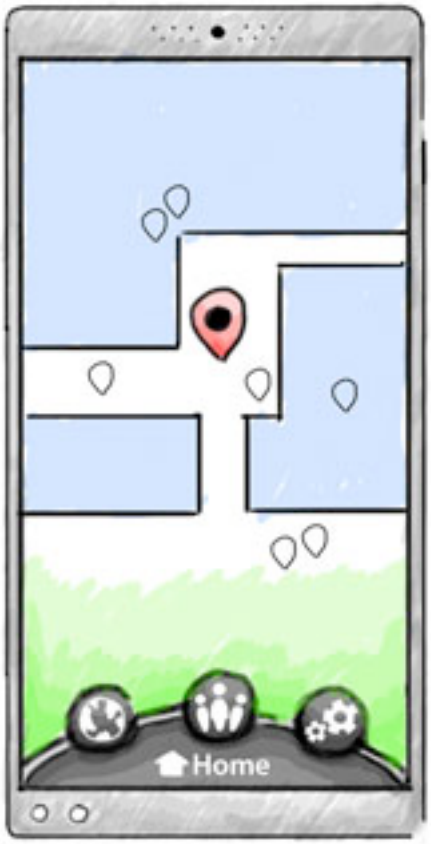
*

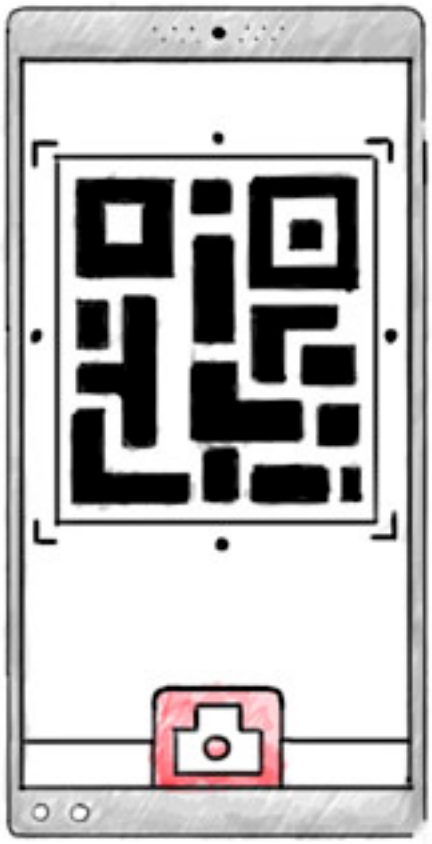
Object Explanation: The user gets the explanation of an object in the self-guided mode. But unlike the tour mode the user can't skip to the next piece. The user can either cancel or pause what he/she is seeing and go back to the *Information Vs. Games screen* or continue with this explanation.

*

About: The user may retrieve further textual information on his screen about certain piece if it is available. The museum staff is able to indicate what content can be displayed in the users screen.

Game Screen: There is no screen available for the game screen due to the variety of games that are going to be available in the museum. Apart from that; games are played in a larger screen and not in the smartphone device. Therefore the look of the screen is unimportant or likely to be turned off if it is not in use.	 * **Scores:** If the user played a game, he/she is likely to generate a score out of it. The user may share his/her accomplishment with his/her friends at one of the many social networks available on the web. In addition, the user will automatically share his/her score in the museum's network.

	
* **Map (with group):** This is the general view of the map. Unlike the Navigation screen, the user may see the map as a whole and identify others within the museum. The may also identify if the user is in a group and mark down the other members of a group.	* **Map (without group):** This is the general view of the map. Unlike the Navigation screen, the user may see the map as a whole and identify others within the museum.



Download and Installation of the App: The user is scanning a QR Code from the main wall of the museum (the most visible preferably) in order to start the automated installation process. At this stage the help desk assistant may assist the user.

*

Loading: The default-loading screen that the application is going to show whenever it's processing data or information in large amounts. It's likely to appear upon the complete launch of the application.

*

Language Selection: This is the first option that the user gets to choose from. The application contains several languages to choose from. Therefore the user is required to define his or her language of preference.

*

Welcome: The user gets to know for the first time the Avatar and its functions in this screen. It's worth noting that this is just a approximation of how it could look. Dialogs, icons and the aspect in general could and will change in the final version of the software.

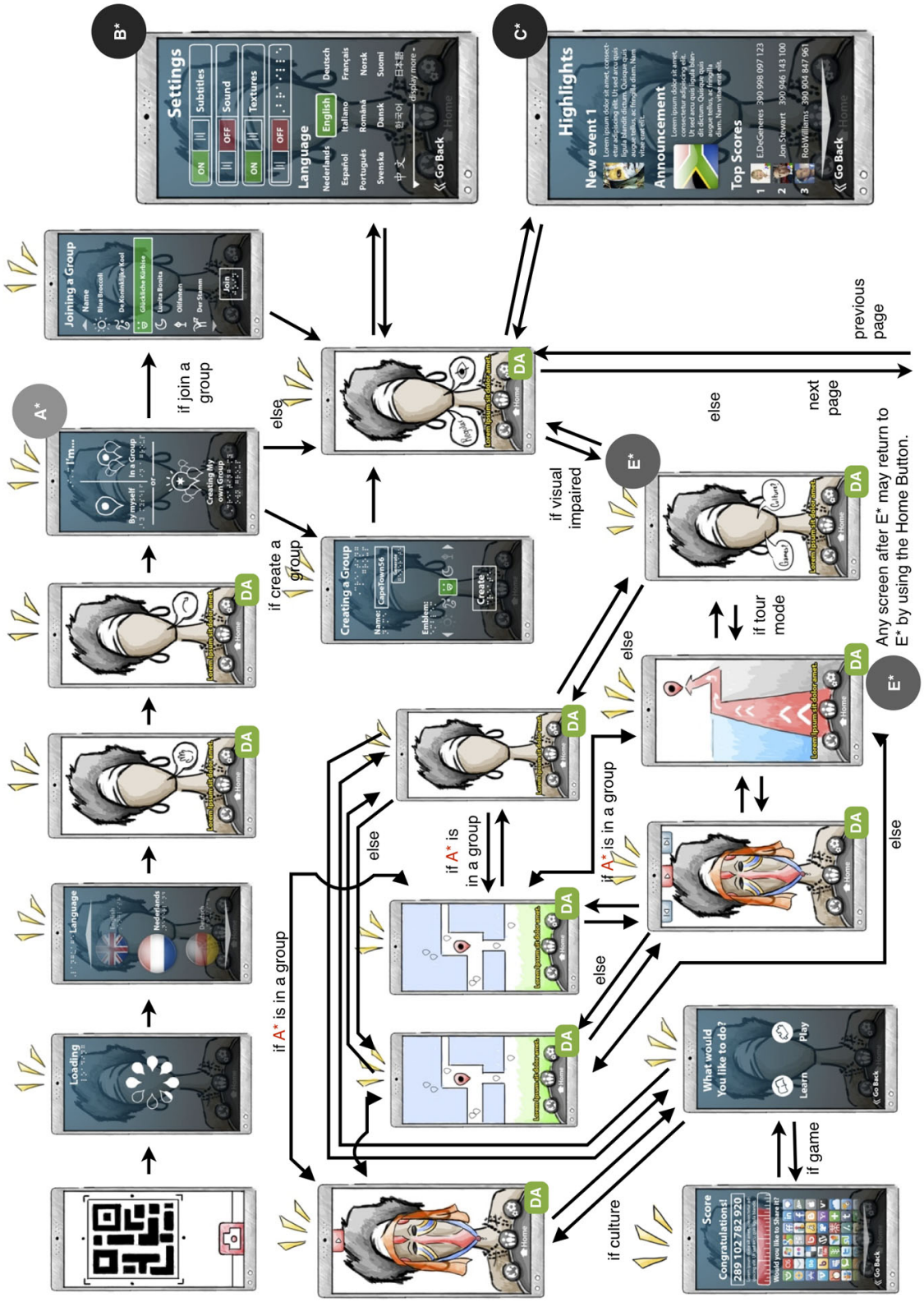
*

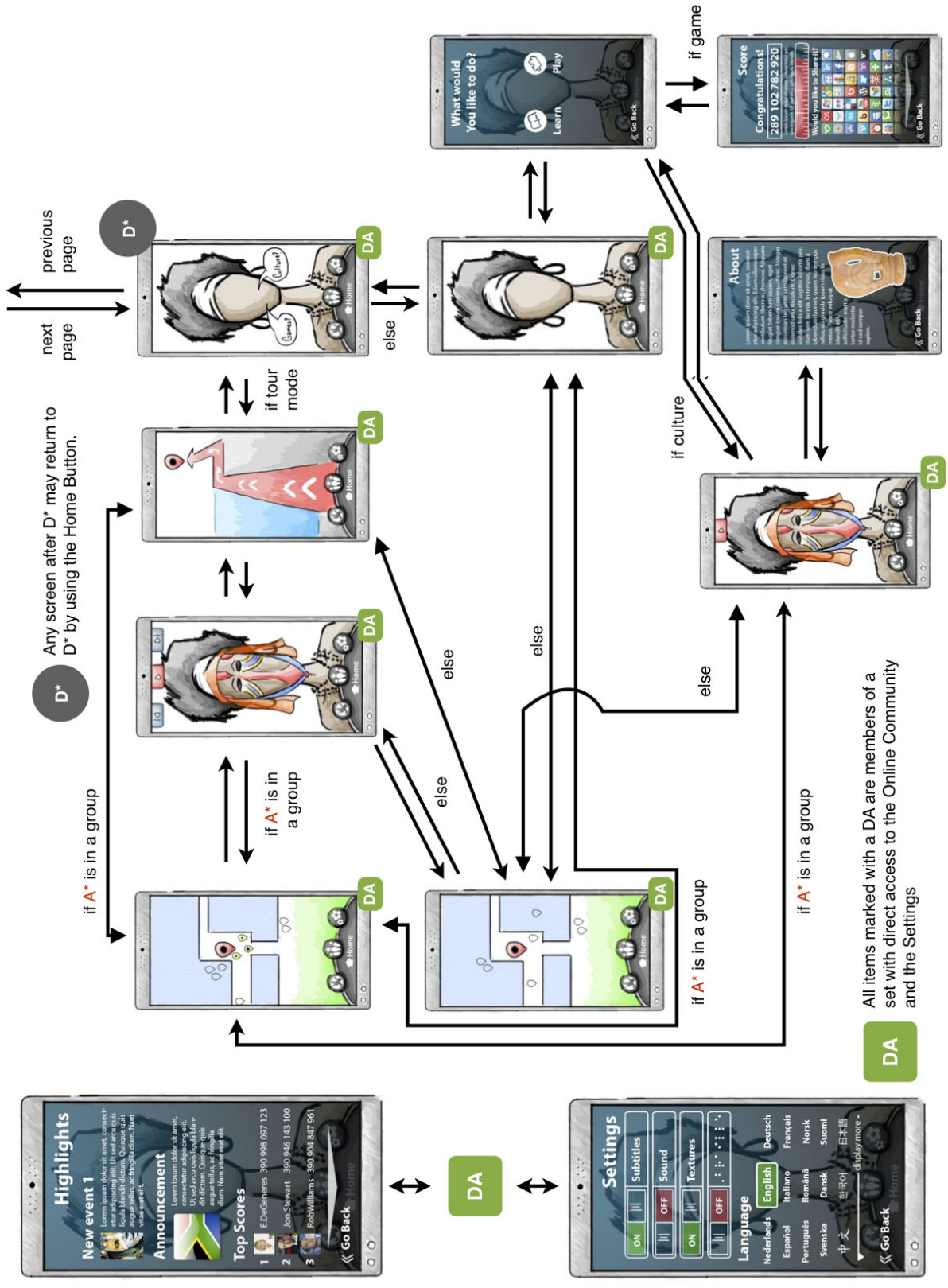
Instructions of usage: Once presented, the Avatar will start explaining how the Graphic User Interface works and what functions may the user find in here. It's worth noting that this is just a graphical approximation of how could the final version of the software may look.

*

Group Settings: The user may define in this screen whether he/she comes alone, in a group or if he is going to create his/her other companions.

5.1.2 Prototype Map (Gil)




Highlights
New event 1
Announcement
Top Scores
Go Back
Settings
Subtitles
Sound
Textures
Language
Nederlands
English
Deutsch
Español
Italiano
Français
Português
Română
Norsk
Svenska
Dansk
Suomi
DA
D*
Any screen after D* may return to D* by using the Home Button.
previous page
next page
if A* is in a group
if A* is in a group
if tour mode
else
else
else
else
if culture
if game
What would You like to do?
Play
Learn
Score
Congratulations!
289 102 782 920
About
All items marked with a DA are members of a set with direct access to the Online Community and the Settings

5.1.1 Audio Mode (Andreea)

Audio description refers to narration track for blind and visually impaired consumers of visual media (including television and film, dance, opera, and visual art). It consists of a narrator talking through the presentation, describing what is happening on the screen during the natural pauses in the audio, and sometimes during dialogue if deemed necessary. (Description Key for Educational Media, 2008)

For the performing arts (theater, dance, opera), and media (television, movies and DVD), description is a form of audio-visual translation, using the natural pauses in dialogue or between critical sound elements to insert narrative that translates the visual image into a sense form that is accessible to millions of individuals who otherwise lack full access to television and film.

In museums or visual art exhibitions, audio described tours (or universally designed tours that include description or the augmentation of existing recorded programs on audio- or videotape), are used to provide access to visitors who are blind or have low vision. Docents or tour guides can be trained to employ audio description in their presentations.

Researchers are working to show how description, through the use of varied word choice, synonyms, metaphor and simile. It not only benefits children who are blind and others who have learning disabilities but can also boost literacy for all children.

5.1.1.1 Sound in the Interface

Sound in the computer interface has been looked at for some time, and it is probably Gaver's SonicFinder that is the first striking example of this being used in a fashion noticed by a large number of people. (Gaver, 1989)Sonic Finder was interesting as it went beyond the simple 'beep' to try to convey more than the auditory equivalent of an exclamation mark. Gaver was not the first person to use sound in this way, but it has been seen as an important as being a principled introduction of sound into the interface.

Gaver was interested in sound in computer interfaces, not because it was necessary, as in the case for this work, but as he says, "because it is there", sound is used in everyday life and "listening complements looking". Sound is also part of everyday life, which can compliment vision for sighted individuals – the sound of money being counted in a cash machine indicates that it is still working and will produce the money shortly. Gaver makes the distinction between sound and vision: while sound exists in time and over space, vision exists in space and over time. By this he means that sound is inherently transitory, it is often the case that the beginning and end of a sound is experienced by a listener, and also can be heard when the source is not visible; while objects need to be visible to be available for repeated sampling. Sound can present information when visual access is not possible, or is undesirable, and vision can present information that requires access over time.

