WPI

Development of a Mobile Website for the Worcester Art Museum

This is an IQP report submitted to the faculty of WPI in partial fulfillment of the Bachelor of Science Degree:

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Abstract

The Worcester Art Museum is looking to deploy interpretive technologies within galleries to increase visitor engagement throughout the museum. Through interviewing, brainstorming, and collaboration with museum professionals, we decided the best course of action for this project was to implement a WAM Mobile Website with top features being an exhibit viewer, audio tours, and an interactive map. Implementation involved an iterative design process, learning three web development languages, and refinements to the website design. The project culminated in the mobile website, a promotional video, recommendations, and a set of guides to sustain the mobile website.

Executive Summary

Museums have been cultural destinations within their communities for centuries. Not only do they provide amazing art, but are places for community interaction. Museums are looking to use interpretive technologies to enhance visitor experience (Hawkey, 2004). Interpretive technology is any technology that helps improve the visitors interaction with the art in the museum. Popular interpretive technologies include iPads, smartphones, and other similar mobile technologies. The Worcester Art Museum (WAM) is looking for ways to improve the visitor experience with the development of interpretive technology (Forgeng J., February 2, 2018, Personal Communication). The project achieved this by following the Mission and Objectives.

This project was designed to assist the WAM in improving the visitor interaction with exhibits through the implementation of interpretive technology. To achieve the desired visitor experience the team used the following process:

1. Document existing interpretive technologies in the WAM and other museums.
2. Brainstorm interpretive technology ideas with the group, sponsor, and other WAM staff
3. Assess the insights of WAM curators and other staff to determine how they use interpretive technology, and determine what the technical abilities of the WAM.
4. Determine interpretive technology ideas and suggestions for the WAM.
5. Decide interpretive technology for the WAM.
6. Prototype decided interpretive technology and test with WAM staff and peers.
7. Implement decided interpretive technology at the WAM.

The main project outcome was the new WAM Mobile Website (Figure 1). Other deliverables that supported the website were HTML Generating Excel Sheets, How-To Guides, and the WAM Mobile Website Promotional Video. The WAM Mobile Website had three main features:

1. Exhibit Viewer
2. Audio Tours
3. Interactive Map

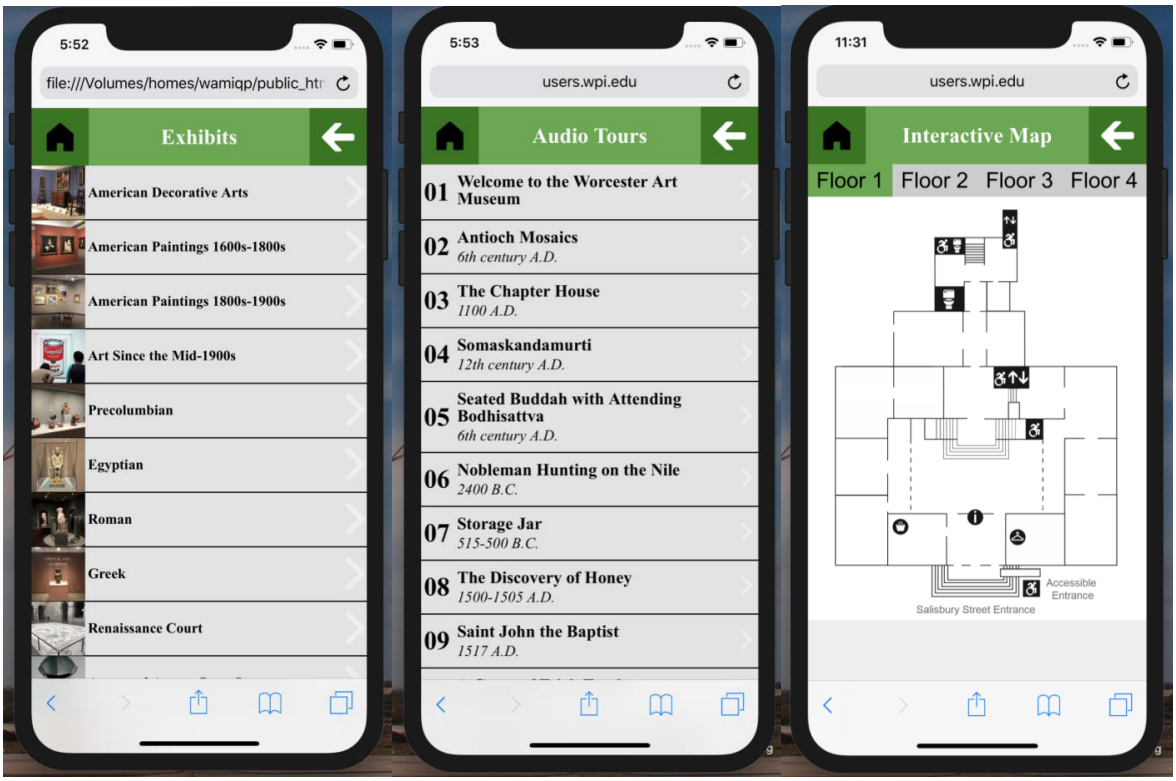

Figure 1: WAM Mobile Website

The Exhibits page in the website lists all the permanent exhibits in the museum as well as other sections of the building including the library and café. The Audio Tours page on the website takes all of the current audio tours found on the WAM's existing mp3 players and makes them accessible to the user on their mobile device. Since the audio tours are labeled by number, the user can scroll through and search for the audio they want to listen to. The Interactive Map page gives the user the ability to plan out and personalize their visit to the museum. The map can allow visitors to guide themselves around the museum while inside. Each of the floors can be viewed by pressing a tab with the corresponding name.

The purpose of the HTML Generating Excel Workbook is to allow WAM curators and other staff who may have little to no knowledge about HTML to be able to edit and add information to the website. The Excel Workbook is laid out with an input and output sheet. The staff member will input the data they want added to the website on the input sheet and from the output sheet they will copy and paste the HTML code to the HTML file corresponding to the page they want to change. This easy update method will help keep the website sustainable. Three How-To guides were also created to cater to the sustainability strategy of the mobile website:

1. HTML List of Exhibits Guide
2. HTML Audio Tours Guide
3. iMazing iPad Guide

A humorous promotional video for the mobile website was also created, the purpose of which is to connect especially with high school, college students, and anyone app-inclined in the Worcester area to influence them to visit the museum, and to use the mobile website. The video also shows off the features of the mobile website and how it is navigated. The video will be distributed on the Worcester Art Museum's website as well as on the project website which can be found on the title page of this report.

Beyond creating the new WAM Mobile Website we left recommendations for its further development including adding new features to the mobile website, further development of current features and improving the sustainability of the mobile website.

Chapter 1: Introduction

Museums are more than just places to admire art and other artifacts; they are places to be social and interact with others. Yet people are sometimes intimidated to enter a museum because they are unfamiliar with how a museum might be experienced. To make people less intimidated and more willing to enter, museums are using familiar technology to help the visitors engage and interact with the exhibits they encounter. Whether the technology be iPads, iPhones, or even simple MP3 players, the goal is to create a less intimidating and a more inviting atmosphere where groups of people come together to interact and learn more about what is inside the museum (B. Loring, personal communication, March 23, 2018).

The idea that museums are intimidating and confusing to visit can be said about the local art museum in Worcester, Massachusetts. The Worcester Art Museum (WAM) wants individuals and groups of people to be comfortable enough to enter the museum with the intent to interact with each other as well as interacting with the art that surrounds them. Currently, the WAM is in a period of adjustment in order to achieve the goal of increasing visitor engagement at the museum, but the curators and other staff are not yet sure what the most effective solution to this challenge is (J. Forgeng, personal communication, February 2, 2018).

Other museums, on the large and smaller scales, have successfully implemented interactive technologies into their exhibits. The museums range from the EcoTarium in Worcester, MA to the Smithsonian Museums in Washington D.C., while technologies used have ranged from mobile applications to motion tracking and virtual reality. Previously, larger museums have done research into increasing visitor engagement though the use of simple or complex technologies (Burbules, 2009). On the local level, previous WPI research groups have worked with the Ecotarium to develop an interactive educational exhibit using technology so visitors can learn as an individual along with learning in groups (Bell et al., 2014). Similarly, other research projects have successfully improved visitor engagement at the WAM. One project consisted of developing a prototype jousting game the utilized the Nintendo Wii that visitors could interact with as an individual or as a group while still learning about the exhibit. Another project implemented iPad kiosks in several galleries to help visitors engage and learn more about the Arms and Armor exhibit where the iPads were installed.

Opportunities still exist to increase visitor engagement at museums like the Worcester Art Museum are definitely desirable and feasible. Previous projects that worked with the WAM have implemented engaging technologies successfully, however there is still room for expansion and improvements beyond what previous efforts have accomplished (J. Forgeng, personal communication, February 2, 2018). There are still opportunities to develop engaging technologies for use throughout the entire museum, instead of being restricted to one exhibit.

The goal of the project was to personalize a visitor's experience and increase the engagement with exhibits throughout the museum. The methodology consisted of documenting current technologies, brainstorming technologies, interviewing museum staff, presenting a suggested technology, prototyping suggested technology, and developing the technology. A

decision to use a mobile website was finalized after presenting suggested technologies. The project resulted in a publicly available mobile website with features like Audio Tours, Description Pages, and Exhibit Pages. The mobile website can allow visitors to personalize their experience by connecting to the art in the way they want to be.

Chapter 2: Background Information

Many museums are attempting to increase visitor engagement, improve curatorial design, make better use of interpretive technologies. This chapter discusses these topics both broadly and in the context of the Worcester Art Museum. Visitor engagement is being studied by popular museums such as the Dallas Museum of Art and the Smithsonian in Washington D.C. Curatorial design is important to how museums implement their interpretive technologies since curators want to keep the visitors engaged but they also want to keep the visitors interested in the art, not enthralled by the technology. Interpretive technologies are an inherently broad field, and many different museums can have unique uses for them. Therefore, the different needs and technological abilities of different museums must be considered when determining how to use interpretive technologies. Currently, the Worcester Art Museum is looking to improve visitor engagement with their exhibits, especially through the use of interpretive technology. So far, they have implemented iPads in exhibits, however, these are not very sustainable due to the software on the iPads. The rest of the chapter goes into greater detail on visitor engagement, curatorial design, and interpretive technologies.