Sound in the interface can be split into four different types: Sonification, Auditory Icons, Earcons and speech. The first three of these are often referred to as non-speech sound, while the latter as speech based sound that can be split into recorded natural speech and synthesized speech.

Sonification is the attempt to translate some physical aspect of another medium into one of sound, such that a listener once versed in the basic principle of the system may interpret any example of the system correctly.

Auditory icons, as used by Gaver in SonicFinder, are sounds that have some kind of natural mapping from the sound to their meaning. For example, the sound of an object hitting a metal dustbin, or trashcan, to represent a item being deleted and placed into the trashcan on the Apple Macintosh interface. Gaver used more auditory icons and in a manner that conveyed more than just this type of simple information. For example, a rising pitch indicated operations that would take some time as the task progressed. He preferred the use of auditory icons to earcons, due to the natural mapping, rather than the somewhat arbitrary mapping that earcons provide. However, it must be questioned as to whether, as he suggests, the use of a 'wooden' sound suitably suggests text-based files.

Earcons, on the other hand, are not necessarily based around a natural mapping, but rather a principled use of music that can represent certain features of the item to be represented by using certain perceivable aspects of music. While it may be easy to find auditory icons to certain items that require presentation, it is not necessarily the case for all items. Earcon display tends to rely on converting the items to be displayed into descriptions based upon characteristics that can then be presented in sound. In this way, earcons can represent items for which there is no natural mapping, and also convey a certain amount of structural information about the domain items.

Brewster has performed work on a number of issues relating to presentation of information in earcons. One area of work that he has performed is using earcons to provide navigation cues. (Brewster, 1997) In this, he looked at navigation through tree structures and representing each location in the structure with an earcon so that a person navigating through the system would not become lost. He broke down the tree structure into a number of levels, each of which could be characterized by certain features of the earcons set used. In testing it was found that recall for the meaning of earcons was good, but was surpassed by a simpler method of simply using a numerical code to which branch or leaf was being presented.

While sound is often introduced into the interface in a fairly ad hoc manner, Mitsopoulos and Edward look at a more principled approach. (Edwards & Mitsopoulos, 1999) Their approach is based around three levels of design: Conceptual, Structural and Implementation and the suitability of different information types to different auditory display methods.

At the conceptual level, items are identified as having one of four types: nominal, ordinal, interval or ratio. Whether a check box in a user interface item is checked, or not, is a

nominal value. The way in which these basic types are combined together is looked at, and properties that emerge are considered. For example, a list structure when used by sight indicates when a user is reaching the end of the list, and this property should also be conveyed to the reader using the sound version.

At the structural level, auditory scene analysis is used to determine what streams of information should presented to the user. In this area these streams of information are looked at to ensure that information that is required to perform tasks is available within the limits of human perceptual ability.

At the implementation level the actual sounds that are used are developed. In their view, certain types of information are suited to implementation in sound using certain forms. For example, nominal values are suitably presented in sound using auditory icons, earcons or speech. They believe there should be some redundancy in the sound dimensions used to present just one conceptual dimension. This is to assist with overcoming individual differences between users, so that this information is as clear as possible.

One of the most important requirements concerns the ability to mute the system. The importance of this function is given by the fact that the visitors need to take a break or they want to socialize with their friends, and they need to listen to them. To understand the necessity of this function, just imagine that you get lost in the museum and start asking somebody how to find your way to a room: for example, the sculpture room. When they give you the answer, you listen. The person who is speaking has the information you need, so you probably actively listen. You may even make mental notes and ask questions when you do not fully understand something.

Our device allows the museum to effortlessly meet the needs of the visitor, whether it is offering tourists the option of listening in their native language or presenting customized information to adults and children. Special audio presentations for the blind and partially sighted are also possible with our device – allowing you to achieve greater accessibility.

Wearing headphones the museum visitors will feel more comfortable, because they can continue their visits to exhibitions without any interruptions and also, they can put an end to incomprehensible tours by museum guides due to loud background noise.

A lot of people enjoy music; some of them also like museums. So why not give them a pleasant surprise with the music of Africa. Museum visitors may enjoy this form of culture through sounds, because they will listen to the music of different traditional instruments and learn various things about them. For example, the African Xylophone is known as the Balo, and it was introduced to Southeast Africa by traders from Indonesia hundreds of years ago.

When words are sung to xylophone accompaniment, they often tell the history of the people in Zimbabwe and of the strength of their ancestor's or about African music in general. African music is most noted for its drums and drumming techniques. In the 1800s black slaves were transported from Africa to the United States to work on farms called plantations and were forbidden to play drums. Instead, they developed stringed instruments such as the banjo, which was the beginning of blues music.

We used speech recognition and voice recognition to establish a connection between the user and the system (in our case, the device, the smart phone), through the avatar. The avatar plays the role of a complex interface, that offers to the visitor various information regarding the exhibits and, of course, alternatives like listening to music, playing games, enjoying multimedia representations, and learning more about the artifacts.

All of our voices are uniquely different (including twins) and cannot be exactly duplicated. Speech is made up of two components: a physiological component (the **voice** tract) and a behavioral component (the accent).

Some companies use **voice recognition** so that people can gain access to information without being physically present, like in a phone call. (Carbonell, Hauptmann, Hayes, & Tomita, 1987) Unfortunately people can bypass this system by using a pre-recorded voice from an authorized person. That's why some systems will use several randomly chosen voice passwords or use general voiceprints instead voiceprints of specific words.

The voiceprint generated upon enrolment is characterized by the vocal tract and a cold does not affect the vocal tract. (Jurafsky & Martin, 2009) Only extreme vocal conditions such as laryngitis will prevent the system from proper **voice recognition**.

During enrolment, the user is prompted to repeat a short phrase or a sequence of numbers. **Voice recognition** can utilize various audio capture devices (microphones, telephones and PC microphones). The performance of voice recognition systems may vary depending on the quality of the audio signal. (Rudnicky) Random words and phrases are used so that no unauthorized use is suspected.

The benefits of **voice recognition** are that it can use existing telephone systems, it can be automated and used with speech recognition and that it has a low perceived invasiveness. The weakness of the system is a high false non-matching rate.

Speech recognition is the computing task of validating a user's claimed identity by using characteristics extracted from their **voice**. (Lea, 1980) Speaker recognition uses the acoustic features of speech that are different in all of us. These acoustic patterns reflect both anatomy (size and shape of mouth & throat) and learned behavior patterns (voice pitch & speaking style),

If a **speaker** claims to be of a certain identity and their **speech** is used to verify this claim. This is called **verification** or authentication. Identification is the task of determining an unknown speaker's identity.

5.1.2 Visual Mode (Gil)

One can take so many measures to improve the user's experience in the device or application which is being built or as Jim Palmar (Google 10-IO) said "What makes UI [User Interfaces] usable **is being clear**, which is being confused. [It] Leads to frustration and a general sense of -I don't know how to use this product-" (Fulcher & Palmar, 2010) In other words for User Interfaces to be successful they must be clear and consistent "By focusing on clarity over simplicity, we can get products [we think] that are both straight forward to use and powerful" - Jim Palmar (Fulcher & Palmar, 2010)

A Dashboard; which is the very first and most representative screen of an application must respond to these two questions: What can I do with this application? and What's new with this Application? or as Richard Fulcher (Google 10-IO) noted "It's really just a quick introduction to the app that tries to lay out the key functionality, and give the user (kind of) a clear way-points into the particular sub-tasks that the app can perform for them" (Fulcher & Palmar, 2010). The dashboard of our application contains the Avatar that is the most representative visual in our whole system. The Avatar is the graphical representation system that gives our system the human touch that we are trying to achieve while it also responds to the two earlier questions.

As our research points out; our Users pointed at a preferred default look for the Avatar. Because our user studies we found that collectively our users may find more appealing to find an adult cartoon-like avatar in which they may choose the gender for.

5.1.2.1 Graphic User Interface (GUI)

Nowadays building a graphical user interface requires great care and detail. Since the creation of the Internet, Visual Graphical Interfaces have evolved to become what it is right now. It is important to remember where this field came from in order to understand why these interfaces are done in a particular way and how the majority of users find certain decision favorable or unfavorable.

There are some basic GUI guidelines that can be applied to any visual design including this one such as using dark text (preferably black) over white or almost white backgrounds and this is reflected in many corporate and government websites. In fact the U.S. department of Health and Human Services clearly states in their accessibility guidelines that "Research studies consistently show on a plain background elicits reliably faster scanning and reading performance". (U.S. Department of Health & Human services) This guideline does not only help the readability and of the textual content in a design but it also improves the accessibility of the textual content for people who happen to have any type of color blindness due to the high contrast. (American Optometry Association) (Kyrnin) In addition, the font size must always be considered , textual content should be in a universal font such as Verdana or Arial that is available in several operative systems for both mobile devices and computers (Perez, 2008) (Gruber), making sure the font is no smaller than 11 point for regular text and not less than 8 points for small notes in accordance to the guidelines of the

U.S. department of Health & Human Services which concludes that this are the optimum sizes for readability for these two font families. (U.S. Department of Health & Human Services)

The Graphical User Interface (GUI) of our system also faces the challenge of any other smart-phone application. The multiple display resolutions, like computers, are not homogeneous in resolution; there is a blasting variety of screens and resolutions used by smart-phone devices that varies depending on the manufacturer and the Operating Systems (OS), especially now with the introduction of the tablets which could also count for a mobile device. Factors such as the Physical Screen Size, Aspect Ratio, Resolution and Pixel Density must all be considered when building the GUI (Google Inc, 2010), or like Christian Robertson said at Google 10-IO "Android is aware of the pixel density and classifies devices that have a lot of pixels in a small space as HDPI or high density devices" (Robertson K.). In addition, most smart phone devices and tablets support both landscape and portrait orientation so creating a GUI of an application for every single device could prove to be somewhat challenging but not impossible. Our GUI must address both the present and the near future user screens. Therefore, it's important to consider the trends of the screen sizes and their pixel density. One could conclude that with time our screens will tend to get bigger, but they are also getting sharper and brighter. (Hjerde, 2008)As for now it seems that the ideal resolution to develop a GUI on would be 240 x 360px (Hjerde, 2008) but that is subject to change due to technology advancements, user demand or technology getting cheaper just to mention some examples.

As mentioned earlier by Jim Palmar, it's crucial for our application to be clear in order to be usable. Just as in editorial design GUI should not be stuffed with content and designers should not attempt to occupy every single space in the screen. Simplicity comes into place along with Prioritized Content and Clearness in order to make a visually successful GUI. These three aspects (Clearness, Simplicity and Priorities) are all keys to make the GUI of this app as user friendly as possible. (Snell, 2009)

5.1.2.2 Clearness

Although it could prove to be difficult to maintain clear spaces (also known as white spaces or negative spaces) for visual rest, the user needs those spaces for better readability. (Robertson K.) (Condouris) It's easy to fall on the assumption that more stuff in the screen is better for the user, especially with small screens. However, there is a balance that needs to be addressed. Blank spaces serve to highlight the important information, the more the white space surrounds an element the more importance the element will get. (Condouris) However, an excess of blank space could also spoil the GUI. In our design, blank spaces are strategically placed within the GUI. It becomes very obvious on pages with a lot of content like Settings or the Online Community where the user is actively reading and interacting with the content.

5.1.2.3 Simplicity

"Herb Simon - one of the founders of cognitive psychology once said, --information consumes attention-- and with all the options and choices available to users today, products need to focus on engaging their users" - Jim Palmar, Google 10-IO (Fulcher & Palmar, 2010). Simplicity is key for a successful application. A system that is crowded with options can become too complex for the user. While our user studies show that users love the idea of being able to customize many aspects of the application this could create an extremely long and very complex setting screen. It's important to recognize what it elemental and what is not and find a balance to it. Making it simple is vital for the success of the application, especially if we are talking of an application that is not a professional tool but an entertainment tool. We believe that users come to the museum to learn about the subject and, therefore, creating a limited number of options and a simple menu to control the application is vital.

As of today our users have consistently shown preference for what we call a rotating wheel menu. Which pretty much works like a wheel with buttons that leads to different screens. Our users also pointed at the three most desired options for their menu: Home, Settings and Map. These options will appear by default on the top of the wheel menu. The user will have no need to rotate in order to access these three screens.

Keeping the application simple also means keeping a tree of the application simple as well. Users dislike putting a lot of effort to learn something in order to use it, especially if it's for pleasure and/or entertainment. It's very important to build a system that can remember the user's configuration and preferences such as the language. Users do not appreciate constantly entering into the settings screen (no matter how simple or visually attractive this may look) to change a configuration again. "[Users] want to organize the stuff once, and they expect to be able to use that organization in future context." (Fulcher & Palmar, 2010) or "People do a lot of experimenting both trying out new devices, downloading apps, trying out the app. What they [users] don't want to do and don't have time to do is [to] constantly reorganize their stuff." (Nielson J.) Both are quotes from Jim Palmar Google 10-IO. This is why we identified three simple options that need to be addressed in screens before the system is ready for full interaction and this are (order matters as well):

1. **Language of Choice:** The user will be forced to choose one of the languages available in a very simple single-option screen. Both Dutch and English are immediately available with a single tap.
2. **Single or Group:** This is a single-option screen with three possibilities, one coming alone, two coming in a group or three creating your own group for you and your friends.
3. **With or without accessibility tools:** The third critical screen before the system runs asks the user whether or not the user needs additional tools to understand the content displayed on screen. The user may choose between the regular mode on the left that won't contain tools for the visually impaired and the mode for people with visual limitations that is on the right. It's worth noting that the user will generally

read from left to right, so in such manner the GUI is optimized for faster and more efficient reading of elements by prioritizing the elements on the left or the center of the screen depending on the context (Nielson J.)

5.1.2.4 Content Priority

"When the user is at the home screen they don't always necessarily know what they want to do" - Richard Fulcher, Google 10-IO, (Fulcher & Palmar, 2010) this is the reason why the home screen should include the priority or main functions of the application, the Home screen is the screen that should tell you what the application is all about. In our application we have a couple of options before accessing this screen. Once there the user gets to choose between two options or go to the menu and choose a particular sub-menu or section of the application. In this way, the user knows that what he/she needs to do is to make a decision between A or B.