2.1 Visitor Engagement In Museums

In today's society the museum's job is to inspire engagement, creativity, and passion, but it's not always that easy. The National Endowment for the Arts reports a decline in people personally experiencing art over the last two decades. Surveys show that 75% of people view art online while about 33% of people personally view (New Media Consortium, 2015). The statistics show that people are changing with technology and museums have to rethink their strategies to bring greater amounts of people to view art. Society is changing through technology, and museums visitors expect museums to keep pace with society (New Media Consortium, 2015).

The goal of this section is to gain knowledge on how visitors interact with art exhibits by focussing on how technology can improve visitor engagement. Understanding visitor engagement is the key to start gaining knowledge on how other museums used technologies and other tactics to increase visitor engagement in their museums.

Learning in Museums

Museum learning can be looked at from a number of different perspectives. There is no set of guidelines to follow as different approaches have been taken all the time revising what has been tried in the past. The process of learning in a museum shouldn't only be from transmitting information, but rather an engaging constructive dialogue, that can connect to visitors in a stronger way (Hawkey, 2004). By having a dialogue, the visitor might feel less overwhelmed with the information of an expert, and will be free to draw his or her own perspective and opinion on the art.

Museums look to facilitate “lifelong learning” which is defined as “the provision or use of both formal and informal learning opportunities throughout people's lives in order to foster the continuous development and improvement of the knowledge and skills needed for employment and personal fulfillment.”(Collins Online English Dictionary, 2012). This is similar to “ubiquitous learning”, which can happen anywhere at anytime. Ubiquitous learning is often experienced in museums, as it blurs the line between formal and informal learning (Burbules, 2009). Creative, cultural, and intellectual activities look to maximize life-long and ubiquitous learning by building museum exhibits into a free-choice learning environment with varying possibilities. Life-long learning, museums, and digital technologies all emphasize the ability to learn from objects rather than learning about objects (Hawkey, 2004). Advancements in mobile technologies has been a major factor in blurring the between formal and informal learning (Hwang and Tsai, 2011). Mobile learning complements ubiquitous learning, which is why museums have been going through a rebirth to incorporate technologies into exhibits. The Campaign of Learning in Museums and Galleries (CLMG) and the Museums Libraries and Archives Council (MLA) both focus on the importance of informal learning over formal learning (Hawkey, 2004). Informal learning can be very effective in keeping visitors interacted and fully involved in the exhibits.

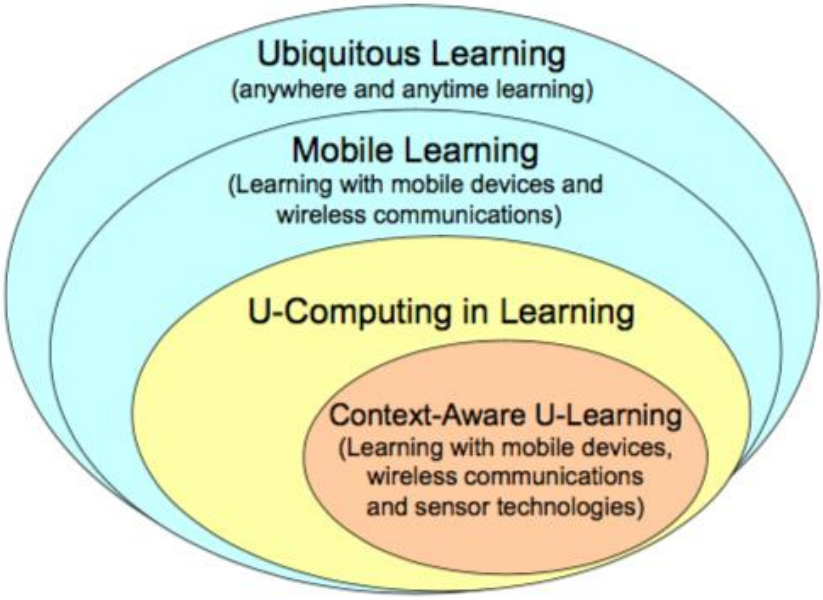

Figure 2: Ubiquitous Learning Relatons (Hwang and Tsai, 2008)

Figure 2 put emphasis on different ways of learning, and how they can all fit under the ideal of “ubiquitous learning”. Museums have always sought out ubiquitous learning method, and now in today’s world there are many more tools to help achieve this (Hwang and Tsai, 2008).

With websites and apps, museums have expanded into online learning. Online galleries give easy access to all types of art, and link important information accordingly. Museums using virtual tools have allowed for a virtual experience for visitors. The learning experience museums offer can be broken into online learning and on-site learning (Hawkey, 2004). Online learning is

dependent on the individual's interest to dig deeper. On-site learning looks to intrigue the individual, and also maintain their interest while going deeper into the art. In both cases the main goal is in achieving learner participation (Hawkey, 2004). When curators get feedback from visitors, whether it be online or on-site, it is a chance to get a view into the visitors experience, and better understand the outcomes the exhibit is giving. The experiences online and on-site may differ in many ways, but an end goal of receiving simple feedback is very important, and gives insight into the minds of the visitors. As museums continue to grow through technology the learning tactics will become more personalized and ubiquitous. By personalizing the means of learning, the goal for each individual is to grow a deeper perspective with the art, and gain more from the overall experience.

Understanding Visitor Engagement

Visitor engagement is defined as how a certain individual experiences art (Pitman-Gelles & Hirzy, 2010). Over seven years the Dallas Museum of Art (DMA) conducted six visitor studies to find out how different groups of people reacted to art. The survey had 10 statements that are shown in Table 1. After the surveys were completed the DMA split the people who took the survey into 4 different clusters: Observers, Participants, Independents, and Enthusiasts (Pitman-Gelles & Hirzy, 2010).

Table 1: Visitor Survey (Pitman-Gelles & Hirzy, 2010)

STATEMENTS ABOUT ART-VIEWING PREFERENCES Does not describe me (1) / Describes me very well (7)	Observers 26% n = 110 MEAN	Participants 24% n = 99 MEAN	Independents 20% n = 81 MEAN	Enthusiasts 30% n = 125 MEAN	Overall 100% n = 415 MEAN
I feel comfortable looking at most types of art.[1]	5.5	6.6	6.7	6.8	6.4
I like to know about the story portrayed in a work of art.[2]	6.0	6.5	4.7	6.4	6.0
I like to know about the materials and techniques used by the artist.[3]	4.6	6.1	5.1	6.3	5.7
I enjoy talking with others about the art we are looking at.[4]	4.5	6.3	5.9	6.3	5.7
I am emotionally affected by art.[5]	4.3	5.9	5.6	6.4	5.6
I like to be told a straightforward insight to help me know what the work of art is about.[6]	5.6	6.0	3.0	6.0	5.3
I like to view a work of art on my own, without explanations or interpretations.[7]	4.4	4.8	6.1	5.0	5.0
I am comfortable explaining the meaning of a work of art to a friend.[8]	2.9	5.2	5.1	6.1	4.8
I like to connect with art through music, dance, performances, and readings.[9]	3.0	5.4	4.2	5.1	4.4
I find some terms used in art museums difficult to understand.[10]	3.8	5.6	2.6	1.6	3.3

Table 1 identifies the statements that were used in the surveys to identify these certain clusters. The responses were rated on a scale from one to seven, with one being "does not describe me well" and seven being "does describe me well". The graph then shows the average group answer on every question (Pitman-Gelles & Hirzy, 2010).

These four visitor clusters define and show, on a smaller scale, how different types of people engage with art. The clusters will become a backbone for how the team will create a better understanding of what visitors want out of museums, and how we are going to fulfill these wants whether it may be through technology through social media through curatorial design or through interaction with others (Pitman-Gelles & Hirzy, 2010).

Visitor groups

Observers are the most uncomfortable when looking at art out of the four groups. This could be because observers have the least amount of background in art. Observers don't like to put their own creative interpretation on pieces of art so they like help from others when interpreting art. Whether that is guided tours from museum staff or other sources like technology that can help people better understand artwork. Some ways to improve an observer's visit to a museum is to have a lot of resources for them such as good guest services, easy parking, good wayfinding material whether online or in person (Pitman-Gelles & Hirzy, 2010).

Participants have a strong interest in art and are comfortable in viewing and learning about art. People in this cluster like to connect with art in a variety of ways whether it's through music, dance, or performances. Also, participants avidly use technology to interpret art. Ways to get participants involved in art is to create social interactions like music, dance, performances, or readings. Museums can also connect with participants by enhancing creativity whether it be through technology or aspects like ones previously mentioned like music dance, performances, or readings (Pitman-Gelles & Hirzy, 2010).

Independents like to experience arts by themselves, and come up with their own thoughts about art. Independents also like to take their time when viewing art, and they would rather not have anybody tour them around or tell them about the museum. Museums can serve this cluster by letting them observe art on their own terms, and give them primary source information about the art. Which could be brought to them by technology (Pitman-Gelles & Hirzy, 2010).

Enthusiasts make up the biggest cluster out of the 4 at about 30% of the total. This cluster is the most knowledgeable about art out of the 4 clusters. Enthusiasts use their emotions to connect with art. They're very willing to participate and they use all types of interpretive resources including technology. A good way museums can connect with people in this cluster is to create ways to challenge them with different types of learning. Also museums can create more ways of interpretation including technology (Pitman-Gelles & Hirzy, 2010).

Seeing how all of the visitors can use technology in different ways, it is probably a good idea to use a technology that is very versatile. Picking a versatile technology can be great for keeping everything simple, especially when the goal is to try to serve all of these visitors in one way or another. A good example of a versatile technology is a phone application which can incorporate a large number of operations that can easily be found by the user (Mobile Applications and Museum Visitation). More on mobile applications can be found in the mobile applications subsection of 2.3.

Visitor Engagement In Popular Museums

To gauge where the Worcester Art Museum is we can first look at visitor engagement in popular museums. To get a good grasp of what good visitor engagement tactics are we can look at the state of the art museums like the Smithsonian, and the Metropolitan Museum of Art. These museums use very different tactics when it comes to. We can look at these different museums, and find different approaches that might work for the WAM.