5.1.2.5 Thematic Consistency

Just as in Brand Design, consistency is key in any GUI. Consistency brings the family of screens together it gives a context to the whole application. In a GUI it is always important to add some thematic consistency to the elements of the interface. Thematic Consistency is closely related with the Design Economy of a GUI. The Design Economy basically consists of repeating familiar elements within a design to create a pattern, like the home button being always of certain color, having certain shape and being in certain position and place in all screens. (Ritter, 2001)

5.1.2.6 Accessibility

On this matter there is a lot of room to improve. It is vital for this matter to take into account color contrasts, font families and sizes for improved readability. Making text legible is critical for making an accessible application. Decorative fonts like the ones used in weeding invitations or fonts that look like hand-made writings can complicate a lot the readability of any text both on screen or on paper. Serif and Sans serif fonts work better for this matter. (Arditi) There is certain evidence that serif fonts are superior to sans-serif fonts for readability. (Swanson) However these studies are being disputed by several studies as well. (Bernard, Frank, McKown, & Mills) (Beatty, Esterhuizen, & Lange) (Gaultney)

Readability can also be greatly improved by applying the proper space in between lines. "Leading, or spacing between lines of text, should be at least 25 to 30 percent to the point size" - Aries Arditi (Arditi) Aries explains that many people with just partial sight have trouble finding the beginnings and ends of lines which therefore they have a hard time finding continuity. By adding some space (Leading) between lines the eye may distinguish better the continuity in a paragraph. The same applies to Letter spacing, Aries suggests that Monospaced opposed to proportionally spaced fonts tend to provide more legibility to partially sighed people. (Arditi)

Red-Green Color-Vision Deficiency or Dyscromatophsia (Overall) is prevalent among 7 to 10 percent of the population and it affects males more than females. (Jacobs & Williams) (Montgomery) (Cruz, Cardena, Cabrera, Garcia, Santos-Morabe, & Nanagas)Due to the great variety of types of color blindness it is very difficult to address all of them and since it is very difficult to represent exactly how a color blinded person sees doing a perfect GUI could prove to be almost impossible. However, there are two recommendations that should be followed in every case, not just on designing User Interfaces but everything in general.

1. Thomas G. Wolfmaier puts it like this: "Avoid combining light colors from either end of the spectrum (reds, blues) with dark colors from the middle of the spectrum (yellows, greens). To individuals with color vision deficiencies, the light colors appear darker and the lightness contrast between the colors is reduced. Instead, combine light colors from the middle of the spectrum with dark colors from either end of the spectrum." (Wolfmaier, 1999)
2. The second recommendation also by the same author is to use textures (read Haptic mode for this) and different shapes if available. (Wolfmaier, 1999)

5.1.3 Action Mode (Alex)

5.1.3.1 Overview of Action mode of communication

"As long as mankind has existed, people have used their body language, more or less consciously, as a tool for negotiation, clarification or persuasion." (Moen, 2007) As stated by the quote, the communication mode of action is one of the primary ways that humans communicate with one another. Communicating via gestures, motions, and just body language in general has been around since the beginning of time. Therefore, it's only natural that nowadays technology is going back to these gestural and motion interfaces for people to communicate with machines. There is a slight problem however. Each person has his or her own gesture set. So before we can understand the gestures of other people we must understand our own gestures. (Granum, Moeslund, Nielson, & Storring) One can't design a gesture interface that is based on the gestures of others until one can base it on one's own gestures. By understanding one's own gestures, one has taken a step toward understanding what gestures would be intuitive in a gesture interface for a system.

In addition, we must also understand that there are three different types of movements in gesture interfaces today:

"Sensible being natural movements for a combination of user, technology and environment…Sensable being movements that a computer can measure determined by the sensing technologies…Desirable being movements that are required by a given application." (Edwards, Larssen, Loke, & Robertson)

Not only must our team take these three types of movements into consideration when developing our system, but we must also make sure that our gesture interface is designed from a human based approach and not a technology one. The four principles of the human based approach are that a gesture should be easy to perform and remember, intuitive, metaphorically and iconically logical towards functionality, and ergonomic; not physically stressing when used often. (Granum, Moeslund, Nielson, & Storring)

5.1.3.2 Technologies that are Relevant to Our System

The technologies that are being developed to improve gesture interfaces are numerous. There have been many developments in the gaming field with the Xbox Project Natal, the Sony PlayStation Eye and Move, and the Nintendo Wii. However, there is one upcoming development for mobile telephones. This new technology is known as EyeSight Software. "EyeSight's software lets you control your mobile phone without actually touching it. It uses the built-in camera to manipulate the phone in many different ways." (Motion Tracking Creates Hands Free Cell Phone Control, 2010) This technology is very valuable to our team since we have made it a requirement of the system to recognize the behavior and moods of the user.

Another technology that is helpful to our system would be the surfaces such as Microsoft surface. Microsoft surface incorporates multi-touch that is a multi-finger, multi-user interface that has been bouncing around the world of computer science since the 1980s. (Derene, 2007) These surfaces allow multiple users to interact on one surface. This is an ideal way of allowing multiple museum users to interact and share with one another their experiences in the museum via photos and videos. It can also be a way for the museum to show videos to multiple users at the same time. A further use for these surfaces would be to incorporate the online community into them.

5.1.3.3 Features for our System

With gestures based interfaces there are a number of features that our team can add to make our system more interactive and fun to use. To keep things simple though we chose a few functions that we believe would aid the user in their tour of the museum and compliment the other modes in improving the user experience. Functions that we are thinking of including in our system include keeping gestures simple and easy to understand, the ability to use the mobile device as a motion controller, the ability to tour the museum by oneself, and the capability of the system recognizing the behavior and mood of the users and responding to them.

Keeping the gestures of our system simple follow the human-based approach of designing gesture interfaces as described earlier. These gestures will be intuitive, easy to remember, and make sense. Some of the simple gestures that we have in mind for the user to use include pinching and spreading for zooming in and out on an object.

Our reasoning for using the gestures of pinching and spreading to zoom in and out on an object has been partially explained above, but one of the main reasons is that it is a feature that is already built in to many smart phones. As Norman states "pinching and spreading seem like natural ways of zooming an object out and in…not all places allow this: another source of confusion." (Nielson & Norman) When Norman states that not all places allow this, he is referring to the fact that some applications make the pinch and spread gesture inactive and instead force you to zoom in and out using a different way. Why do such a thing though? There is simply no need to make a different way of zooming in and out on an object if the current gesture system works just fine and feels natural to the user.

Our team has decided to add some simple gestures to our system for the various games and motion control features. We have decided to keep the gestures simple and as intuitive as possible since "understandability is useful when new gestures are added to the gesture set and must be differentiated from past gestures" (LaViola Jr. & Marks, 2010) Some gestures that we have thought about are the stirring motion to simulate as though you were mixing ingredients to cook some cultural dish from Africa. We chose stirring because it is a relatively easy motion to do and does not become annoying after repeated use.

Another gesture that can be useful is a full arm swiping gesture in order to clear off the multi-touch screens that would be provided in the game area. This gesture is simple to understand since it would be like swiping off everything on a desk. Our reasoning for including large multi-touch surfaces like the Microsoft surface is because it brings a whole new level of interactivity to the user. Also, much like a projection screen a multi-touch surface "provides users with a more immersive feeling in their interactions with the virtual world" (Gupta, Kim, Lee, & Mazalek)

The justification of using the mobile device as a motion controller is backed up by the fact that eight out of ten people from our user studies said that they would want to use their mobile device as a motion controller. Furthermore, "gestures add a welcome feeling of activity to the otherwise joyless ones of pointing and clicking." (Nielson & Norman) It is through simple gestures that the motion controlling would be enacted. There is no need to create a complicated set of gestures that people will not be able to remember.

Furthermore, "nearly all people have physical and bodily memories, but not everybody has the vocabulary to express these experiences." (Moen, 2007) Gestures are important to have because nearly everyone has a way of expressing himself or herself through body language. So technology might as well begin developing ways of using human gestures since the human body has such a wealthy vocabulary of motions for certain actions.

The ability to go anywhere in the museum by oneself and have the system recognize where one is would also be an important feature of our system. User studies have shown that people want the Avatar, the representation of the system, to wait for them to come to an object before asking them what they want to learn or do. There are numerous ways of doing this. In terms of the action mode, the person can simply just walk around, and the system would use a built in GPS system that could keep track of the person's motions.

One last feature that we want to include is the ability of the system to recognize your gesture behaviors and your mood and respond accordingly. The previous eyesight technology will aid in this cause. It utilizes the device's built-in camera, advanced real-time image processing and machine vision algorithms, to track the user's hand motions and convert them into commands. (Junior, 2010) If this new technology can sense gestures, via hand motions, than it isn't that much further until phones can begin to recognize facial features and body language. The justification for this ability for the system to do this is the fact that the best "A good technology is an invisible one." (Junior, 2010)Using this type of technology would make the reactions of the system invisible to the user. The system would simply read the person and react accordingly, improving the user experience automatically. Finally, for those of you who are worried about the battery life being eaten up by gestural interfaces, in reality the opposite is true as stated by an article about eye-tracking software: it's better for battery life too." (Motion Tracking Creates Hands Free Cell Phone Control, 2010)

5.1.4 Haptic Mode (Ning)

5.1.4.1 Overview

When talking about the haptic mode, there are two possible understandings: one is about haptic communication while the other is about haptic technology. The focus of this haptic mode research will be how different haptic technologies are being developed based on the understanding of touch communication, as well as the potential of those technologies to be implemented into interaction design. The possibilities of using developed haptic technology into the certain user centered design project for AR-Africa Museum will be discussed

Haptic communication is communicating through touching. It can provide information about surfaces and textures, thus it is one of important senses for humans. Touching is often used in nonverbal communication that people do all the time, and it often works together with other human senses such as vision. (Wikipedia) Haptic technology is a tactile feedback technology that takes advantage of a user's sense of touch by applying forces, vibrations or motions to the user. (Robles-De-La-Torre, Isfh.org) Haptic technology is always being researched and developed to either assist in the enhancement of a certain type of feeling into different areas or the creation of virtual objects. Haptic technology allows the creation of computer-generated Haptic Virtual Objects, which can be touched and manipulated. It provides a rich combination of cutaneous and kinesthetic stimulation through a bidirectional haptic information flow between the Haptic Virtual Objects and human users. (Robles-De-La-Torre, Virtual Reality: Touch/Haptics, 2009)

5.1.4.2 Examples about haptic technology and application

In order to know how exactly haptic technology can help people gain more experiences with sense of touch, literature studies have been done and three examples are described below that focus on creating a certain type of feeling and enhancing visual simulation

5.1.4.2.1 Haptic influences on the Sense of Being Together

C. Ho, C. Basdogan et al. had an experiment to test if the haptic communication can influence the sense of people being together. (Basdogan, Durlach, Ho, & Slater) During the experiment two people sat at different locations and interacted with the same virtual environment. Whether a sense of togetherness was enhanced through force feedback from haptic communication was studied by asking uses questions like: to what extent did you have a sense of being with the other person? To what extent did you feel embarrassed, with respect to what you believed the other person might be thinking about you, in the way that you carried out this task? Conclusions were: the haptic plus visual condition results in a higher sense of reported togetherness than the visual only condition. Also females and elder ages tended to report a higher sense of togetherness than males. Togetherness was positively associated with the estimated extent of social anxiety of the remote partner. The degree of togetherness also significantly improved task performance

5.1.4.2.2 Haptic assists game experience

As haptic can enhance user feeling of being together, whether this point can be practically used becomes an important topic. A research and evaluation of a computer game for blind and visually impaired people using a new haptic audio virtual environment is a very good example by John Wood et al. (Byungha, Cha, Eom, Kim, & Ryu) The working system consists of a new two-finger haptic interface and Haptic Geometric Modeler that enables people to locate and interact with 3D computer-generated objects using their sense of touch and audio feedback. A simple search and adventure game was developed and tested. The evaluation results show that it is possible to create an enjoyable and immersive game using this approach. These technologies offer chances for the blind and visually impaired people with new leisure activities

5.1.4.2.3 Haptic enhances multimedia-broadcasting system

Another example is that haptic can help with creating a clearer picture of visual display for people that can then enhance the multimedia broadcasting system. There are four stages of a proposed system created by Oryong-dong et al (Bergamasco, Francisca Cano Arias, Graupp, Gutierrez, Magennis, & Wood)to do achieve the goal of creating a clearer picture of visual display. It contains: scene capture, haptic editing, data transmission, and display with haptic interaction. It is possible to have a brief data structure and processing algorithm of future realistic multimedia broadcasting system that includes a sense of touch. An example of the use of this system is provided in the case of home shopping. With a transmission over the system, the user can touch the real product with a haptic probe while seeing it on a screen.

5.2.4.3 Practical using in designing for AR-Africa Museum

Whether these haptic technology possibilities can be applied into the certain interaction design project largely depends on target users. In this case, it will be both the client AR-

Africa Museum and the museum visitors. In order to generate background ideas from the target groups, several user-centered design methodologies, including user surveys, user interviews, and user studies, have been done. The application was then designed based on smart phones with touch screens. The smart phone was chosen as the final design since it was the best fit for the client's wish of enhancing the user interaction experience in the museum while helping with visual disabilities. It also met the wishes from the museum visitor target group. As shown in user interviews a great amount of people preferred to stay with familiar devices that help when visiting the museum

Haptic technology can be practically implemented into the smart phone touch screen design. On one hand, it should work well together with other modes such as audio and visual interfaces. (Astley, Cruz-Hernandez, Grant, Hayward, & Robbles-De-La-Torre, 2004) Plenty of research has been done to find out these principles and in our design we will base the displays according to user preferences in our user studies. As the system should be able to provide information to the users at a certain time, the haptic representatives such as vibration can be applied upon notifications by default. In this case, visual audio and haptic modes can be active together to make sure the user gets the information. The user getting annoyed is important to take into consideration so the haptic feedback will only be given when the user has a need for it. This will basically be a change on the system. Vibrations for the menu must be off by default. Also as touch is always done by hand gestures, the haptic interface should also be under the consideration of being suitable for user to behavior on the limited screen, and detail design will be focused on this part and solve this problem.

On the other hand, the technology development of touch screen can contribute to a better user experience, especially for visual disabilities. V.G. Chouvardas et al (Chouvardas, Hatalis, & Miliou)have been researching into Tactation technology recently and it has the potential to be launched into real market in the near future. Tactation is the sensation perceived by the sense of touch, and is based on the skin's receptors. The blind or deaf can enhance their access to computer graphical user interfaces and to enhance mobility in controlled environments by using Tactation. The skin nerves can be stimulated through different types of receptors by mechanical, electrical, or thermal stimuli, while modalities such as vibration and pressure can stimulate these receptors. Thus in our design, different stimulus can be applied on certain area of touch screen to give users information. Example can be that a tactile display installed on mobile phone that provide an advanced human computer interface. It can reproduce the same tactile parameters from the shape and surface texture as well as roughness of those exhibition objects in the AR-Africa Museum while the visitors can feel it as real. Another possibility is to provide guide or other practical information with changes of temperature on certain area of touch screen, in this case it can largely help visual disabilities move, look around and to find out certain object to visit easily.

5.1.5 Implementation of the four modes (Luca)

5.1.5.1 Overview

The museum has four goals: increase the layers of information on the artifacts exposed in the inside part, making the museum a "cool" place for people ages 18-30 years old, creating a community of those interested in Africa arts and allowing those people to create content, and working with the digital rights issues.

5.1.5.2 The Game modality

Basing the research on our surveys we discovered that users would want to experience interactivity in the museum. So we focused our research on the appropriate media to provide them with this interactivity and to reach the museum's goal at the same time. We discovered that it would be really interesting to provide a game modality in our application to increase the interactivity, the motivation and the experience of the users inside the museum. What is especially interesting is that applications of this modality will increase the information that our user can learn during their visit. In fact, the learning principles that good games incorporate are all strongly supported by contemporary research in cognitive science, the science that studies human thinking and learning through laboratory research, studies of the brain, and research at actual learning sites like classrooms and workplaces. (New London Group, 1996)

Good games give information on demand and just in time, not out of the context of actual use or apart from people's purposes and goals, (James, 2003) "Motivation is the most important factor that drives learning. When motivation dies, learning dies and playing stops. Cognitive science has had a hard time defining motivation, though one definition is a learner's willingness to make an extended commitment to engage in a new area of learning." (Disessa, 2000)

Since good games are highly motivating and interactive, they allow the users to be producers and not just consumers. Based on our user studies, we designed a system that allows the user during the visit to have the possibility to play , inside the museum, videogames that interact with the artifacts and are based on the artifact information.

The use of videogames will also be useful to increase the "cool" factor of the museum: Video games are not only popular and they are becoming more and more a part of general cultural awareness. Huge numbers of devoted blogs cover the world of games, and even respected newspapers such as the Guardian devote space to video games on their websites.

We designed our application to allow the user during the visit the option of choosing to play videogames on their device whenever they want, helped by a simply tutorial at the beginning that explains the rules, the interface and the controls.

"Video game is an area with great potential. Our argument has been that, in order to study video games from an HCI perspective, we must understand their nature as games and media as well as software. We claim that interaction with video games is best understood in terms of values, a central feature of games generally. Specifically, the user-interface of a game represents values of gameplay to the player, and also mediates that player's expression of values through their conduct." (Bar, Biddle, & Nobles, 2006)

According to our surveys and users studies it will be possible to design games using all the functions of the system like the map, the avatar and the online community, and also all the technologies of the devices especially during the disability mode for the visually impaired.

Playing these games the users will have to explore the content of the museum and acquire information to get higher scores that will be possible to shares on the users profiles on the online community of the museum; with this system the users will reach new layers of information and also they will be motivated by the competition between the others members of the community. "Good games operate at the outer and growing edge of a players competence, remaining challenging, but do-able." (Disessa, 2000)

5.1.5.3 The Online community

'"The existence of such communities is often brought about by people who share similar goals, beliefs or values, with such commonality forming the basis of an agreement to form and sustain a virtual existence." (Figallo, 1998)

To create the community of people interested in African Arts we implemented in our system a direct connection between the application and the online community. The user installing the application on their phone will create a profile in the community, where the application will send all the information about the experience of the user inside the museum, during the tour or playing games.

"These social networking sites give everyone a place to share their personal stories, in words, pictures, and videos with their friends. They also connect people with friends and others who work, study, and live around them. They help people learn more about events, parties, and other social functions." (Cheung, Chiu, & Lee, 2010),

According to our user studies there will be a user profile, games scores, and an experience bar that will show like in a RPG (Role Play Game) the experience made by the user visiting the museum; this experience is calculated by the numbers of artifacts seen and by the amount of information asked to the avatar during the tour. Collecting the experience points the user will reach different level of "African Skill" like in the RPG games and will receive a rank on the profile that will show to the other members of the community his level of experience about the African Culture. This will give a return also at the elderly African arts lovers that use to follow the museum more often than the normal visitors:

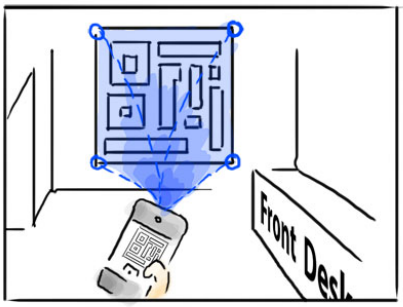
"On the other extreme is a group of community members that can be describes as 'elders', who are active members of the community, regularly posting to share their knowledge and the culture of the community." (Kim, 2000)

This system will give visitors the opportunity to enjoy the museum many times and will incentivize the interactivity between the visit and the community of the museum increasing also the participation. Anytime the users make new record in the game or a level up to a higher rank the Avatar will ask them if they want to share these scores on their social network page to give them the possibility to share not only with Afrika community but also with their acquaintances .

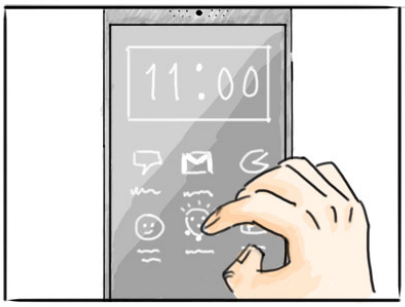
We designed the online community based on our research, making it interactive, competitive and just a passive provider of information about the museum's events.

"Through being based on such weak ties, many of these functional systems find their existence to be unsustainable, with the goals to keep the community going without being abandoned by its members. Actions, such as posting a message to a bulletin board or joining a sub-community require a drive that appears to be absent in the members who chose not to participate in online communities." (Bishop, 2006)

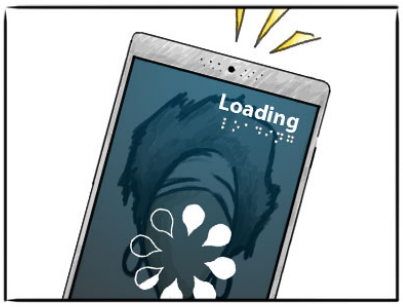
5.2 Storyboard (Gil)



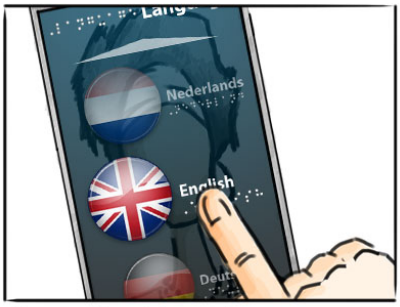
Scene 1: Installation



Scene 2: Accessing App



Scene 3: Loading App



Scene 4: User Selects a Language

Scene 5: Avatar welcomes user

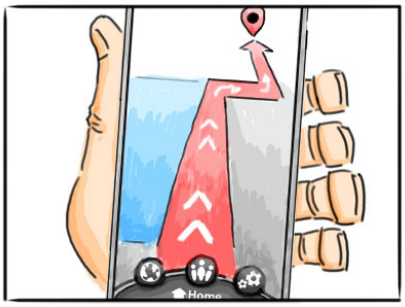
Scene 6: Avatar explains menu

Scene 7: User comes in a group

Scene 8: User joins a group

Scene 9: User takes the regular mode

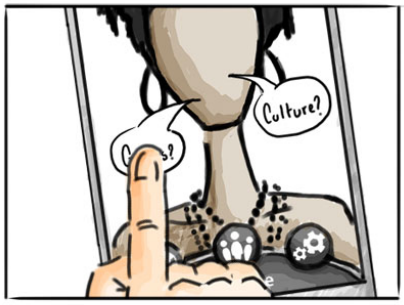
Scene 10: User takes cultural tour



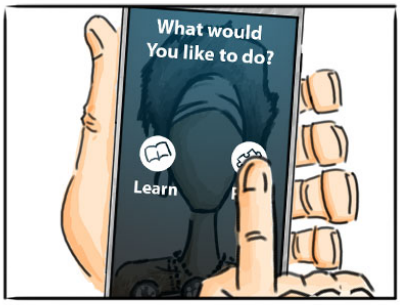
Scene 11: User Follows Tour

Scene 12: Avatar according to context

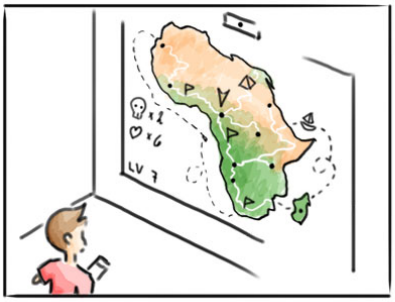
Scene 13: User goes home



Scene 14: User picks games mode

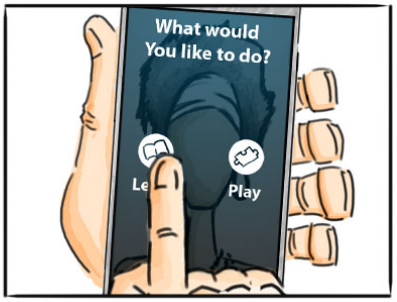


Scene 15: User decides to play a game



Scene 16: User plays

Scene 17: User Scores Points

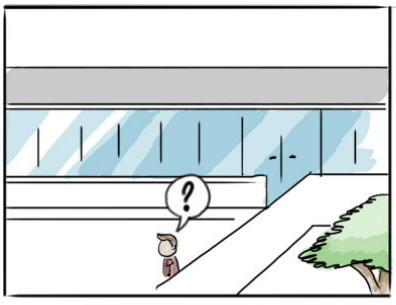


Scene 18: User selects Learn option

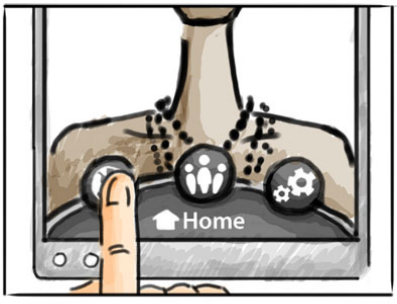
Scene 19: Avatar explains piece

Scene 20: User retrieves information

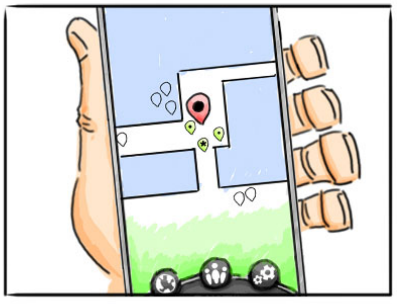
Scene 21: User lost his friends



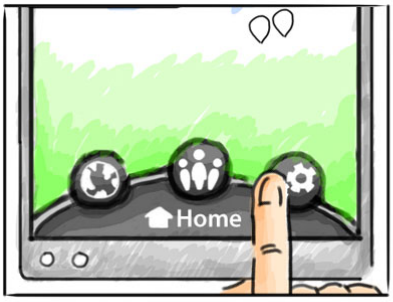
Scene 22: User wanders around



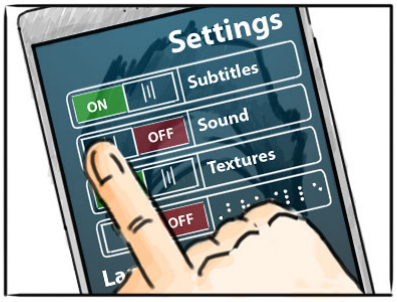
Scene 23: User clicks on Map



Scene 24: User finds his group members

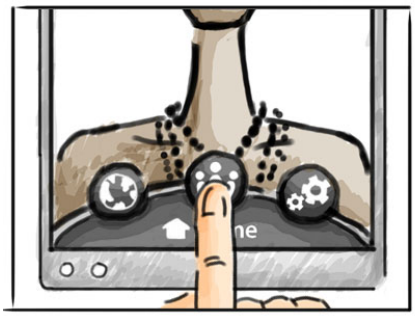


Scene 25: User goes to Settings

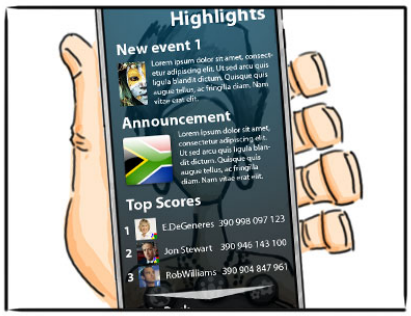


Scene 26: User turns sound off

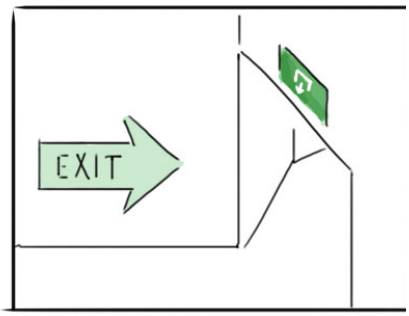
Scene 27: User goes back



Scene 28: Goes to Online Community



Scene 29: User looks at his score



Scene 30: User Leaves Museum

5.2.1 Scenes Explanation (Gil)

1. The user installs the application by scanning the QR Code placed in the most visible wall within the entrance of the museum.
2. The user opens the application for the first time.
3. The application is going to look for any previous information in the database of the user, in this case, since it is the first time the user visits the museum, the application will ask several configuration questions that otherwise would be skipped. The application loads for the first time.
4. Since this is the first time the user visits the museum, the application is going to ask what is the preferred language of the user. Because the user is likely to be able to speak Dutch that will be the default visible option. However, the user may be able to scroll a little and quickly find English as well if Dutch is not the language of his/her preference.
5. The user will find for the first time the avatar. He/She [Avatar] will meet the user. The Avatar will be speaking by default just in case the user is blind.
6. The avatar is telling the user how does the menu works and what the user will find in the main sections.
7. The application then leads the user to a screen that addresses whether or not the user came with company and if he/she does whether the user would like to start his own group in the application for his team.
8. The user indeed came with company, however, the group was already created by one of his friends, so he decides to join the group created by his friend.
9. The user is not visually impaired, so he decides to click on the regular mode that suits his needs better. Otherwise, the user settings would have included sound, and everything would have been written in both his language and braille system.
10. The user at this point is given two options; if he wants to enjoy a self-guided game oriented mode or a tour information and culture-oriented mode. The user finds himself choosing for the latter.
11. The screen gives the user directions to follow to the different pieces of the museum. The tour is revealed in parts as the user progresses through. The path is dynamic so the user may choose to skip any piece he deems not worth seeing.
12. Upon the arrival of the user to the piece, the avatar dresses him/herself according to the context of the piece and starts providing information in relation to the piece to the user. The user may choose to pause the avatar, replay it, go to the previous piece seen or go to the next piece in the tour.