Visitor Engagement in the Smithsonian Institution

The Smithsonian Institution is a made up of 19 different museums and 9 research centers. had a total of 30.1 million in person visits in 2017. On top of that they had 151 million visitors online (Parilla & Ferriter, 2016). But to the Smithsonian it's not just about the visitors it's more about what the visitor gets out of the visitation.

Before the Freer Gallery of Art closed in 2016 for repair the Smithsonian Museum did three studies between July and December of 2015 to help the redesign of the exhibit (Pekarik, 2016). Of the three the Entrance-Exit Survey and the Observation Study have the most relevant data to our study, the other study was quantitative data. The studies, goals and results are listed in Table 2 below.

Table 2: Freer Gallery Studies (Pekarik, 2016)

Study Type	Goal	Result
Entrance-Exit Survey	Find out what the visitor particularly enjoyed in the museum.	Most people surveyed said that quality of art, and design/layout of the exhibit were more superior to variety of art, and long labels
Observation Study	To find out how visitors interacted with the museum. And which pieces were the most visited/brought the most attention	The average time stopped at a piece of art was 23 seconds. The max was 83 seconds and the min was 12 seconds.

Recommendations of both studies were to improve texts, help people connect to art pieces, and highlight some of the not so popular pieces (Pekarik, 2016). All of these recommendations go very well together. They all highlight a key topic and that's connecting visitors with the art. The whole goal museums have is to help people connect with the art and get the most out of every visit. By taking these recommendations we can understand how visitors best engage in museums, and we can use it in our methods to change how the WAM can present itself to visitors.

2.2 Curatorial Design

"Curatorial Design" is a common term used by curators to simplify contemporary curatorial practices, that place emphasis on the aesthetic experience created by the combination of artwork and placement in each exhibit (Cippitelli, 2012). An aesthetic experience is defined as an experience qualitatively different from everyday experiences and similar to other exceptional states of mind. Aesthetic experience can be compared to artistic experience. Art pieces can be aesthetic, but not all aesthetic experiences come from artwork (Dziekan, 2012). Examples of aesthetic experiences not from artwork can be viewing sunsets or mountain vistas.

Exhibit design links artwork together in a complementary way, to make for a high quality experience. When done properly, visitors connect with exhibits in an aesthetic way that the artwork alone could not replicate. Cippitelli (2012) analyzes Dziekan's Virtuality and the Art of Exhibition, to focus on space and the way a curator must adapt to the new media of enjoying the space that is derived from the digital revolution. He also draws upon the relationship between the artwork, the audience, and how the artwork can be imagined, programed, foreseen, and realized by the artist as well as the curator. Dziekan (2012) describes the term "virtuality" as not specifically related to digital artwork, but to the concept of the "quality of aesthetic experience under contemporary conditions; conditions that are influenced, in part, by digital mediation, and by the multimedial nature being so identified as the cultural form through which virtuality is expressed" (p.8). Virtuality then becomes the result of three contemporary production fields. These fields are cultural analysis of new media (digital media, multimedia communication, and virtual spaces), cultural production (exhibition-making), and digital aesthetics (creative forms of interaction, connectivity, and systems) (Cippitelli, 2012). The overall experience a visitor takes away from an exhibit relies just as much on the design of the exhibit than the physical artwork itself. The art is what a visitor is expecting to go see, but with an effective design the experience can become much more aesthetically powerful to each individual. Curatorial design focuses on arranging the artwork together through physical and spatial realization. There is a relationship between art, the viewing experience and the exhibition space. Dziekan (2012) points out that the Australian Centre for the Moving Image (ACMA) provides a conceptual framework for curatorial design by having an integrative approach to both digital mediation and spatial practice. He also cites the Advanced Visualization and Interaction Environment (AVIE) for creating experiences of a virtual nature. Cippitelli (2012) depicts Dziekan's practical curatorial pattern to use artwork and aesthetic experience together to equal the material realization of an authorial project and the spectator's past experiences. This is possible by incorporating social, physical, and technological architecture in the curatorial design. New technological advancements can greatly extend the aesthetic possibilities within exhibits. By finding the right balance between the artwork, technologies, and space for the exhibit, each individual visitor can experience an

aesthetic experience. These new approaches of curatorial design challenge the conventional forms, and expand upon the impression an exhibition can leave.

2.3 Interpretive Technology

The engagement of visitors is of utmost importance for attendees to get the most from their museum experience. In the past, the options for museums to engage visitors have been quite primitive in their use of technology. Nowadays with the recent boom in mobile technology, a whole new method of engaging visitors has arisen in the form of interpretive technology. Interpretive technology can be defined as technology that improves the engagement of museum visitors by providing more ways to interact with the exhibit. In the following section, forms of interpretive technology, other museums implementations of interpretive technology, and the effects of interpretive technology will be discussed.

What is Interpretive Technology

Interpretive technology is a broad and ever changing field, however currently there are a multiple examples of interpretive technology that are relevant to museum engagement. For convenience sake all of the relevant forms of interpretive have been organized into the following table:

Table 3: List of Interpretive Technologies and Their Descriptions

Interpretive Technology	Description/Functionality	Usefulness
Audio Tours	Easy to use by everyone Provides more information through an audio track	Visitors get most of the information that a physical tour could provide without needing many tour guides
QR Codes	Allows the visitor to bring their own device to scan for more information	More information per exhibit without spending more money on displays
Phone Applications	Allows for a lot of information regarding the museum and exhibits to be	Can be changed and pushed to all users at once with new information, also a lot of versatility
Augmented Reality	Adds detail in a way that allows the user to explore what they want	Can provide a much greater experience for exhibits without spending a lot on exhibits, can also provide views impossible with exhibits

Virtual Reality	Fully immerses the viewer in the visual experience	Can transport the viewer to a completely new place to experience the exhibit in a way that wouldn't be possible
Motion Tracking	Allows the user to interact with a virtual object with their body as if it were a physical object	Lets the user interact with objects that they wouldn't be able to easily do in the real world.
Social Media	Use existing social media platforms such as Facebook, Twitter, Instagram, Snapchat to raise awareness for the WAM and its events	Promotes the WAM in new ways to audiences that might not see other advertising methods

Audio Tours

In the past the first forms of interpretive technology were found in audio tours. Audio tours allow attendees to choose audio tracks that correspond to various exhibits that gives much more information than just what is posted on the wall next to the exhibit.

QR Codes

QR stands for quick response code, which means that when someone scans the code, information instantly pops up relating to what the code is attached to. These QR codes are easy to implement and design. QR Codes are an older technology than the constantly updated mobile applications and robust hardware like iPads. According to a case study on QR codes by Michelle Schultz, the effectiveness of the QR code in a museum is not fully clear. The case study states that the codes are more commonly successful and used in libraries than in museums. This is a sustainable technology that has been used in many museums, but the effectiveness of the QR codes is not always clear according to a case study on QR codes by Michelle Schultz (Schultz, 2013). The use of the QR codes by visitors depended on if they knew what the QR code was or if they ever used on before. According to the case study, QR codes have been more effective in libraries than they have been in museums. On the other side of QR codes being beneficial, games, videos, websites, all can be instantly brought up with the code. They also cost nothing to produce and next to nothing to implement in museums. Although some more limitations are that QR codes can sometimes be unfamiliar to people and are even hard to depend on them because there are many factors that will prevent the code from being scanned (Medic, 2014).

Mobile Applications

Mobile applications can be seen as a step forward in influencing visitor interaction with the museum. Applications are so versatile that they can have an abundance of activities for the visitor to do while in the museum. A mobile application in the case of the WAM would most

likely consist of a map of the exhibits which provides more information for each piece, some sort of feedback system, and some games.

The main importance that mobile applications are very versatile and can be used for anything ranging from games to reading books. Similar to the iPads but the user of the mobile application has it with them as they go through the museum so the experience of the user is dependent specifically on the visitor itself. Mobile applications make it easy to give more information about an exhibit that may not be written out on a panel. Depending on how the mobile application is implemented the museum would be able to update it to give users notifications to events at the museum or update information as new exhibits come out. Another advantage to making a mobile app for the WAM is that it could consolidate the software used on the iPads and the visitors phones into one experience.

Some drawbacks mobile apps is that they are difficult to sustain in the long run. Mobile operating systems such as iOS and Android constantly upgrade which can break functionality in applications, requiring an upgrade to the code. Additionally, visitors need to download the app prior to visiting the museum (Medic, 2014)

Augmented Reality (AR)

Augmented reality is a new form of interpretive technology that primarily has manifested itself in the form of smartphone applications. The idea of augmented reality is that it uses a camera that records the real world then adds some virtual elements into the image to augment the scene (Ding, 2017). Modern smartphones are essentially cameras, sensors, a high power computer, and a screen, all of these combine to make a device that can transform a scene in real time to add effects or objects that are purely virtual.

In museums augmented reality can add a substantial amount of information to an exhibit. Exhibits where AR has been implemented, have been found to have longer and more collaborative interactions than exhibits without AR. AR also has the ability to enhance the learning of visitors by creating immersive environments that would otherwise not be possible to convey in an exhibit (Matuk, 2016).

Virtual Reality (VR)

Virtual Reality is another new form of technology that engages visitors. As opposed to AR where the real scene is supplemented by virtual objects, VR creates a whole new world that the user can view. In most cases the user puts on a headset with two monitors and lenses for each eye to create an effective 3D environment that takes up most of their field of view (Virtual Reality Society, 2017). Currently, the VR headset is the most popular method of experiencing virtual reality, and can be broken down into two main categories, Desktop VR and Mobile VR devices. Mobile VR is a type of virtual reality where the user places their smartphone into a headset and that uses the phone's screen and sensors to create the experience. Mobile VR typically allows for users to view 360 degree photos and videos and move around with a small degree of freedom. VR for computers however requires a high power computer that connects to a

headset that has its own screen and sensors to create the environment. Due to the greater processing power of a desktop computer and the multitude of sensors on the headsets, Desktop VR allows for the user to explore and interact with 3D environments with tracking of the head with the headset and hands with controllers. Some examples of Mobile VR headsets include Google Cardboard, Google Daydream, and Samsung Gear VR, while Desktop VR includes the HTC Vive and Oculus Rift.