13. The user decides to go back to the home screen to change his mode. By clicking on the home button the user is instantly sent to the home screen.
14. The user now decides to try the other mode that is more Game oriented and self-guided (no tour with directions is available).
15. Upon the arrival of the user to a piece the system detects that the user is approaching to the piece and displays a new screen that questions the user about what would he like to do. The user decides to play with whatever interactive game there may be for that piece (most likely a screen).
16. A screen in front of the user displays the game where the user may play. The user uses his device as a motion controller (only if required) to accomplish his task. The museum previously provided safety wristbands to the user so he is able to tie his mobile device to his wrist and avoid throwing it out to the air potentially harming someone else or himself.
17. The user achieved a new score and his mobile device shows him his progress in that particular game, along with his record and provides him with the option to display his score or accomplishment in the social network of the user preference. The user may skip it or share it. It all depends on his interest.
18. Once arriving to a new piece, the user gets again, the option to either play with the interactive game or learn a little bit of culture of the piece he has next to him. The user now decides to learn about it.
19. The avatar appears again, dressed up according to the context but this time the user can only pause/play it or retrieve more information than what the avatar is presenting.
20. The user retrieves the information and reads about the piece (both regular and visually impaired mode count with this feature but they work slightly different, since one can be read by the user and the other one the user listens and/or reads Braille written words in the screen.
21. The user lost sight of his friends and wonders where are they by looking around for any hints. The user is likely to be in such situation if he applies enough attention to his device and not to the surroundings.
22. The user wanders outside the museum while looking for his friends. While this happens, he remembers that they came in a group and registered as such in the system, therefore, the user wonders if he may find them in the map.
23. The user clicks on the map button to find out where he is and where his friends are. The map button is one of the four buttons available all the time by default in the wheel menu.
24. The user sees in the aerial view of the map that his friends are in fact close to him. He decides to approach them by using this tool. The green dotted pins are the members of his group. The transparent pins are simply other people. The system displays other people too in order to prevent unintentional collisions between walking users who aren't paying attention to their surroundings. The user finds his friends.
25. Curiously, the user decides to click on the other buttons on the menu to find out what they do. The user decides to start by clicking on the gears.
26. The user finds out that the gears lead him to the setting screen of the application where again he may customize his preferences in another format. He decides to slide the bar of sound and turn it off. He also decides to click on the slide bar to turn the subtitles on.
27. After configuring the application to his [user's] desires, he decides to go back to his home screen.
28. Again curious the user tries to click on the button that hasn't been explored yet.

29. The user finds out all the news of the museum and the upcoming events as well. This is the online community. The user finds this vibrant community of people posting Tweets, Buzzes and Posts related with the museum on Internet. He also finds an internal list of the museum of the best scores within determined period of time. He [the user] finds himself in the list of the top scorers.
30. After a fun and interactive afternoon, the user and his friends leave the museum. The application auto-locks itself to prevent the user using it outside of the museum. The user may return to the museum but next time his configuration will be remembered by the system, so he won't need to go through the configuration steps again. Also, next time the user visits back the museum he will find the most recent updates in the online community and the announcements of the museum. While the user can only make use of the application within the museum, he can be notified of the announcements and events going on in the museum by opening the application outside the museum. In other words, if the user opens the application outside the museum boundaries, he will only be able to access to the online community.

6. Design Evaluation(Andrea)

The use of low-fidelity prototyping techniques has blossomed over the last decade, with researchers claiming low-fidelity prototypes: (1) are an efficient way to search the design space (Virzi, What can you learn from a low-fideility prototype?); (2) are predictive of preferences in the actual product (Dumas, Thurrot, & Wiklund); (3) enhance user participation in the design process (Muller, 1991); (4) enable visualization of possible design solutions (Moggrdige, 1993); and (5) provoke innovation (Evensen, Rheinfrank, & Wulff). While there have been dissenting voices to the acceptance of prototyping in general (Thimbleby, 1985), current practice seems to demand some level of prototyping activity during the design process.

We address a critical question that appears to remain open: In the later stages of user-interface design, are low-fidelity prototypes as effective as high-fidelity prototypes in identifying usability problems? We cast the question this way because we think it is apparent that low-fidelity prototypes are useful in the early stages of design, before the details of the user interface are well known. One might also argue that even in later design phases, when it would be possible to build a high-fidelity working simulation of the product, low-fidelity techniques could be as effective in identifying usability problems. If this were true, then the choice of using low- or high-fidelity techniques would be based on considerations other than efficacy (e.g., cost). Alternatively, one could argue that low-fidelity prototypes can never be as effective as high-fidelity prototypes late in the design process. That is, one should build as high fidelity a prototype as possible, striving for realism as design activities progress. There are two forms this argument might take. First, one might suppose that there are particular aspects of a design that cannot be adequately simulated in a low-fidelity prototype. Thus, in using a low-fidelity prototype a usability specialist would risk missing an entire class of usability problems. A second argument against low-fidelity prototypes is that, due to their very nature, they are less effective in

detecting problems; that is, they are a blunt instrument when compared to a high-fidelity prototype. Thus, use of a low-fidelity prototype would mean risking sensitivity in detecting problems. That is, any given subject would detect a smaller percentage of the total problems using a low-fidelity prototype compared to a high-fidelity prototype.

Two studies are relevant to the current question. Nielsen (Nielsen, 1990)compared the effectiveness of two types of prototypes in a heuristic evaluation, a low-fidelity paper mockup and a higher fidelity (but not high fidelity) computer mockup. Nielsen claimed that evaluators using the computer mockup were more likely to see the major problems than evaluators using the paper mockup, but the study is difficult to evaluate because he provides very few procedural details. Some of the differences between mockups could have arisen from evaluator variability, and the most important result, the difference between conditions in finding major problems, was based on a measure of problem severity that was not validated

Wiklund et al. (Dumas, Thurrot, & Wiklund) examined the relationship between the aesthetic refinement of a prototype and perceived usability. They created four versions of an electronic dictionary that varied in how realistically they represented what the actual product looked like. Subjects rated the prototypes on a variety of scales including ease of use and ease of learning, both before and after using the prototypes. These ratings were not affected by level of realism. They also had these subjects use the actual device, and provide the same ratings. This manipulation pointed out one of the pitfalls of low-fidelity prototyping. Because they did not accurately represent the slow response times for some aspects of the actual device's performance, estimates of usability for all the prototypes were greater than that of the actual device. Wiklund et al. argue that prototype fidelity does not affect how sensitive the test is, that is, low-fidelity tools are not blunt, but it does affect the kinds of problems one can detect.

Prototype fidelity is a continuum, not a dichotomy, and a prototype can vary from the final product along several orthogonal dimensions, including breadth of features, degree of functionality, similarity of interaction, and aesthetic refinement. Breadth of features refers to the number of features the prototype supports. Each of these features can then vary in its degree of functionality, or the extent to which the details of its operation are complete. Similarity of interaction refers to how one communicates with the product (whether by pressing buttons, clicking a mouse, touching a screen, speaking, etc.), and aesthetic refinement refers to aspects of the product that do not directly influence its functionality, such as choice of colors and graphic design. Although prototype fidelity is difficult to define precisely, a prototype that compromises on one or more of these four dimensions in a way that is obvious to the user is a low-fidelity prototype. Low fidelity prototypes may have fairly complete breadth of features and degree of functionality and so may be similar to the final product on these dimensions, but users do not typically interact with low-fidelity prototypes in the same manner as the final product, and they do not typically look, and feel the same with respect to the last dimension, aesthetic refinement.

Although illuminating, the studies reviewed above have not addressed our particular issue. We wanted to know if low-fidelity prototypes are as effective as high fidelity prototypes in

detecting problems under the following conditions: (1) at the later stages of the product design process (i.e., when enough is known about the application to build a high-fidelity prototype); (2) when the study is under the supervision of usability specialists; (3) when the think-aloud protocol is used (Lewis); and (4) when the primary measure of effectiveness is the number of usability problems uncovered in a user interface.

6.1 Assisted Evaluation

6.1.1 User Testing Results (Ning)

Because of the time limitation, the testing for the system can only be based on low-fi paper prototype and only 2 people were tested. Here are the results and the feedback from one normal user and one expert user.

For both of them, the whole system was designed logically. They both agreed that it is a good design attempt aimed at helping the user with a better visiting experience in AR-Afrika Museum. The best feature of the current system is the different modes as well as the very convenient way of switching between different modes. Both testers believed that it would be a nice aid when going to visit a museum.

During the testing some problems were found. Some of the problems are because of the limitations of the lo-fi paper prototype. For example, both normal and expert users mentioned that the welcome screen is not clear enough for them. This is mainly because the whole design aims at creating welcome experience with both visual and audio support. This means when the user looks at the welcome screen there will be sound behind it as well as a welcome speech, but it can't be shown in the paper prototype. The two participants understood the reason for their confusion once the fact of what the welcoming screen would include was explained to them. Both of them then thought that the welcoming feeling would be improved with the sound working.

There are also some other problems related with the design. A lot of icons are not right to be used and are not placed at the right position. Two of the most important ones are the rotation icon and the icon for visual impaired mode. As suggested by the expert user, the rotation icon should be bigger and should be placed right above the scroll wheel, which would let the user clearly know that the scroll wheel is there. The icon of an eye with a line on it is not the right icon for visual impaired people and needs to be changed.

Problems with text were the most serious problems during the test. It is not clear enough to simply use labels such as 'Games', 'Culture' for different visiting modes like 'Tour mode' or 'Self-guided mode'. These words are only for designers, not for users. As during the design process, it is always good to name some certain points shortly just to speed up the design explanation, but those can't be directly used into the final design and prototype. It is right that there shouldn't be too much text on a mobile application but most important

thing is still to make things clear. This means some words can't be omitted. For the current prototype it is better to change the name into like 'Tour/Self guided mode', and also with some explanations below the name, to make sure users understand where they are and what they are supposed to do next.

There is one problem about system itself. The normal user participant mentioned that choosing whether you are a regular person or visually impaired person should be placed at the very beginning of the system, as it should be the first thing to check for every user.

The normal user mentioned that there is actually no difference between regular mode and disability mode, except the audio provider. So if possible it would be nice to differentiate this part, to make it more attractive towards all people from different target groups. There are also comments and recommendations on system functions, for example, the function of voting for favorite exhibition items were mentioned, and it can also be connected online, to help people choose what kind of exhibition they want to visit.

For the whole prototype, both participants think it works well as a lo-fi prototype. Some problems have been found during the test, which means it was a successful prototype, because the user testing and evaluation are always aiming at finding possible problems and then solving them. It is strongly recommended by the expert user that, as an interaction tool, hi-fi prototype will be needed, to make out the find design. But at this stage, those problems existing in current paper prototype which mentioned before should be fixed first. Later if possible hi-fi prototype with all other functions in can be tested, and then there will be more accurate feedbacks from user experience point of view.

6.1.2 Participants (Ning)

6.1.2.1 Participant A (Ning)

Test Place: Vrijhof, University Twente
Test Setting: Paper Prototype

Age: Smart phone experience:	24 Nokia Symbian User
Cases and Tasks	**1. User behaviors** **2. Problems** **3. Feedback and notes**
1) Please install the application	1. User hesitated a bit, not very sure 2. User did not understand that the QR-Code is for installing 3. User thought it won't be a real problem to install for the real application because she has experience in smart phone using
2) Please open the application	1. User chose and waited 2. No big problem

	3. User hope that there is not a long time to wait
3) Please select English	1. User touched and clicked the English flag 2. No problem 3. OK
4) Please access introduction screen	1. User waited and saw the introduction 2. No big problem 3. User thought without audio, only the picture is not very clear for her that it is the introduction screen, the welcome hand icon is too small for the user
5) Please select whether you are by yourself or with a group If you are in a group select a group to join or create your own group	1. User touched to fill in name and wait 2. No big problem 3. User asked if it is possible to see all existing groups in the museum at the same time
6) Please look at the user settings	1. User clicked the Setting menu from the home screen 2.No problem
7) Please go back to the Home page	1. User clicked Go Back 2. No problem
8) Please choose the disability mode and take a look at it before going back to the Home page	1. User stopped 2. User totally did not understand what 'Regular' and the eye icon means, before explanation. 3. After explanation user thought to choose as normal or visual blind options should be placed at the very beginning, before language selection.
9) Please choose regular mode now	1. User clicked on Regular 2. No big problem
10) Please choose the tour mode	1. User stopped 2. User did not understand Games and Culture means what, before explanation 3. Better change name to Tour/Self guided mode
11) Please go back and choose self guided mode	1. User touched and clicked Home 2. No problem
12) Please try to find out more information about the certain object	1. User waited for the Learn/Play screen to show, but then stopped 2. User did not get the idea about what is Learn and what is Play before explanation 3. Better change words
13) Please play a game	1. User clicked Play

	2. No problem
14) Please publish your scores online	1. User clicked on Share 2. No problem
15) Please choose the online community (you can access this using the scroll wheel)	1. User stopped 2. Before explaining that you can use the scroll wheel to find out the online community, user did not know where to go, but after explanation user easily access the online community 3. At the very beginning user did not notice the scroll wheel at all, and user thought this is the main problem for her, but maybe others will notice the wheel so it won't be a problem

6.1.2.3 Participant B (expert) - (Ning)

Test Place: de Horst, University Twente
Test Setting: Paper Prototype

Age: Smart phone experience:	23 iPhone User, with UCD design experience
Cases and Tasks	**1. User behaviors** **2. Problems** **3. Feedback and notes**
1) Please install the application	1. Look at the install screen 2. The install screen is not clear enough 3. Normally for install screen, you should have some explanation as these words will guide people to install, because it is the most important part for starting an application
2) Please open the application	1. User wait 2. OK
3) Please select English	1. User touched and clicked the English flag 2. No big problem 3. Here it is better to consider, better to make both the flag and the text clickable, because it is possible that some users will click on the flag while others will choose on words
4) Please access introduction screen	1. User look at the screen 2. Not a good welcome screen enough 3. As the limitation of lo-fi paper prototype, it shows to be not a very good welcome screen, it can work better with audio help, for example to have welcome speech at the same time. But for the screen itself, recommend to make the welcome icon more clear, it is also possible to add text with 'Welcome', which will just help with providing a clearer understanding of the certain screen for uses

5) Please select whether you are by yourself or with a group If you are in a group select a group to join or create your own group	1. User selected group, touched to fill in name and wait, then clicked create 2. No problem 3. Very clear, and with proper text
6) Please look at the user settings	1. User clicked the Setting menu from the home screen 2. No problem 3. It is good to put Settings on the Home screen
7) Please go back to the Home page	1. User clicked Go Back 2. No problem 3. The Go Back button is placed logically, as normally people have the general idea that Go Back is under bottom and left side.
8) Please choose the disability mode and take a look at it before going back to the Home page	1. User asked if the Regular and the eye icon means normal and disability mode, then clicked 2. The icons are not clear enough 3. The eye with a line is not a typical icon for visual impaired, also the word 'Regular' is not clear, change both of them
9) Please choose regular mode now	1. User clicked on Regular 2. Now no problem, but same recommendation as 8
10) Please choose the tour mode	1. User stopped 2. It is not clear enough to name Games and Culture for different visiting modes 3. Better change name to Tour/Self guided mode, and maybe with some explanations below the name.
11) Please go back and choose self guided mode	1. User touched and clicked Home 2. Then again the same problem mentioned before
12) Please try to find out more information about the certain object	1. User waited for the Learn/Play screen to show, then clicked on Learn 2. No big problem 3. The words better need to be thought over, as Learn maybe better named as 'More information'
13) Please play a game	1. User clicked Play 2. No big problem 3. The words better need to be thought over, as Play maybe better named as 'play a game'
14) Please publish your scores online	1. User saw the screen 2. No problem
15) Please choose the	1. User stopped

online community (you can access this using the scroll wheel)	2. Two problems: first, not sure that where the online community is places, second, after knowing that you can select it from the scroll wheel, then it is very important to show before. 3. At the welcome screen, it needs to show that there is a scroll wheel, the rotation icon should be bigger and placed exactly above the scroll wheel.

6.2 Heuristic Evaluation (Andreea)

Expert evaluation looks at the complete system from many perspectives and reveals potential problems such as inconsistency, support for different ways of working, visibility of information and language use. It also enables elements such as error messages to be thoroughly investigated.

6.2.1 The benefits of expert evaluation

It is something of a given in the usability industry that testing with real users is the most effective way of identifying interface issues that may cause usability problems. Whilst it is true that testing is the best way to get real feedback on user experience with a site or application, there is an argument that evaluation by an expert is an equally efficient way to identify these problems.

For some reason, the process of expert evaluation in usability circles has acquired the name 'heuristic evaluation', a term that is largely inaccurate in this context and certainly confusing for those unfamiliar with the jargon. However, that is a different story. Here we are more concerned with the pros and cons of expert evaluation as compared with user testing.

6.2.1.1 The Case Against

Recent research has suggested that expert evaluation cannot be relied upon to identify 'real' interface problems. For example, (Allan, Bailey, & Raiello, 1992) reports that 46% of problems identified in an expert evaluation are real problems, 54% are false alarms, and about 20% of real problems are missed altogether. He concludes that "the only way to determine the real usability problems in a website is to conduct well-designed and professionally executed performance tests".

6.2.1.2 The Case For

However, there are a number of questions to be asked about this data and conclusion. The data says nothing about the seriousness of each problem. One usability problem may cause important users to be unable to complete a common task, whereas another may only cause

a minority of less important users to take longer than necessary to complete a less important task.

This data also assumes that because a problem identified in an evaluation does not occur in a user test, it is therefore not a problem. This is an unusual way of looking at things - reminiscent of the driver who claims speeding is safe because “I've never had an accident".

6.2.2 Representing Minorities

Many problems will occur for a minority of users but not for any of those tested. Very rarely can a user test represent 95% of all users, though preventing 5% of your customers from buying is a serious issue for your business. In a heuristic evaluation, evaluators can look at the system from the perspective of the user population as a whole, anticipating problems that only a small minority would experience and only in particular circumstances.

Imagine if software engineers carried out functional testing by simply running through the major tasks in the kind of way most users would perform them. The result would be an extremely buggy product. User testing is nowhere near as comprehensive as software functional testing - expert evaluation can help to fill in the gaps.

6.2.3 Filling In The Gaps

A statement that 20% of problems identified in a user test are missed in an expert evaluation begs the question - how many problems identified in an expert evaluation are missed in a user test?

A user test will uncover the major problems that real users will have using the system to carry out the major tasks. However, there are likely to be a number of potential problems that are not uncovered by a user test, because:

6.2.3.1 None of the users in the test actually had the problem

None of the users in the test carried out the task in such a way that the problem arose

Casting an expert eye over the interface reveals some issues that may well cause problems for those user profiles perhaps not represented in the test participants. Even problems experienced by only 1% or 5% of users are worth resolving.

Similarly, there are usually many possible ways of carrying out any particular task. It may be that an interface supports some methods very well but for other methods it fails to provide the right information at the right time. A small number of users in a user test are not likely to cover all the ways that all users will carry out a task.

What to say is the key issue in interaction design of our project, and the main usability determinant. Whether you say something by speaking or by typing is less important to most users. Thus, voice interfaces will not free us from the most substantial problems of user interface design:

- Selecting the **tasks** to support,
- Determining the **structure** of the dialogue,
- Deciding which **commands or features** are available,
- Letting users **specify** what they want, and
- Making the system provide **feedback** on its actions.

All that voice does is let users speak, rather than write, commands and parameters. A small part of the puzzle, indeed.

So, it is not that voice is useless. It is just that it is often a secondary interaction mode when additional media are available. It is much easier to pick out the desired item from a list when the list is displayed on a monitor than when it is read aloud. Voice is a one-dimensional medium with zero persistence; a monitor is a **two-dimensional** medium that combines **persistence** (you can look at it for as long as you please) with **selective updating** (you can type a value into a field anywhere on the screen without changing the rest of the screen).

Animation and other multimedia effects also add to the richness of visual interfaces. The bottom line, though, is that **visual interfaces can communicate much more information** than auditory interfaces whenever users have a monitor and are capable of looking at it.

You can stand in front of an object with an application that, sensing your location, is already displaying precisely the right information. It might offer historical background or direct you through links to other works that have some connection to the object. It might provide links to critical commentary. It might become, for each object, an exhibition in itself, ripe with alternate narratives and elaborate associations, or even encourage the users to play games.

And, best of all, you could save it for later, glance up from the screen and look carefully at what faces you, all scrims removed, all distractions discarded.

6.2.4 Conclusion

Expert evaluation looks at the complete system from many perspectives and reveals potential problems such as inconsistency, support for different ways of working, visibility of information and language use. (Hvannberg & Law, 2002) It also enables elements such as error messages to be thoroughly investigated. In a user test, many potential error messages simply do not appear because no users make the error.

6.3 Satisfaction Questionnaires

6.1.2.2 Participant A: Post-Test Survey (Ning)

1. On a scale of 1-10, 1 being the worst, and 10 being the best, how would you rate your user experience?
   - 6
2. What did you like about the prototype application for the Afrika Museum?
   - I like it, but the settings takes too long time.
3. What features do you think should be added? What features do you think are redundant?
   - Add: The regular/disable mode icons are not clear. The icon shows to turn around the scroll wheel is not clear.
   - Redundant: The About screen has too much text. The setting session at the very beginning costs too much time Do not think game is a must
4. Are the functions and features all logically placed?
   - With explanation the whole system is clear enough, but some icons are really not clear, these things lead to a big failure on explain the function for the application, for example the eye with a line on it means visual blind mode, and really did not get the idea.
5. What do you think about the font size and type and colors of the prototype? Do you think improvements should be made?
   - Some icons are too small, for example on the welcome screen the hand icon is too small, which did not see. Also the important one, the one shows that there is a scroll wheel that can be rotated; this one should be bigger and clearer.
6. Would you use the application again? Why or why not?
   - No, the setting is too complicated.
7. Do you think there should be more games?
   - No. I don't get the idea why to put games in visiting museum.
8. Should there be more interaction with other users?
   - Yes. For example, users can vote for their favorite exhibition items.
9. Do you think there should be more material than just news, events, special events, and game scores and ranks on the online community? Do you have any suggestions of what to include?
   - No, see above.
10. Do you have any other suggestions for improving our prototype?
    - There are actually no differences on regular mode and disability mode, except the audio provider, maybe you can spend more idea on this part, and also the visual things can be improved.

6.1.2.4 Participant B: Post-Test Survey (Ning)

1. On a scale of 1-10, 1 being the worst, and 10 being the best, how would you rate your user experience?
   - 7

- It is a nice design. Something went not so smoothly in the testing is because of the limitation from lo-fi paper prototype, so this is acceptable. There are some problems related with especially text name and icon design. As sometimes designers know very well about those names but users won't know, so do not be loath to the needed explanations.

2. What did you like about the prototype application for the Afrika Museum?
    - It does help when visiting museum. I like the different modes provided in the system very much, just be aware that users will get a clear understanding when they choose those different modes. In short, mode name needs to be thought over again.
3. What features do you think should be added? What features do you think are redundant?
    - Add: There should be some explanation added at some certain points, as only designers know those really simple words mean what. User will get stuck if they only see like 'learn'/'play'.
    - Redundant: No
4. Are the functions and features all logically placed?
    - It is logical. Only need to change word description of functional button.
5. What do you think about the font size and type and colors of the prototype? Do you think improvements should be made?
    - Some icons are too small; especially they are very important ones.
    - The welcome icon is not clear enough. And the rotation guide icon for sure needs to be bigger, and placed above the scroll wheel.
6. Would you use the application again? Why or why not?
    - Yes, will be helpful when visiting.
7. Do you think there should be more games?
    - Could be fun, but depends on what kind of the museum it is.
8. Should there be more interaction with other users?
    - With explanations, I think there are already a lot of interactions in this system, also with sound on. Games will also be one type of interaction. The way of how the system will provide more information towards exhibition items is not included in the prototype and this can be an interesting topic to go further.
9. Do you think there should be more material than just news, events, special events, and game scores and ranks on the online community? Do you have any suggestions of what to include?
    - I cannot think much more now, I think for an application that helps when visiting museum it is now already enough.
10. Do you have any other suggestions for improving our prototype?
    - Yes. As it is really an interaction tool, to really test it won't be like now using the paper prototype. It would be nice if those problems mentioned before can be solved first, and if possible hi-fi prototype with all other functions in can be tested, then you will get more accurate feedback from user experience as well.

7. Conclusions and Future work (Alex)

Through the past eight weeks our group has designed an Augmented Reality System for the Afrika Museum that incorporates the museum's three goals of making the museum a "cooler" place for people in the age ranges of 18-30 years, making the museum more accessible to the visually impaired, and creating an online community that lets users stay in touch with the museum.

We have conducted user surveys, user studies, user interviews, and usability tests during the process of creating our system and have also created a number of requirements for our system, all of which, after tests, have been met by our system. Through our report we have shown that it requires a combination of all four-communication modes in order to create a design that is interactive, informative, and useful to users.

For future work, and before the full implementation of the system into the museum, there should be more user tests conducted to find any more errors before a trial run is conducted in the museum. Although, based on current testing, the prototype can be taken into further higher fidelity development for testing. Once the higher fidelity prototype is created, further testing needs to be done with several users, before a trial run with a working prototype is done.

8. Acknowledgements (Alex)

Our group would like to thank the Museum, our Professor, Dr. Thea M. van der Geest, and our friends for helping us out with our project through reviews of our report, doing our surveys, and answering our questions about the general requirements for the project.

9. Bibliography

1. U.S. Department of Health & Human services. (n.d.). *Use Dark Text on Plain, High-Contrast Backgrounds*. Retrieved October 25, 2010, from http://www.hhs.gov/web/policies/webstandards/backgrounds.html

2. U.S. Department of Health & Human Services. (n.d.). *Font Size and Typeface*. Retrieved October 23, 2010, from http://www.hhs.gov/web/policies/webstandards/fontsize.html

3. *Wikipedia*. (n.d.). Retrieved October 17, 2010, from Haptic Communication: http://en.wikipedia.org/wiki/Haptic_communication

4. Wolfmaier, T. G. (1999). *Designing for the Color-Challneged: A Challenge.* Retrieved October 28, 2010, from http://www.internettg.org/mar99/accessibility_color_challenged.html

5. Virzi, R. (n.d.). What can you learn from a low-fideility prototype? 224-228.

6. Virzi, R. Refining the test phase of usability evaluation: How many subjects is enough? *Human Factors , 34* (4), 457-468.

7. Abras, C., Maloney-Krichmar, D., & Preece, J. (2004). User Centered Design. *Encyclopedia of Human-Computer Interaction* .

8. Allan, R., Bailey, R., & Raiello, P. (1992). Usability testing vs. heuristic evaluation: A head-to-head comparison. *Human Factors Society*, (pp. 409-413).

9. American Optometry Association. (n.d.). *Color Vision Deficiency*. Retrieved October 25, 2010, from http://www.aoa.org/x4702.xml

10. Astley, O., Cruz-Hernandez, M., Grant, D., Hayward, V., & Robbles-De-La-Torre, G. (2004). Haptic Interfaces and Devices. *Sensor Review* , 16-24.

11. Arditi, A. P. (n.d.). *Making Text Legible: Designing for People with Partial Sight*. Retrieved October 26, 2010, from Making Text Legible: http://www.lighthouse.org/accessibility/design/accessible-print-design/making-text-legible/

12. Byungha, A., Cha, J., Eom, S., Kim, S., & Ryu, J. *Haptic Interaction in Realistic Multimedia Broadcasting.*

13. Basdogan, C., Durlach, N., Ho, C., & Slater, M. *An Experiment on the Influence of Haptic Communication on the Sense of Being Together.* Massachusetts Institute of Technology, Cambridge.

14. Bar, P., Biddle, R., & Nobles, J. (2006, October 2). Video game values: Human-computer interaction and games. 181.

15. Beatty, D., Esterhuizen, H. L., & Lange, R. W. (n.d.). Performance differences between Times and Helvetica in Reading Task. 142-146.

16. Bergamasco, M., Francisca Cano Arias, E., Graupp, H., Gutierrez, T., Magennis, M., & Wood, J. *The Design and Evaluation of Computer Game for teh Blind in the GRAB Haptic Audio Virtual Environment.*

17. Bernard, M., Frank, T., McKown, J., & Mills, M. (n.d.). *Which fonts do Children prefer to read Online*. Retrieved October 27, 2010, from http://www.surl.org/usabilitynews/31/fontJR.asp

18. Bishop, J. (2006). *Increasing participation in online communities: A framkework for human-computer interaction.* University of Glamorgan, School of Humanities, Law and Social Sciences. Pontypridd: Llantwit Road.

19. Brewster, S. A. (1997). *Using non-speech sound to provide navigation cues.* Department Report, University of Glasgow, Department of Computing Science.