Motion Tracking

Motion tracking is a form of virtual reality that allows for the user to that tracks the user's body and/or hands to allow them to interact with virtual objects. Some popular recent examples of motion tracking are the Nintendo Wii which captures motion through the use of the Wii Remote Controller, the Xbox Kinect, which uses a series of image processing with visible and infrared cameras to track the user's body, and the Leap Motion which does hand and finger tracking. These technologies allow for the user to interact using their bodies with virtual objects which provides a far more immersive experience (Vosinakis, Koutsabasis, Makris, Sagia, 2016). These newer technologies are powerful and cheap enough to be used on a consumer scale, and can be implemented in a museum setting to provide more engaging experiences.

Social Media

Social media is a very prevalent in the modern digital age. Social networks provide ways to communicate with people all over the world and keep in touch with close acquaintances. Social media also allows for entities such as museums to communicate with the general public through posts and responses. These kinds of interactions allow for the museum to interact more with their audience than previous methods of communication (Russo, Watkins, Kelly, Chan, 2008). Additionally, social media can be used in an education setting. For example, Tumblr allowed students to easily learn between settings, by allowing them to quickly document their initial thoughts about given exhibits to analyze more at home (Kali, Sagy, Kuflik, Mogilevsky, Maayan-Fanar, 2015).

Implementation of Interpretive Technology in Other Museums

Without proper implementation, interactive technologies are useless for visitor engagement in museums. Forms of older interpretive technology, such as audio tours, have been around in museums for some time now. Some museums such as the Cleveland Museum of Art, the Detroit Institute of Arts, and The Smithsonian have already created and implemented some state of the art technology; this section will focus on those implementations.

The Cleveland Museum of Art is one leading museums in state of the art interpretive technology. It's latest project ArtLens Studio is a series of interactive exhibits that allows for attendees "to begin a relationship to the collection through artwork-centered play" (Cleveland Museum of Art, 2017). The museum uses different forms of interpretive through smaller focused activities including the following:

- Portrait Maker: Let's attendees make self portraits using either charcoal, oil, or watercolor on a digital screen
- Pottery Wheel: Uses motion tracking depth sensors to let visitors use a virtual pottery wheel to sculpt their own pottery
- Games: Memory Game, Matching Game - need to find an object in paintings.
- Line and Shape: Visitors draw lines and shapes which are matched to one of the works in the museum's collection then displays that can then be used. (Cleveland Museum of Art, 2017)

The ArtLens Studio of the Cleveland Museum of Art used a lot of forms of interpretive technology, the Detroit Institute of Arts uses augmented reality to drive visitor engagement. Recently the museum added a smart phone application called Lumen AR. Lumen AR uses the camera from the smartphone and the processing power of the phone to allow "the user to interact with real size 3D animations, information and display directions in the visitor's field of view" (Detroit Institute of Arts, 2018). The application also allows for there to be quizzes, and puzzles and other games relating to artworks. The program has various different features for different exhibits such as allowing for an x-ray view of a mummy, restoring the colors of a faded Assyrian palace, or walk through the gates of ancient Babylon (Detroit Institute of Arts, 2018). The Detroit Institute of Arts has done a great job implementing interpretive technology in the form of augmented reality, and driving engagement by incorporating itself into the visitors cell phones.

The final implementation of interpretive technology that will be discussed is virtual reality. The Smithsonian American Art Museum recently implemented a virtual reality experience called Wonder 360. The application allows for viewers to view 360 degree images of some exhibits before going to the actual museum. The experience also has a mode where the artists explain their artwork, and the program was described as a "whole new way of sharing art with the public" (Rothbard, 2016). With the use of virtual reality, the Smithsonian is able to engage its audience in the museum experience without them needing to be physically at the museum. This allows for more people to be able to engage in the exhibits than what was previously possible.

Impact of Interpretive Technology in Museums

Interpretive technology has been improving alongside the underlying technology behind it. With so much advancement and possibilities it is important to make sure that the technology is being used in a way that improves the visitor engagement and does not mask it behind unintuitive technology. It is important that our proposal for implementing interpretive technology in the WAM is ultimately beneficial to the engagement of the museum patrons. The best way to know if a form of interpretive technology is successful or not is to perform studies on visitors. The Victoria and Albert Museum British Galleries integrated interpretive technology into their museum. In a case study before integration of interpretive technology 50% of visitors spent less

than 10 minutes in the galleries, and after the integration of interpretive technology 83% of visitors spent over an hour in the galleries (Sayre, 2005). According to this case study the implementation of interpretive technology kept visitors in exhibits for longer, which suggests that they are spending more time interacting and engaging with the exhibits, and are enjoying it enough to stay for longer.

Although other museums have had success with their implementation of interpretive technology, all museums are different with different people visiting them, so the community of the WAM must be considered. The Worcester Art Museum has been working on implementing interpretive technology in the museum mostly through iPads. In the group's interview with Jeffrey Forgeng of the Worcester Art Museum we asked him how he thought the iPads have been doing for improving the engagement of visitors at the WAM. He responded saying that some of the iPads have been doing better than others, with the best being the quiz based activities (Forgeng). Based on the information given by Forgeng, it appears as if the interpretive technology that has the most interaction, the quiz, is doing the best at drawing in the visitors. Therefore in considering possibilities for interpretive technology in the WAM the best choice will probably involve the most direct user interaction.

Mobile Applications as Interpretive Technology

As discussed Section 2.3, mobile applications are a form of interpretive technology. The best part of using a mobile application is that it allows for a lot of functions relating to the museum to be implemented with relative ease. They also personalize the experience of the museum visitor both before, during and after the visit (Mobile Applications and Museum Visitation). Some technologies that are possible through the use of a mobile application are listed below:

- Wayfinding: Location-aware mobile technologies that can map out directions around the museum
- Bookmarking: Enables personalization to tours, by saving information before and after visitors can look deeper into exhibits/artwork, which allows for visitors to design their own museum experience
- Casual Games: Apps often have causal games to interact with kids and also not overload the visitor with information. Examples include: scavenger hunts providing clues around the museum, matching games with the art

With a mobile application tailored to the Worcester Art Museum, visitors would be engage with the exhibits in the art museum.

2.4 Worcester Art Museum

The Worcester Art Museum (WAM) is a small art museum in the center of Worcester, Massachusetts. Currently the WAM is under a reconstruction stage regarding the use of interpretive technologies to improve visitor engagement with the exhibits. As of right now, the WAM is using iPads as their main interpretive technologies being used in the exhibits. WAM curators would like to implement different technologies to encourage the visitors to engage more with the art in the exhibits.The technologies could include the use of iPads, QR codes, mobile applications, or other types of technologies not yet encountered or researched thoroughly.

Visitor Engagement in the WAM

Adam Reed Rozan is the Director of Audience Engagement at the Worcester Art Museum. He defines Audience Engagement as a way for museums to intrigue audiences using different thoughts about exhibit design, and also finding ways to get visitors to come back to the museum (Rozan, 2016). Which is very similar to the definition of visitor engagement which explained earlier is how certain individuals engage with art (Pitman, 2010, p.33).

The Worcester Art Museum tries to engage audiences through involving the community in projects that they are doing at the WAM. For example the WAM started a project where they had local community artists bring their art in for display (Rozan, 2016). The WAM also has many other different tactics to get visitors engaged like Art Carts, iPads, Audio Description Devices, and Staff. Art Carts usually have a piece or pieces of art that a staff member can give more insight on. At some art carts visitors could interact with the art, and touch it or even wear it. The iPads have all different types of uses throughout the WAM some are used for games and information while others are used for surveys that the visitors can fill out. The Audio Description devices are used for the visually impaired, and it gives them a detailed description of the piece of art and information about it.

Curatorial Design in the WAM

The current curatorial design of the WAM includes new types of exhibits with the intent of appealing to a broader audience. Curators were working on a reenvision exhibit where the exhibit is trying to get the visitors engaged with the art. The new types of engagement included Helmutt, a cartoon dog that shows up around the museum when you can touch or interact with the exhibit using iPads. For example, in the medieval exhibit in the WAM, there is a sword, a piece of chainmail, and a helmet that visitors can touch and feel. Underneath the pieces is Helmutt, where he has a speech bubble telling the visitor to touch and feel the pieces to learn how they felt to the actual people who wore and used those items centuries ago (Fletcher, 2017).

During the weekend of January 25th to the 28th in 2018, the WAM put on an event called “Flora In Winter”. This was a change of pace from the current exhibit designs that the museum offers. Flora in winter was a flora design event where florals were designed around the art inside the WAM. The designs were posted all around the WAM and brought many visitors during that

weekend to engage with the museum. From the fact that the WAM brought in many people during the Flora in Winter event, that shows that the WAM is good at bringing in visitors to view and engage with art. Implementing new technologies can bring in even more people during large events like the Flora in Winter event.

Figure 3: Flora in Winter Medieval Exhibit

Implementation of Interpretive Technology in the WAM

The Worcester Art Museum is currently implementing iPads as their main interpretive technology. The iPads are located at designated spots in the exhibits and are running applications relating to that section of the exhibit. One iPad had and application with a mini quizlett and another iPad had an application where you can interact with the details of a painting. The WAM also had audio description tours in one exhibit, these were easy to set up and gave descriptions of the items in the exhibit.

The iPads were located at strategic places in certain exhibits. One of the iPads was in the re-envisioned exhibit. This iPad was below a painting and on the iPad it had an application for that painting. The application allowed the user to zoom in on the painting and look at descriptions for different parts of the painting that had different meanings to it. Also that iPad had Helmutt on it and it was having him tell the user to go look for a suit of armor that was featured in the painting that the WAM has in the exhibit. This allowed the visitor to get engaged with the art and to go look around the WAM and learn more about other arts from that single iPad.

Figure 4: iPad painting interactive

For the small arms and armor section there were two iPads. One of them had a fact or myth game where the user would test their knowledge about arms and armor with varying difficulties to be chosen and then post their score to see where they lie in comparison to other visitors. The other iPad had an open storage application that can be explored and it would show most of the arms and armor collection that has been cataloged.

Sustainability of the technologies at the WAM is a main concern for keeping the technologies implemented. Hardware fails and software becomes outdated and hard to keep working. WAM is looking to implement a sustainable technology that allows the user to get engaged with the exhibits while having the hopes of being used for a long time with no worries of it failing (Emidy, Gillis, Herrington, Moquin, 2018).