20. Carbonell, J., Hauptmann, A., Hayes, P., & Tomita, M. P. (1987). Spoken Language: A Semantic Caseframe Approach. *Coling. 86.* Bonn: Association for Computational Linguistics.

21. Cheung, C., Chiu, P., & Lee, M. (2010). *Online Social Networks: Why do students use facebook?* Hong Kong Baptist University, University of Hong Kong, Department of Finance and Decision Sciences, Department of Information Systems, Hong Kong.

22. Chouvardas, V., Hatalis, M., & Miliou, A. *Tactile Displays: Overview and Recent Advances.* Aristotle University of Thessaloniki, Informatics Department, Thessaloniki.

23. Condouris, A. (n.d.). *Web Page Readability.* Retrieved October 25, 2010, from Ezinearticles.com: http://ezinearticles.com/?Web-Page-Readability&id=2839362

24. Cruz, E. M., Cardena, H. S., Cabrera, A., Garcia, C. B., Santos-Morabe, E. T., & Nanagas, L. R. (n.d.). Prevalence of Color-Vision deficiency among male-highschool students. *The Philippine Journal of Ophthalmology* .

25. Evensen, S., Rheinfrank, J., & Wulff, W. (n.d.). Animating interfaces. 241-254.

26. Edwards, A. D., & Mitsopoulos, E. N. (1999). A Principaled Design Methodology for Auditory Interaction. *INteract 99* (pp. 263-271). Edinburgh: IOS Press.

27. Edwards, J., Larssen, A. T., Loke, L., & Robertson, T. *Understanding Movement as Input for Interaction – A Study of Two Eyetoy™ Games.* University of Technology, Sydney, Faculty of Information Technology, Sydney.

28. Dumas, J., Thurrot, C., & Wiklund, M. (n.d.). Does Fidelity of software prototypes affect the perception of usability? 399-403.

29. *Description Key for Educational Media*. (2008, November 4). Retrieved September 7, 2009, from The Descriped and Captioned Media Program: http://www.dcmp.org/descriptionkey/

30. Derene, G. (2007, May 30). *Microsoft Surface- Exclusive Review*. (B. Chertoff, Producer) Retrieved October 16, 2010, from YouTube: http://www.youtube.com/watch?v=-9j_tYP-kzc&feature=fvst

31. Disessa, A. (2000). Changing Minds.

32. Fulcher, R., & Palmar, J. (2010). Android UI Design Patterns. USA.

33. Figallo, C. (1998). Hosting Web Communities: Building Relationships, increasing customer loyalty and maintaining a competitive edge.

34. Gupta, G., Kim, H., Lee, H. J., & Mazalek, A. *WiiArts: Creating collaborative art experience with WiiRemote interaction.* Georgia Institute of Technology, Synaesthetic Media Lab, GVU Center, Atlanta.

35. Gaultney, V. *Balancing typeface legibility and economy: Practical techniques for the type designer.* University of Reading, Reading.

36. Gaver, W. W. (1989). The SonicFinder: An Interface That Uses Auditory Icons. *Human Computer Interaction 4* , 67-94.

37. Google Inc. (2010). *Supporting Multiple Screens*. Retrieved October 24, 2010, from Android Developers: http://developer.android.com/guide/practices.screens_support.html

38. Gruber, J. (n.d.). *iPhone Fonts*. Retrieved October 23, 2010, from http://daringfireball.net/2007/07/iphone_fonts

39. Granum, E., Moeslund, T. B., Nielson, M., & Storring, M. (n.d.). A procedure for developing intuitive and ergonomic gesture interfaces for HCI. *Michael Nielsen, Moritz Störring, Thomas B. Moeslund, and Erik Granum* .

40. Hvannberg, E., & Law, L. (2002). Complementarity and Convergence of Heuristic Evaluation and Usability Test: A Case Study of UNIVERSAL Brokerage Platform. *NordCHI*, (pp. 71-80).

41. Hjerde, M. (2008). *Mobile Screen Size Trends*. Retrieved October 24, 2010, from http://sender11.typepad.com/sender11/2008/04/more-on-mobile.html

42. Junior, D. (2010). *Eyesight Brings Natural User Interface to Android Devices.* Android Community.

43. Jurafsky, D., & Martin, J. (2009). *Speech and Language Processing-An Introduction to Natural Language Process, Computational Linguistics and Speech Recognition.*

44. Jacobs, G. H., & Williams, G. A. (n.d.). *The Prevalance of Defective Color Vision in Old World Monkeys and Apes*. Retrieved October 28, 2010, from http://onlinelibrary.wiley.com/doi/10.1002/1520-6378(2001)26:1+%3c::AID-COL27%3E3.0.CO;2-6/abstract

45. James, P. (2003). What Video Games have to Teach Us About Learning and Literacy.

46. Kyrnin, J. (n.d.). *Guide, Color Blindness can make your webpages unusable*. Retrieved October 23, 2010, from About.com.

47. Kim, A. (2000). Community building on the web: Secret strategies for successful online communities.

48. LaViola Jr. , R. L., & Marks, J. J. (2010, July 27). An Introduction to 3D Spatial Interaction with Video Game Motion Controllers.

49. Lewis, C. *Using the "thinking-aloud" method in cognitive interface design.* IBM.

50. Lea, W. (1980). *Trends in Speech Recognition.* Englewood Cliffs, NJ: Prentice-Hall.

51. Lowgren, J. (1995, September). Personal Communication.

52. New London Group. (1996). A Pedagogy of multiliteracies: Designing social features. *Harvard Educational Review , 66*, 60-92.

53. Nielsen, J. (1990). Paper versus Computer Implementations as Mockup Scenarios for Heuristic Evaluation. *IFIP INTERACT* , (pp. 315-320).

54. Nielson, J. (n.d.). *F-Shape Pattern for Reading Web Content*. Retrieved October 25, 2010, from http://www.useit.com/alertbox/reading_pattern.html

55. Nielson, J., & Norman, D. A. (n.d.). Gestural Interfaces: A Step Backward In Usability. *Design and Usability* , 46-49.

56. Muller, M. (1991). An exploration in participatory design. *Human Factors in Computing Systems ACM*, (pp. 225-231). New York.

57. Moen, J. (2007). From Hand-Held to Body-Worn: Embodied Experiences of the Design and Use of a Wearable Movement-Based Interaction Concept. *TEI'07* , 251-258.

58. Moggrdige, B. (1993). Design by story-telling. *Applied Ergonomics , 24* (1), 15-18.

59. Montgomery, G. (n.d.). *Color Blindness: More Prevalant among Males.* Retrieved October 28, 2010, from http://www.hhmi.org/senses/b130.html

60. *Motion Tracking Creates Hands Free Cell Phone Control.* (2010). Eye Tracking Update.

61. Perez, A. M. (2008). *Common fonts to all versions of Windows&Mac equivalents*. Retrieved October 23, 2010, from http://www.ampsoft.net/webdesign-l/WindowsMacFonts.html

62. Swanson, G. (n.d.). Graphic Design & Reading: Explorations of an Uneasy Relationship. 104.

63. Snell, S. (2009). Mobile Web Design Trends for 2009. *Smashing Magazine* .

64. Rudnicky, A. The Lexical Access Component of the CMU Continuous Speech Recognition System. *IEEE International Conference on Acoustics, Speech, and Signal Processing*, (p. 1987).

65. Ritter, D. J. (2001). *LabVIEW GUI: essential techniques* (Professional ed., Vol. 1). McAllister Publisher Services LLC.

66. Robertson, C. (n.d.). *Android UI Design Patterns*. (G. Inc., Producer) Retrieved from http://www.youtube.com/watch?v=M1ZBjlCRfz0

67. Robertson, K. (n.d.). *On White Space*. Retrieved October 25, 2010, from Logoorange: http://www.logoorange.com/white-space.php

68. Robles-De-La-Torre, G. (2009). Virtual Reality: Touch/Haptics. Thousand Oaks, CA, United States: Sage Publications.

69. Robles-De-La-Torre, G. (n.d.). *Isfh.org.* Retrieved February 26, 2010, from International Society for Haptics: Haptic Technlogy, an Animed Explanation.

70. Thimbleby, H. (1985). Failure in the technical user-interface design process. *Computers and graphics* , 187-193.

10. Appendix

10.1 Moodboard

10.2 Wordle


African
Augmented
Technologies
Culture
Interaction
Motion
Dancing
Reality
controller
New
Images
Ritual
Audience
Africa
Music
Wide
Impairment
Prototypes
Mythology
Multimedia
Visual
Centered
Design
Virtual
Online
Sound
Masquerades
Experience
Art

10.3 User Survey Results

Statistics for Museum Survey

Total submissions: 43

* *Calculated using numeric values*

Multiple choice - one answer (button)
Question

What is your age?

Total responses (N): 43 Did not respond: 0

Numeric value	Answer	Frequency	Percentage
1	6-10 years	0	0.00%
2	11-14 years	0	0.00%
3	15-17 years	1	2.33%
4	18-24 years	30	69.77%
5	25-30 years	8	18.60%
6	31+ years	4	9.30%

	Response statistics*
Mean	4.35
Median	4.00
Mode	4
Min/Max	3/6
Standard deviation	0.69

Multiple choice - one answer (button)
Question

Have you ever been to a museum?

Total responses (N): 43 Did not respond: 0

Numeric value	Answer	Frequency	Percentage
1	Yes	43	100.00%
2	No	0	0.00%

	Response statistics*
Mean	1.00
Median	1.00
Mode	1
Min/Max	1/1
Standard deviation	0.00

Multiple choice - one answer (button)
Question

When was the last time you went to a museum?

Total responses (N): 43 Did not respond: 0

Numeric value	Answer	Frequency	Percentage
1	within the last week	2	4.65%
2	within the last month	11	25.58%
3	within the last year	20	46.51%
4	more than a year ago	10	23.26%

	Response statistics*
Mean	2.88
Median	3.00
Mode	3
Min/Max	1/4
Standard deviation	0.82

Multiple choice - one answer (button)
Question

	Response statistics*

Why haven't you been to a museum within the past year? (Select the main reason why you don't go.)

Total responses (N): 34 Did not respond: 0

Numeric value	Answer	Frequency	Percentage
1	It is too far	2	5.88%
2	I have no time	6	17.65%
3	I am not interested	11	32.35%
4	I have no idea what museums there are	3	8.82%
5	It costs too much or I don't want to pay	3	8.82%
6	There are no popular museums around	6	17.65%
7	Other:	3	8.82%

Mean	3.85
Median	3.00
Mode	3
Min/Max	1/7
Standard deviation	1.79

Multiple choice - one answer (button)
Question

How far would you go in one day to see a museum?

Total responses (N): 41 Did not respond: 0

Numeric value	Answer	Frequency	Percentage
1	0-15 miles (0-24 km)	16	39.02%
2	16-30 miles (25-48km)	12	29.27%
3	31-60 miles (49-97km)	6	14.63%
4	61+ miles (98+ km)	7	17.07%

	Response statistics*
Mean	2.10
Median	2.00
Mode	1
Min/Max	1/4
Standard deviation	1.11

Short response
Question

What is your favorite Museum?

Total responses (N): 43 Did not respond: 0

Statistics are not calculated for this question type.

Short response
Question

Why is it your favorite Museum? (Answer only if you have a favorite Museum.)

Total responses (N): 33 Did not respond: 10

Statistics are not calculated for this question type.

Multiple choice - multiple answers (check)
Question

What type of museum was it? (Answer only if you have a favorite Museum. You can also select multiple answers)

Total responses (N): 38 Did not respond: 5

Numeric value	Answer	Frequency	Percentage
1	Art	23	60.53%
2	History	18	47.37%
3	Science	11	28.95%
4	Other:	5	13.16%

	Response statistics*
Mean	1.96
Median	2.00
Mode	1
Min/Max	1/4
Standard deviation	0.98

Multiple choice - one answer (button)
Question

On a scale of 1 to 5 with 5 being the best and 1 being the worst, how would you rank the experience of your favorite museum? (Answer only if you have a favorite Museum.)

Total responses (N): 36 Did not respond: 7

Numeric value	Answer	Frequency	Percentage
1	1	0	0.00%
2	2	0	0.00%
3	3	0	0.00%
4	4	20	55.56%
5	5	16	44.44%

	Response statistics*
Mean	4.44
Median	4.00
Mode	4
Min/Max	4/5
Standard deviation	0.50

Multiple choice - multiple answers (check)
Question

Which of the following would encourage you to come to a museum? (You can select multiple answers)

Total responses (N): 43 Did not respond: 0

Numeric value	Answer	Frequency	Percentage
1	Special Themes	38	88.37%
2	Interactive exhibits	27	62.79%
3	Free food samples	10	23.26%
4	Games in the museum	12	27.91%
5	Live shows	14	32.56%
6	Days where it costs nothing	21	48.84%
7	Other:	0	0.00%

	Response statistics*
Mean	3.00
Median	2.00
Mode	1
Min/Max	1/6
Standard deviation	1.90

Multiple choice - multiple answers (check)
Question

What do you expect when you go to a museum? (You can select multiple answers)

Total responses (N): 43   Did not respond: 0

Numeric value	*Answer*	*Frequency*	*Percentage*
1	To learn about another culture	23	53.49%
2	To have some kind of experience	29	67.44%
3	To have fun	29	67.44%
4	Other:	4	9.30%

	*Response statistics**
Mean	2.16
Median	2.00
Mode	2, 3
Min/Max	1/4
Standard deviation	0.88

Your Tools Alexander Pham (apham3) Help

WebQ

Museum System Survey

Summary Build Results Preview

View Statistics

Back to results Printable view

Total submissions: 18

[2] Calculated using numeric values

Multiple choice - one answer (button)

Question

Do you usually go to a museum alone or with friends and family?

Total responses (N): 18 Did not respond: 0

Numeric value	Answer	Frequency	Percentage
1	Alone	2	11.11%
2	Friends and Family	16	88.89%

Response statistics[2]	
Mean	1.89
Median	2.00
Mode	2
Min/Max	1/2
Standard deviation	0.32

Multiple choice - one answer (button)

Question

We are designing an Interactive Smart Phone Application for a Museum. The system would have a series of built-in tours, and the possiblility of customizable tours. We are also thinking of having the possibility of having a group tour by synching phones together. Would you like the idea of synching your phone with your friends and family's phones so that you can all tour the museum together?

Total responses (N): 18 Did not respond: 0

Numeric value	Answer	Frequency	Percentage
1	Yes, I want the app to synch with others	13	72.22%
2	No, I don't want the app to synch with others	5	27.78%

Response statistics[2]	
Mean	1.28
Median	1.00
Mode	1
Min/Max	1/2
Standard deviation	0.46

Multiple choice - one answer (button)

Question

Would you want the Museum Application to remember your preferences so that if you ever came back to the museum you would not have to set the application up again?