Chapter 3: Methodology

This project was designed to assist the Worcester Art Museum (WAM) in improving the visitor interaction with exhibits through the implementation of interpretive technology. To achieve the desired visitor experience the team used the following process:

1. Document existing interpretive technologies in the WAM and other museums.
2. Brainstorm interpretive technology ideas with the group, sponsor, and other WAM staff
3. Assess the insights of WAM curators and other staff to determine how they use interpretive technology, and determine what the technical abilities of the WAM.
4. Determine interpretive technology ideas and suggestions for the WAM.
5. Decide interpretive technology for the WAM.
6. Prototype decided interpretive technology and test with WAM staff and peers.
7. Implement decided interpretive technology at the WAM.

Figure 5 shows the framework of how the project was completed.

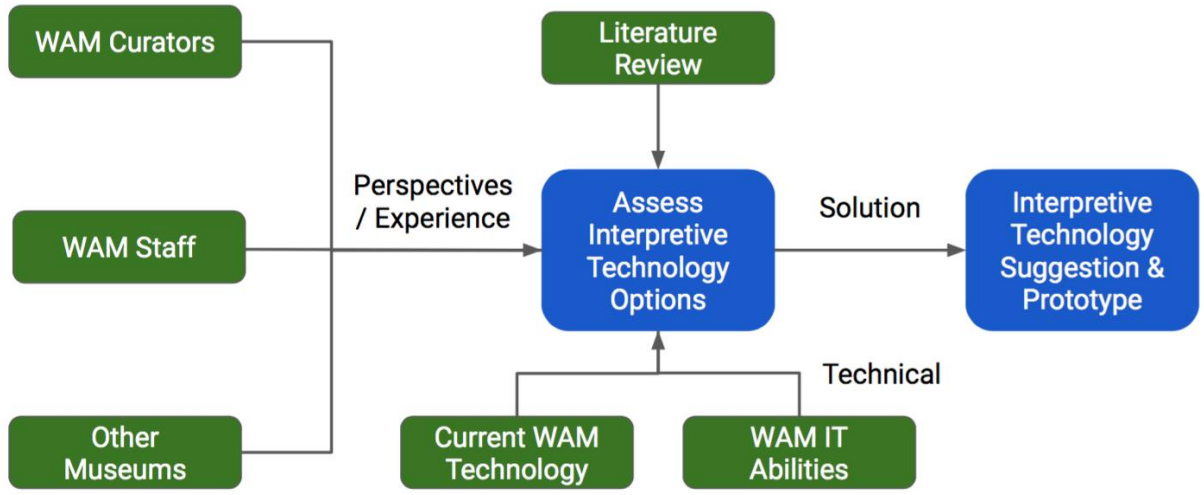

Figure 5: Methodology Objectives

3.1 Documentation of Interpretive Technologies

The purpose of this objective was to understand what the WAM has for interpretive technologies in its galleries. This objective was completed in 3 steps:

1. The interpretive technologies were located in the museum.
2. The group then found what content was on the different interpretive technologies.
3. The data gained was put into a spreadsheet organized and analyzed.

This objective provided insight into where the WAM stood in regards to the use of interpretive technologies within exhibits. A map of the museum was used to mark the locations of all technologies, such as iPad interactives and audio tours. This information was analyzed and used as a tool for determining the best direction for the WAM to move forward in improving visitor engagement through the use of interpretive technologies.

The previous research group documented and stored information about the visitors using the current iPads in the Medieval Exhibit. The telemetrics recorded keystrokes on the iPads, as well date and time stamps to know how long each was used for. The data was stored on an Excel sheet and then analyzed for patterns and other data. Three iPads recorded telemetric data in the Medieval Exhibit, and this data was analyzed. Through the analysis graphs were created to compare the differences in the uses of the iPads, that will be further discussed in the results section.

3.2 Brainstorming of Interpretive Technologies

The brainstorming sessions focused on interpretive technologies and the specific features that can be incorporated. The brainstorming was broken down into three phases:

1. As a Group
2. With our Liaison
3. With a Larger Group of WAM Staff

Table 4: Stakeholder Identification

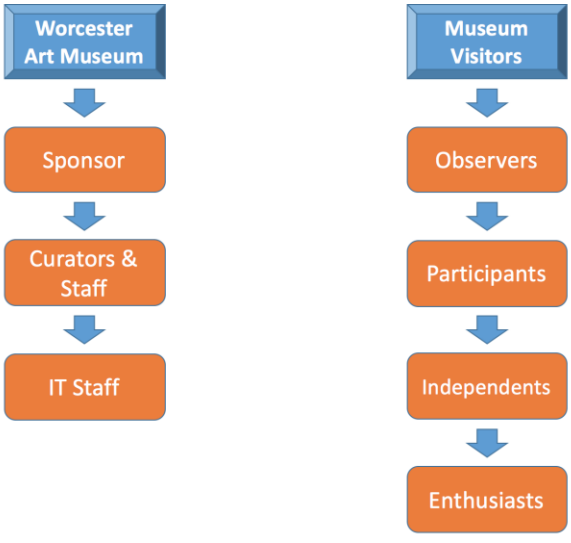

Table 4, above, shows the stakeholders that have a role in the project. All three groups from the Worcester Art Museum were involved in the brainstorming session. The Museum

visitor side of Table 4 is made up of the visitor groups explained previously in Table 1, and all the needs that these certain group have were considered in all brainstorming sessions.

The initial brainstorming was conducted by the group in an informal manner. A document was created to keep track of all the interpretive technology suggestions and ideas. After the initial brainstorming, Jeffrey Forgeng (Sponsor) met with us to go over findings and get a more refined list of suggestions. After meeting with Jeffrey Forgeng we met with a larger group of staff members from the WAM. From this brainstorming session, a greater list of interpretive technologies was created incorporating the ideas of all those in attendance. After the meeting, the list was refined to include a brief description of the technology, any considerations for implementing the technology, as well as its likelihood to be implemented into the project. The refined list of ideas can be found in Section 4.3.

3.3 Interviewing Curators and Staff

In this section curators and staff from the WAM and other museums including the deCordova museum, the EcoTarium, and the Fitchburg Art Museum were interviewed. These interviews were conducted to get expert insight on topics like uses of interpretive technologies in museums, exhibit design, and other considerations that go into visitors interacting with art. The curators and staff that we interviewed from the WAM and other museums gave us a lot to think about. Some sample interview questions are shown below.

- Does your current exhibit or past exhibits use any of the interpretive technology at the WAM?
- Does interpretive technology affect your process in creating an exhibit?
    - What leading factors do you consider when designing an exhibit?
- Have you noticed visitors to the museum and your exhibit using the technology?
- Have you talked to visitors who've used the technology in your exhibit about if the technology was beneficial to their experience at the WAM?
- Do you think that the interpretive technology at the WAM has benefited the engagement of visitors to the WAM?
- Do you think that your exhibit would benefit from more interpretive technology?
- Is there any new technology that you've heard of that you think would help improve the experience of attendees?
- Give a brief overview of our preliminary propositions for interpretive technology at the WAM and ask for their opinions on it
    - Social Media Implementation
    - Mobile Application

A full interview plan can be found in Appendix A. This interview plan is a sample plan, the official interview plans changed depending on who was interviewed and what their role was in the museum.

3.4 Presentation of Technology Options

Using all of the ideas and considerations from the brainstorming sessions and interviews, the final suggestions for the interpretive technologies were determined. The next step was to present these suggestions to WAM staff to decide what interpretive technology, and features will be prototyped and developed. The best way to convey the different options for the project was to create a presentation that has a more detailed look at the potential technologies. This presentation included a more detailed description of each technology and features. A list of positives and negatives were provided, as well as considerations for the technologies.

3.5 Prototyping Technology

After presenting technology options to the WAM staff, the decided technology will be prototyped. According to analysis, this technology will be able to increase both the visitor engagement and overall effectiveness of the exhibits. A process to develop the technology is based on the type of technology chosen but overall process must be followed:

- Decide on a technology to use in the museum
- Ask sponsor/professionals how they think the technology should be implemented
- Prototype and test the technology with the Worcester Art Museum (WAM) Staff, and peers.
- Use input from WAM staff and peers to revise and complete the technology, and implement it into the museum.

3.6 Developing and Implementing Technology

In this section the interpretive technology that was decided upon in previous objectives was developed using HTML, CSS, and JavaScript. Once the technology was designed it was piloted in the museum by WPI Students and WAM Staff.

Chapter 4: Major Project Outcomes

Chapter 4 discusses the major outcomes and deliverables from the project. The chapter starts by discussing the main deliverable of the WAM Mobile Website, and all of its features. It then moves into discussing the tools that were created for maintaining the website after the group leaves, as well as the promotional tools for the website. Next comes an overview of the processes used, developmental phase of the project, and other minor outcomes from the project. Finally the chapter concludes with recommendations for both the WAM and further research groups for what to do with the mobile website in the future.
The sections of this chapter are:

1. The WAM Mobile Website
2. Tools for Web Development and Promotion
3. Developmental Process and Results
4. Recommendations for Future Web Development

4.1 WAM Mobile Website

The project resulted in the development of a mobile website for the Worcester Art Museum. The mobile website intends to stimulate visitor engagement with exhibits, as well as personalizing their experience with the museum as a whole. The intended audience are people more likely to use their phone at the museum. As the museum grows and expands and changes their galleries, the mobile website has the potential to grow and expand with the museum. The goal of this project was not only to build a mobile website but build a sustainable mobile website that can be easily expanded. The elements of the website are briefly described below.

Main Menu

The main menu of the website (Figure 5) is where the user will first land when typing in the URL or scanning its QR code. Tiles are laid out underneath a header where they will link to the corresponding pages in the website. For example, if the “Exhibits” tile is tapped, the user will be brought to a list of the museum's permanent exhibits.