Total responses (N): 18 Did not respond: 0

Numeric value	Answer	Frequency	Percentage
1	Yes	13	72.22%
2	No	4	22.22%
3	Other:	1	5.56%

Response statistics[2]	
Mean	1.33
Median	1.00
Mode	1
Min/Max	1/3
Standard deviation	0.59

Multiple choice - one answer (button)

Question

There is also an online community that will be built for the Museum Application. It would send updates on events that you may be interested in such as special events, upcoming special themes, etc. Would you like to participate in a Museum's online community?

Total responses (N): 18 Did not respond: 0

Numeric value	Answer	Frequency	Percentage
1	Yes	12	66.67%
2	No	6	33.33%
3	Other:	0	0.00%

Response statistics[2]	
Mean	1.33
Median	1.00
Mode	1
Min/Max	1/2
Standard deviation	0.49

Multiple choice - one answer (button) Response

Multiple choice - one answer (button)

Question

The Museum Application will also include some short games for you to play at certain exhibits. The games would be about the objects in question and scores would be created. Would you like these scores to be automatically posted to the online community?

Total responses (N): 18 Did not respond: 0

Numeric value	*Answer*	*Frequency*	*Percentage*
1	Yes, I would like them to be automatically posted	3	16.67%
2	I would like to be notified first	11	61.11%
3	No, I don't want my scores posted at all	2	11.11%
4	Other:	2	11.11%

*statistics**	
Mean	2.17
Median	2.00
Mode	2
Min/Max	1/4
Standard deviation	0.86

10.4 Interview Transcripts

Interviewee A, 22 years old, male
I: Interviewer
A: Interviewee A
I: Hello thank you very much for being here for the interview. As we are doing a design project for better user visiting experience in Africa Museum in Berg en Dal, we would like to ask you some questions about your experiences related with museum visiting, it will take about half an hour, can we start now?
A: Yes sure.
I: Do you have your favorite museum?
A: Well I don't know, maybe Zhejiang Museum
I: Why was it your favorite museum?
A: Because it is close to my home
I: Okay this answer is funny, so I would like to know what kind of this museum is?
A: It is actually very simple-designed museum but with plenty knowledge to know.
I: So how the museum looks like?
A: Yeah as I said with very simple design, in different halls there are different displays with different themes. Displays basically are all inside the glass windows.
I: Did this museum visiting involve some type of interaction?
A: There are films
I: So how was your experience at the museum on a scale of 1 to 5? 1 being the best 5 being the worst.
A: 3 maybe
I: This is not high, so seems you don't like museum a lot? Even your favorite one only scored 3?
A: No no actually I quite like museum but I can't recall which one is my favorite, when you asked me before I just picked up the one in my mind.
I: So how do you say you like museum, because of?
A: They provide a lot of new things to know.
I: What would encourage you to come to a museum?
A: I will say new displays, knowledge I am interested in, and also special themes
I: Do you have any idea towards the interaction design for museum?
A: Not really interested in the idea of having very advanced digital technology application or devices, which means, probably if I am already in the museum, it would be a fancy idea to play with like smart phone, but I won't go to a museum because of I will play with mobile application at that museum.
I: Anything else about introducing interaction design into museum helper?
A: I will prefer some simple display that may contain some funny games to play with. For Africa Museum, I really think the outdoor is way interesting. For hi-tech interaction games, it may not suit a lot for museum.
But I think the navigation idea on the phone is very nice. It would be better to provide both

the exhibition information and the museum practical information, which means it even can help with a better order in museum visiting, for example the toilet in the ground floor is full and the application will know and tell the visitor so he can wait or go to another toilet.
I: Okay, that's it. I got pretty much interesting stuff to know, think they will be helpful for us to generate design ideas and concepts, so, thank you very much for your help!
A: Welcome.

Interviewer B, 23 years old, male
I: Interviewer
B: Interviewee B
I: Hello thank you very much for being here for the interview. As we are doing a design project for better user visiting experience in Africa Museum in Berg en Dal, we would like to ask you some questions about your experiences related with museum visiting, it will take about half an hour, can we start now?
B: Yes please.
I: What is your favorite museum?
B: Summer palace Museum
I: Why was it your favorite museum?
B: Because it is a national museum, contains almost everything you can see though out the whole old Chinese history. A lot of treasured displays to see, which are unique, you can't see them anywhere else, not possible to check on the internet as well. Only to go there to see it in real makes sense.
I: Did it involve some type of interaction?
B: I can't remember anything like that so I'd rather say no. One important thing, it is really a historical and royal museum so I think there is nothing for interaction like playing or entertainment.
I: How was your experience at the museum on a scale of 1 to 5? 1 being the best 5 being the worst.
B: 4, well almost 5.
I: What would encourage you to come to a museum?
B: To gain knowledge, culture, history, etc.
I: Idea towards the interaction design for museum?
B: Hmm, some big screen that can tell stories vividly?
I: Anything else about introducing interaction design into museum helper?
B: For interaction design if you mean like smart phone using, well I am not quite into this kind of thing and I am not sure if I would like to use them in the museum. I am willing to try but really not sure, as I still prefer to learn some knowledge from museum visiting.
I: Well that's basically it, thank you very much!
B: You're welcome, hope these are going to be useful for your project and success!

Interviewer C, 23 years old, female
I: Interviewer

C: Interviewee C
I: Hello thank you very much for being here for the interview. As we are doing a design project for better user visiting experience in Africa Museum in Berg en Dal, we would like to ask you some questions about your experiences related with museum visiting, it will take about half an hour, can we start now?
C: Okay.
I: Do you have your favorite museum?
C: The Houston Museum of Natural Science
I: Why was it your favorite museum?
C: There is a butterfly center, a lot of different kinds of butterfly are just flying around you, so cool.
I: Ah so you really like those kind of real feeling.
C: Of course and I think everyone will be happy to feel this kind of exhibition, because it is just fantastic.
I: So besides those real feeling, are there any other type of interaction?
C: There is another hall about the insects. For every windows contains insects, there is a button, you press it, you can hear the sound of the certain kind of insect.
I: How was your experience at the museum on a scale of 1 to 5? 1 being the best 5 being the worst.
C: 4.5
I: What would encourage you to come to a museum?
C: If the theme of the exhibition is interesting or not.
I: Idea towards the interaction design for museum?
C: Will be helpful.
I: Anything else about introducing interaction design into museum helper?
C: For example you can let the visitor to type into his or her interest towards the museum, and then the device can suggest a best route to visit.
I: Well that's basically it, thank you very much!
C: Welcome.

Interviewer D, 25 years old, male
I: Interviewer
D: Interviewee D
I: Hello thank you very much for being here for the interview. As we are doing a design project for better user visiting experience in Africa Museum in Berg en Dal, we would like to ask you some questions about your experiences related with museum visiting, it will take about half an hour, can we start now?
D: Yes please.
I: What is your favorite museum?
D: Hard to say, I like museum with history or science themes. Oh yes I love paleontology.
I: Why those type of museum?
D: When I was young I saw a lot of TV programs with that knowledge, I think they are really interesting, attract me a lot. And if I have time I would like also do some research.

I: So do you still remember last time you went to a museum?
D: Well maybe one year ago. An exhibition about ruins of human civilization
I: How was your experience at the museum on a scale of 1 to 5? 1 being the best 5 being the worst.
D: 4
I: So I think I can say this way, what encourage you to come to a museum, is the special type of knowledge and information which attract you very much, and something you want to learn.
D: Right
I: Idea towards the interaction design for museum?
D: Yeah if there are some kind of those design would of course be nice. But for me there won't be much differences having or not having it.
I: Anything else about introducing interaction design into museum helper?
D: Information with text will be pretty enough as I think. Oh yes better to have some route sign, sometimes I got lost in museum.
I: Well that's it, thank you!
C: You're welcome.

Interviewer E, 25 years old, female
I: Interviewer
E: Interviewee E
I: Hello thank you very much for being here for the interview. As we are doing a design project for better user visiting experience in Africa Museum in Berg en Dal, we would like to ask you some questions about your experiences related with museum visiting, it will take about half an hour, can we start now?
E: Yes.
I: Do you have a favorite museum?
E: No I don't have one.
I: What would encourage you to come to a museum?
E: Yeah I am interested in not only the museum but also the architecture of the museum, as I am study in architecture. And also a lot of museum is actually a piece of architecture art. For the museum itself, interesting exhibition topic will be important for me to go there.
I: So for your past experience in museum, are there anything with interaction design?
E: Yes, some, I think they are mostly those devices to explain and give more introductions towards different display objects. I can't recall other interaction devices.
I: You found it useful?
E: Yes of course, especially if it also has my native language, then it is very helpful.
I: So you will definitely use it if there is one in the museum you go to?
E: Yes, if it is for free.
I: So do you have some idea towards the interaction design for museum?
E: I doubt, better not make it too complicated.
I: Anything else about introducing interaction design into museum helper?
E: I think it is important to provide a better route for visiting, also some extra information

help visiting a lot.
I: Well we are done, thank you!
E: Welcome.

Interviewer F, 22 years old, male
I: Interviewer
F: Interviewee F
I: Hello thank you very much for being here for the interview. As we are doing a design project for better user visiting experience in Africa Museum in Berg en Dal, we would like to ask you some questions about your experiences related with museum visiting, it will take about half an hour, can we start now?
F: Please.
I: Do you have a favorite museum?
F: No idea, I normally enjoy just watching TV or like movies.
I: Okay then can you think about what would encourage you to come to a museum?
F: Hmm depends on what kind of exhibitions are on in the museum, but for sometimes museum is just kind of boring.
I: Why boring?
F: Sometimes you just go there and look at those displays, good to know a lot of new knowledge but not fun enough.
I: So do you have some idea to make it more fun to visit a museum?
F: I will say the importance of participating, I mean, I would like really enjoy being involved in the museum visiting. One thing is there are really quite a lot of things I liked to see, the other thing is I can also gain some special experience while visiting.
I: Play with those museum displays?
F: If I am allowed.
I: So what about some games, not sure what kind of game it will be but you have any ideas?
F: Yeah that would be fun. And you mentioned Africa museum right? Maybe like I can dance like African people with African music and yeah, wear African clothes would also be cool.
I: If we talk about having some interaction devices you with games, you would like to play with it?
F: This can also be a solution to make the museum alive. But when you mention about interaction devices I think like PSP? Or iPad? Those things? Like I think now mostly in museum they have some guided device or information provider, let users to hold while they walking in the museum.
I: Yes, that's the thing I meant.
F: Okay, then I don't think to focus too much on the so-called interaction devices will be nice. I mean, for example you know that you can play bowling with your iPhone, it is pretty much real, your whole body is moving, I will like such kind of interaction games and I think it do has potential in the Africa museum.
I: I got it, thank you very much for participating!
F: Welcome! Look forward your design!

10.5 User Study Results

Users interviewed	10
Note: Some people answered with more than one answer on some questions	

Answer choices	Answer Frequency
Speaking Avatar by Default	8
Non-speaking Avatar by default	2
I would like to talk to my phone and Avatar will understand	7
I would like to always have graphic buttons to select to let Avatar know what I want	3
I would be willing to wear headphones in the museum	10
I would be unwilling to wear headphones while in the museum	
I would like to be able to mute the avatar	10
I don't mind the avatar speaking to me	
I consider that wearing headphones all the time is isolating	5
I don't mind wearing headphones all of the time	5
I would like to have background music	6

I would not like to have background music	4
I would like to be able to determine the voice of the Avatar	7
I really don't care about the Avatar's voice	3
Avatar suggesting and assisting me on where to go	3
Avatar giving me options every time I approach an object	7
Avatar asking me just once what I want to do and giving me directions	9
Avatar asking me what I want to do every time I approach an object	1
I would prefer to have more information to have more information and media than playing games all the time	9
I would prefer to have more games than reading information and watching pictures	1
I would like to be able to use my mobile phone as a motion controller	8

I would not like to use it as a motion controller		2
I think it's alright to use my mobile device as a motion controller		5
I think that it is unsafe to use my mobile device as a motion controller		5
Would you like your avatar to recognize your moods and act according to them?		
Yes		6
No		5
Do you read on your mobile phone?	Answer frequency	
yes		6
no		4
If Yes how often?		
Everyday		3
Once a week		1
Once a month or more		2
What do you find more comfortable?		
Dark text on light background		5
Light text on dark background		3
What do you usually read on your mobile phone?		
News		4
Friend updates		1
other		4
I would like to have one avatar		6

I would like to have multiple avatars	4
Male Avatar	5
Female Avatar	5
Child Avatar	1
Teen Avatar	2
Adult Avatar	7
Elder Avatar	2
Realistic Avatar	3
Cartoon Avatar	8
Animal Avatar	2
I would like to customize how my avatar looks	5
I don't care how it looks	3
Avatar with subtitles by default	7
Avatar without subtitles by default	2
Not sure	1
How many default options should there in the menu?	
2	4
3	4
4	1
All	1
Of the following options, please mention the top 3 you would consider the most important	
Help	
Map	7

Subtitles	1
Language selection	7
Online community	
Mute	4
Home	6
Settings	6
What type of menu would you prefer?	
A rotating wheel menu	5
A scrollable slide menu	4
A tree menu	3
classical	2
vintage	2
grid	2
Avatar notifications with vibrations	5
Avatar notifications with sound	3
Avatar notifications with both	2
Would you like to experience different textures on your screen?	
Yes	7
No	3
Would you like to experience different temperatures for guidance on your screen?	
Yes	4
No	7
Would you like your device to vibrate whenever you click an option?	
Yes	1
No	9

Would you be interested in playing a game based on a touch system?	
Yes	6
No	4
I would like to see more things through my phone's camera	7
I would not like this	2
Do you have an account with any of the following services?	
Facebook	7
Twitter	1
Google Buzz	
Gmail	5
LinkedIn	2
Orkut	
Technocrati	
Blimpy	
YouTube	2
Delicious	
Yahoo Mail	4
Hotmail	4
Wordpress	
Which of the following do you own?	
iPhone	4
Android smart phone	1
Windows phone	
Apple iPad	
Android Pad	
iPod Touch	1
Symbian Device	2
Would you like to share your score at the online community?	
Yes	5
No	5

Would you like to share your scores somewhere else like Social Networks?	
Yes	1
No	9
Would you be interested in playing a quiz-like game?	
Yes	4
No	6
Do you think the overall system is logical?	
Yes	7
No	
Do you think the overall system is understandable?	
Yes	7
No	1