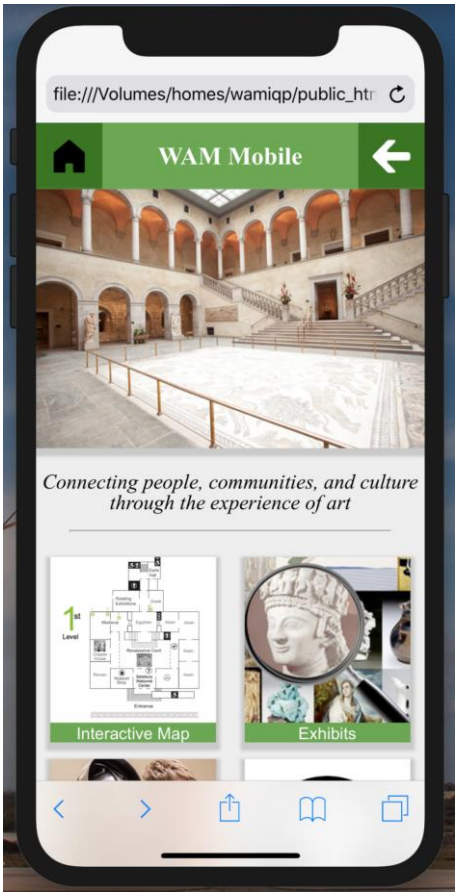

Figure 6: Home Page

Exhibits

The Exhibits page (Figure 6) in the website lists all the permanent exhibits in the museum as well as other sections of the building including the library and café. For example, if the user taps on the [remastered] exhibit, the website will bring them to a Description page that is generated for that exhibit. The [remastered] exhibit includes a description of the exhibit as well as a "view all" button where the user can view all of the objects in the exhibit and get their descriptions for each. A "view all" button is only available for the [remastered] and Medieval exhibits since those were the main focus points of the project due to time limitations.

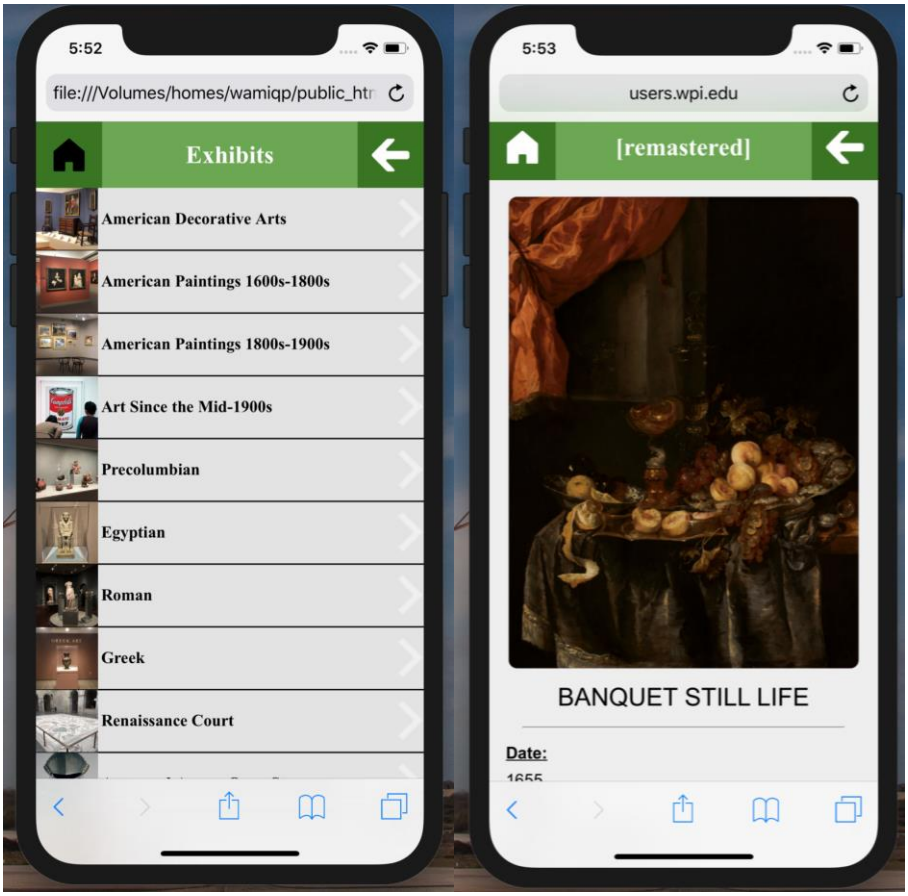

Figure 7: Exhibits Pages

Audio Tours

Currently, the WAM offers audio tours to visitors on mp3 players and to make the audio tours more readily available, the Audio Tour page was developed. The Audio Tours page on the website takes all of the current audio tours found on the mp3 players and makes them accessible to the user. Since the audio tours are labeled by number, the user can scroll through and search for the audio they want to listen to. These audio tours can also be accessed through the Exhibits page that also includes a list of audio tours in that specific exhibit.

Figure 8: Audio Tours Pages

Interactive Map

The Interactive Map page gives the user the ability to plan out and personalize their visit at the museum. The map allows visitors to guide themselves around the museum while inside. Each of the floors can be viewed by pressing a tab with the corresponding name. If Floor 1 is pressed, an image of the first floor will show up.

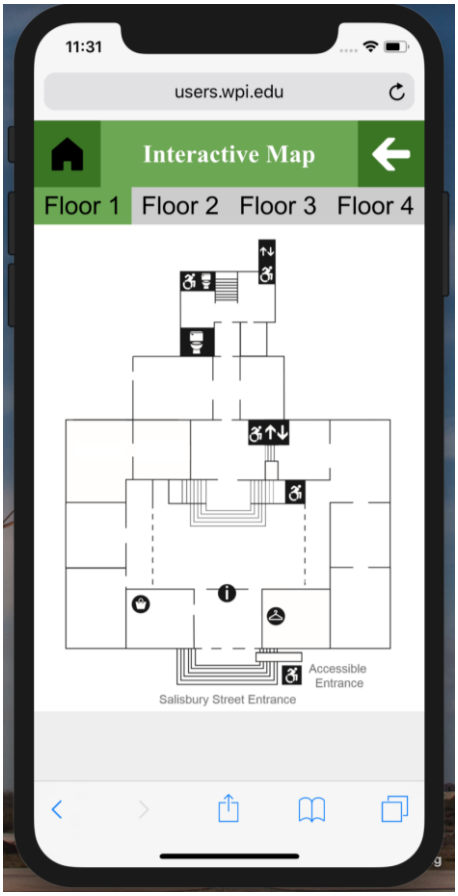

Figure 9: Interactive Map Page

Events and Programs

The Events and Programs page provides links that send the user to the WAM's main website to get more information and details about events and programs.

Figure 10: Events and Programs Page

4.2 Tools for Web Development and Promotion

Since the project resulted in a mobile website for the Worcester Art Museum, we describe below the documents and tools used for its development and promotion of the website. These documents can be used to implement the recommendations laid out in Section 4.4.

HTML Generating Excel Workbook

To support sustainability of the mobile website for WAM Staff, we created Excel Workbooks that can generate the HTML code for each of the website pages. The purpose of the Excel Workbook is to allow someone with little to no knowledge of HTML coding to be able to edit and add information to the website. Each of the Excel sheets are laid out with an input and output sheet. The staff member will input the data they want added to the website on the input sheet and from the output sheet they will copy and paste the HTML code to the HTML file corresponding to the page they want to change. This easy update method will help keep the website sustainable.

How-To Guides

To cater to the sustainability strategy of the mobile website, how-to guides were created for the WAM Staff. These how-to guides, for example, lay out in a step by step process how to use the Excel sheets discussed above for generating the HTML code. The guides that were delivered are:

1. HTML List of Exhibits Guide
2. HTML Audio Tours Guide
3. iMazing iPad Guide

Promotional Video

A humorous promotional video for the mobile website was created. The purpose of the video is to connect especially with high school, college students, and anyone app-inclined in the Worcester area to influence them to visit the museum, and use the mobile website. The video also shows off the features of the mobile website and how it is navigated. Each of the features of the website are highlighted in the video. The video will be distributed on the Worcester Art Museum's website as well as on the project website which is found on the title page of this report.

4.3 Developmental Process and Results

The developmental processes for the mobile website and other related project work were laid out in the methodology section. This section reviews the results and certain insights that emerged from those development processes. These processes are listed below:

1. Documentation of Interpretive Technology
2. Telemetric Data from Previous Research
3. Brainstorming of Interpretive Technologies
4. Interviews with Museum Staff
5. Technology Presentation
6. Prototyping
7. Mobile Website Preliminary Test

Documentation of Interpretive Technology

The documentation that was produced shows where the current iPads are located within the WAM as well as their description of the installed software. This gave details on what software can be extracted and used in the mobile website. Table 5 is the documentation that was built following the methodology. The most promising iPads to be remade into a mobile website were the Medieval Galley and [remastered] iPads since most of the information on the objects in the exhibit are found on the iPad.

Table 5: WAM iPad Documentation

Floor Number	Room Label	# of iPads	Description of iPad Software
1	Medeival Gallery	2	Medeival Trivia and Virtual Armory
1	Medeival Gallery (Side)	1	Medeival Gallery Videos and Coloring Interactive
1	Greek Gallery	1	Greek Gallery Descriptions and Videos
2	[remastered]	2	[remastered] Painting Descriptions
2	Balcony	2	Survey
2	17th-18th Century Italian Gallery	1	Italian Gallery Helmutt Painting Interactive
3	Jeppson Idea Lab	3	Pottery Info and Restoration
3	Gallery	1	Survey
4	Gallery	1	Survey
Total iPads:			**14**

Telemetric Data from Previous Research

The telemetric data indicated that educational games are the most popular use of the iPads among the WAM's visitors. Figure 11 shows the Medieval Trivia game running on the iPad in the Medieval Gallery was the museum's most popular telemetrically recorded iPad application that was telemetrically recorded. Knowing which iPad applications were most successful meant that those applications would be good options to think about putting into the mobile website.

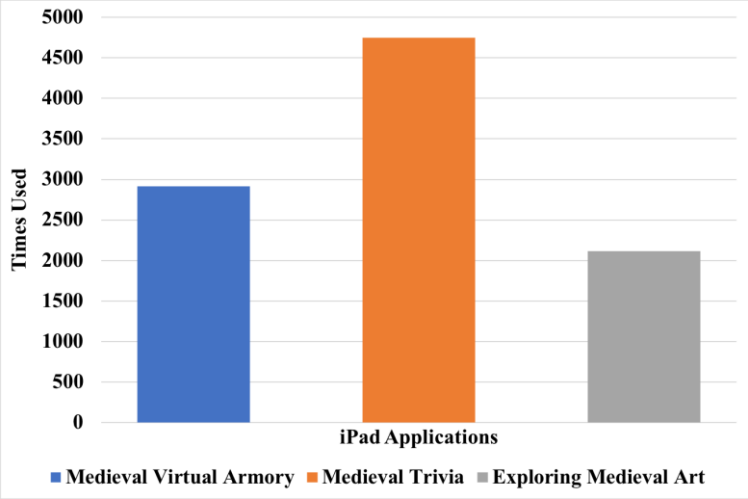

Figure 11: Times Each Application Was Used

Brainstorming of Interpretive Technologies

The brainstorming session was a sit down session with WAM Staff to determine what digital options would be best for the WAM to implement. A list of technology options was developed as laid out in Appendix B. The list of technologies was graded using a technology rubric as laid out in Appendix C, where the rubric was brought to the brainstorming session to show to the WAM Staff. The brainstorming session with WAM Staff resulted in focusing on a list of features for a mobile application or website:

1. Audio Tours
2. Interactive Map
3. Interactive Games
4. Feedback/Discussion Board
5. Curatorial Queries
6. Family Guide
7. Digital Galleries/Info
8. Upcoming Events/Calendar
9. Sign up for Tours/Classes
10. iPad Applications
11. Social Media Incorporation

Concluding the brainstorming session, an analysis of mobile websites versus mobile applications was conducted. A mobile website was determined to be a better and more viable option than a mobile application. The pros and cons of the mobile website outweighed the pros and cons of the mobile application (Table 6).

Table 6: Mobile Website vs. Mobile Application

Mobile Application (iOS)	Mobile Website
+ More access to phone features	+ Cross platform, iOS/Android
+ Locally stored, less WiFi needs	+ Easier to sustain, just update 1 site
+ Can do more complex features	+ Can host through WPI
+ Simple coding libraries in XCode	
	- High WiFi bandwidth in WAM
- Only Apple support to start	- Fewer phone features accessible
- More difficult to maintain	- More programming languages

Interviews with Museum Staff

We interviewed a group of museum curators and staff to get different insights into how museums deal with interpretive technologies. The interviews gave us suggestions and considerations for developing the mobile website.

Suggestions

From the interviews we got many suggestions but the most impactful suggestion was to use paper to prototype the mobile website design to allow for fast and easy changes (details in Section 4.4).

Considerations

The interviews provided us with many considerations, the strongest being to emphasize sustainability. With no dedicated IT staff, it was critical to produce a mobile website that could be easily updated and sustained. Sustainability was a constant thought while building the website (e.g., as laid out in the HTML Excel Workbook section in Section 4.2).

Other considerations ranged from accessibility to the type of audience to be targeted. The considerations were helpful in understanding the thought process of museum professionals, but due to the time restraints of this project it was not possible to implement all of the considerations, hence many are included as recommendations below.

Technology Presentation

The technology presentation with WAM Staff determined which features of the mobile website to focus on. From the feedback provided, we were able to narrow down the features discussed in section 4.1:

1. Audio Tours
2. Interactive Map
3. Exhibit List
4. Object Viewer for [remastered] and Medieval Galleries
5. Events and Programs Page

Focusing on only some features is important because it is better to have a fully working product with only some features rather than have a slightly working product with many features.

Prototyping

This section explains the findings of prototyping the mobile website. Building off suggestions from the interviews, a paper prototype of the mobile website was developed (Figure 12). The feedback from showing the prototype to WAM Staff led to how the mobile website was to designed.

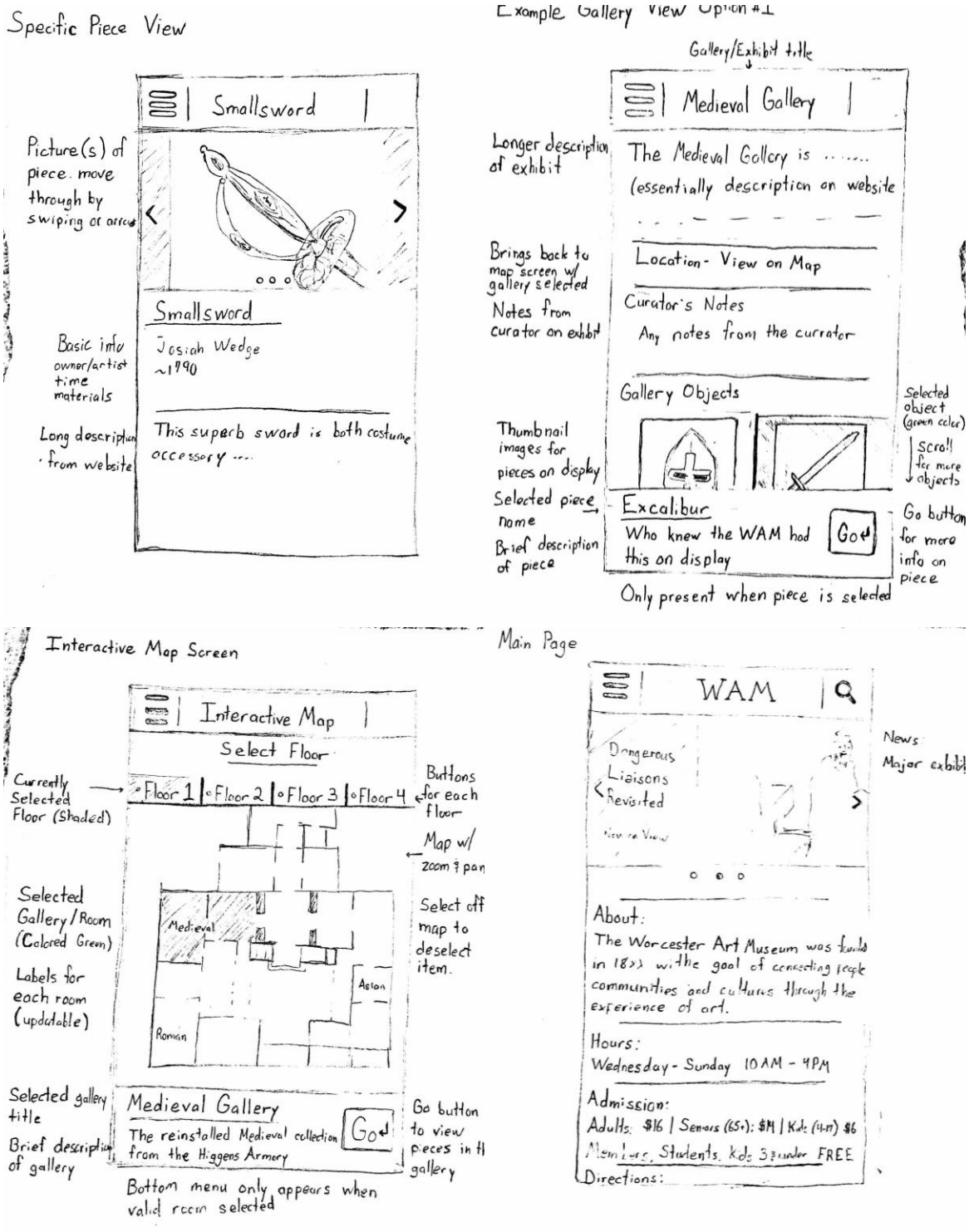

Figure 12: Paper Prototypes of WAM Mobile

Later on in the prototyping process, a program called Figma was used to develop a digital design of the website. This program allowed easy design of various pages on the site using drag and drop tools to build the different elements of the site: including location of images, text, headers, and breaks. Using Figma, the original paper prototypes were changed into digital mockups which

allowed for the use of color choice, image and text formatting, and limited interaction including switching pages.

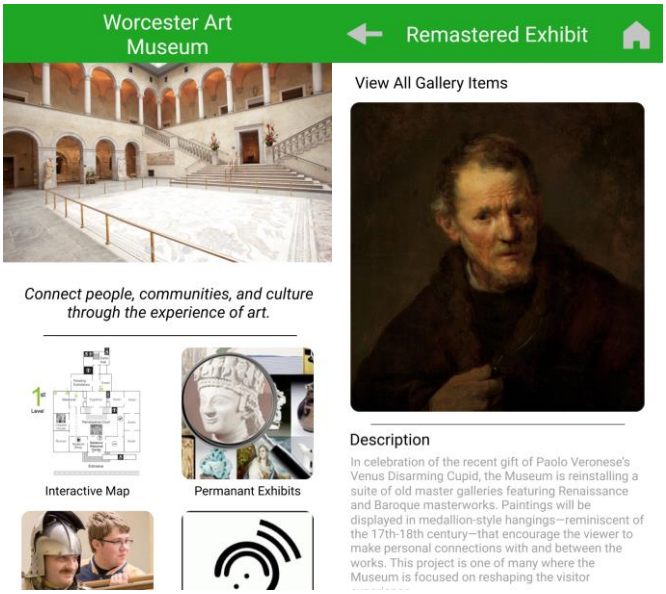

Figure 13: Figma Prototypes of WAM Mobile

Mobile Website Preliminary Test

A very quick preliminary test of the mobile website was conducted by asking fellow students to go through the museum while using the app. From observing the test group, the [remastered] gallery looked to be the most popular of the galleries on the website. Concluding the test run, the group gathered and discussed the mobile website. Some suggestions and feedback were:

1. The interactive map is an important feature that should reflect the museum's layout better
2. Some clickable options should be more obvious
3. Other small bugs in the website need to be fixed

The feedback was reviewed and changes were made as suggested.

4.4 Recommendations for Future Web Development

Throughout the project many ideas and considerations were suggested by WAM Staff. This section lays out the most important recommendations for future research groups or WAM Staff.

Adding Features

Adding more features to the website is highly recommended for future project groups working on the mobile website. More features can allow the visitor to engage more with the exhibits and get more in-depth information about objects. New features may include:

1. Interactive Games/Scavenger Hunts
2. Curatorial Queries
3. Social Media Incorporation
4. Feedback/Discussion Board

Improve Interactive Map

Due to time limitations, the interactive map was only able to feature a static floor by floor map. A recommendation for future development includes to change the map from static to dynamic. The dynamic map could have visible buttons layered on the map so the user can tap the buttons which, once tapped, will bring the user to the corresponding Exhibit page.

Improve Sustainability of Website

One of the goals of the project was to keep the mobile website sustainable. This was achieved by building the Excel sheets as mentioned in Section 4.2 but there are better options that will be even more sustainable. For example, building a Python code to read an excel sheet and directly create the HTML file without any copy or pasting.

Final Recommendations

One final recommendation is to continue to further bring in and develop interpretive technologies into the museum. Balancing the pros and cons of having technologies in a museum is important to think about while considering bringing in more technologies. We would hope future research groups, while working on the mobile website, can also come to appreciate the art that is on display and learn that even when the technology is available it is only a tool to interpret the art, not to replace it.

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Appendix A: Curator Interview Plan

Curator Interview Plan

Group: Worcester Art Museum (WAM)
Members: Ty Moquin, Sean Gillis, Peter Emidy, Spencer Herrington
Date: TBD
Interviewee: Curator
Leader: TBD
Notetakers: TBD

Introduction:

- Introduce ourselves, and our project with the WAM
- Define what we consider to be interpretive technology
    - Tell him/her how we see the role of interpretive technology in the WAM

Curator History:

- How long have you worked for the WAM?
- What exhibits have you curated in the past?
- What current exhibit(s) are you curating?

Curator's Interaction with Interpretive Technology:

- Does your current exhibit or past exhibits use any of the interpretive technology at the WAM?
- Does interpretive technology affect your process in creating an exhibit?
    - What leading factors do you consider when designing an exhibit?
- Have you noticed visitors to the museum and your exhibit using the technology?
- Have you talked to visitors who've used the technology in your exhibit about if the technology was beneficial to their experience at the WAM?

Curator's Opinion on Current Interpretive Technology:

- Do you think that the interpretive technology at the WAM has benefited the engagement of visitors to the WAM?
- Do you think that your exhibit would benefit from more interpretive technology?

Curator's Ideas for Future Implementations of Interpretive Technology:

- Is there any new technology that you've heard of that you think would help improve the experience of attendees?
- Give a brief overview of our preliminary propositions for interpretive technology at the WAM and ask for their opinions on it
    - Social Media Implementation
    - Mobile Application

Appendix B: List of App Features and Descriptions

Feature Name: **Audio Tours**

Description & Considerations: Converting the current audio tour files to be incorporated in the app. Visitors wouldn't have to get an audio tour mp3, and would easily be able to listen on their own.

Likelihood to Implement (Low/Medium/High): **High**

Feature Name: **Interactive Map of the WAM**

Description & Considerations: This would be a map of the WAM that is up to date with the current exhibits in the WAM. The user would be able to click from the main menu to access the map. First the user could select the floor they want to see then click on the rooms to see what exhibits are there and then go to another page to browse the pieces in the exhibits

Likelihood to Implement (Low/Medium/High): **High**

Feature Name: **Interactive Games/Quizzes**

Description & Considerations: Including current Ipad interactive games and quizzes to the app. Possibly adding a scavenger hunt interactive through the app's map feature. This would give clues and lead visitors to different galleries.

Likelihood to Implement (Low/Medium/High): **Medium**

Feature Name: **Feedback/Discussion Board**

Description & Considerations: This would allow visitors to give quick feedback to whatever they are looking at on the app. The discussion board part would be a type of comment stream, allowing visitors to connect with curators, staff, and each other while looking at the art.

Likelihood to Implement (Low/Medium/High): **Medium**

Feature Name: **Curatorial Queries**

Description & Considerations: This would allow visitors to ask a question or reach out to anyone at the museum for additional information. Curators and staff can have more specific questions to specific pieces of art.

Likelihood to Implement (Low/Medium/High): **Medium**

Feature Name: **Family Guide**

Description & Considerations: Within the App we would like to incorporate child friendly features. Fun and educational games with drawing features related to individual galleries throughout the museum.
Likelihood to Implement (Low/Medium/High): **High**

Feature Name: **Digital Galleries/Info**

Description & Considerations: A database that contains all of the pieces within the WAM's collection, a description of them, and where in the museum they are located. Should be able to access a specific piece from browsing in the interactive map or the list of galleries, or potentially through a QR code located below a piece or through object recognition.
Likelihood to Implement (Low/Medium/High): **High**

Feature Name: **QR Codes for Information**

Description & Considerations: Visitors could hold their phone up to the QR code and easily obtain information about any of the pieces of art. This could be difficult to implement because we would have to renumber the artwork.
Likelihood to Implement (Low/Medium/High): **Low**

Feature Name: **Upcoming Events/Calendar**

Description & Considerations: Posting all of the events on a calendar to let visitors plan ahead and see what will be featured.
Likelihood to Implement (Low/Medium/High): **Medium**

Feature Name: **Sign up for Tours/Classes**

Description & Considerations: This feature could be linked to the calendar feature, showing users times and dates for classes and tours along with pricing. There could be an option to buy now and be admitted by showing confirmation on their phone.
Likelihood to Implement (Low/Medium/High): **Medium**

Feature Name: **Augmented Reality**

Description & Considerations: This would allow visitors to hold their phone up to a piece of art and get a deeper look.
Likelihood to Implement (Low/Medium/High): **Low**

Feature Name: **iPad Applications**

Description & Considerations: Using current iPad interactives as features in our app. For example visitors could play the medieval fact or myth game without having to wait for the iPad on display.
Likelihood to Implement (Low/Medium/High): **Medium**

Feature Name: **Social Media Incorporation**

Description & Considerations: Having the App encourage the user to take pictures and have links to post now, which would link then to whichever social media they want. The App could also advertise for the WAM's facebook and twitter pages, telling visitors where to go to stay up on events.
Likelihood to Implement (Low/Medium/High): **Medium**

Feature Name: **Google Museum View**

Description & Considerations: This would be more beneficial to the online website than a mobile app. Advancing the digital gallery experience giving a Google street-view digital lay out of each gallery room. This would give a more realistic preview to the WAM's set-up, and intrigue visitors to come see it in person.
Likelihood to Implement (Low/Medium/High): **Medium**

Appendix C: Technology Rubric Details

Curatorial Querties	High	Med	Low
Sustainability - How easy will it be for WAM staff to interact with the app once we're gone. Either add more content or fix issues		X	
Accessability - Is this feature easily able to work with the accesabilities that the iPhone offers?			X
Cost - How expensive will it be for the WAM to implement a given feature			X
Audiences - Does this feature cater to only a certain type of audience or will it be able to cater to most all audiences?		X	
Ease of Use - Is the feature easy to use and user freindly? Will someone be able to figure out how to use it without any instructions?		X	
Interactivity - Does this feature let the user interact with the art around them?		X	
Relevance to Mission - How does this feature accomplish it's mission?		X	
Family Guide	**High**	**Med**	**Low**
Sustainability - How easy will it be for WAM staff to interact with the app once we're gone. Either add more content or fix issues	X		
Accessability - Is this feature easily able to work with the accesabilities that the iPhone offers?			X
Cost - How expensive will it be for the WAM to implement a given feature			X
Audiences - Does this feature cater to only a certain type of audience or will it be able to cater to most all audiences?		X	
Ease of Use - Is the feature easy to use and user freindly? Will someone be able to figure out how to use it without any instructions?		X	
Interactivity - Does this feature let the user interact with the art around them?	X		
Relevance to Mission - How does this feature accomplish it's mission?	X		
Digital Galleries	**High**	**Med**	**Low**
Sustainability - How easy will it be for WAM staff to interact with the app once we're gone. Either add more content or fix issues		X	
Accessability - Is this feature easily able to work with the accesabilities that the iPhone offers?		X	
Cost - How expensive will it be for the WAM to implement a given feature			X
Audiences - Does this feature cater to only a certain type of audience or will it be able to cater to most all audiences?	X		
Ease of Use - Is the feature easy to use and user freindly? Will someone be able to figure out how to use it without any instructions?	X		
Interactivity - Does this feature let the user interact with the art around them?	X		
Relevance to Mission - How does this feature accomplish it's mission?	X		
QR Codes	**High**	**Med**	**Low**
Sustainability - How easy will it be for WAM staff to interact with the app once we're gone. Either add more content or fix issues		X	
Accessability - Is this feature easily able to work with the accesabilities that the iPhone offers?			X
Cost - How expensive will it be for the WAM to implement a given feature	X		
Audiences - Does this feature cater to only a certain type of audience or will it be able to cater to most all audiences?		X	
Ease of Use - Is the feature easy to use and user freindly? Will someone be able to figure out how to use it without any instructions?		X	
Interactivity - Does this feature let the user interact with the art around them?	X		
Relevance to Mission - How does this feature accomplish it's mission?		X	

Class Signup	High	Med	Low
Sustainability - How easy will it be for WAM staff to interact with the app once we're gone. Either add more content or fix issues			X
Accessability - Is this feature easily able to work with the accesabilities that the iPhone offers?			X
Cost - How expensive will it be for the WAM to implement a given feature			X
Audiences - Does this feature cater to only a certain type of audience or will it be able to cater to most all audiences?		X	
Ease of Use - Is the feature easy to use and user freindly? Will someone be able to figure out how to use it without any instructions?		X	
Interactivity - Does this feature let the user interact with the art around them?		X	
Relevance to Mission - How does this feature accomplish it's mission?		X	
Augmented Reality	**High**	**Med**	**Low**
Sustainability - How easy will it be for WAM staff to interact with the app once we're gone. Either add more content or fix issues			X
Accessability - Is this feature easily able to work with the accesabilities that the iPhone offers?			X
Cost - How expensive will it be for the WAM to implement a given feature	X		
Audiences - Does this feature cater to only a certain type of audience or will it be able to cater to most all audiences?	X	X	
Ease of Use - Is the feature easy to use and user freindly? Will someone be able to figure out how to use it without any instructions?			X
Interactivity - Does this feature let the user interact with the art around them?	X		
Relevance to Mission - How does this feature accomplish it's mission?	X		
Social Media	**High**	**Med**	**Low**
Sustainability - How easy will it be for WAM staff to interact with the app once we're gone. Either add more content or fix issues			X
Accessability - Is this feature easily able to work with the accesabilities that the iPhone offers?			X
Cost - How expensive will it be for the WAM to implement a given feature		X	
Audiences - Does this feature cater to only a certain type of audience or will it be able to cater to most all audiences?		X	
Ease of Use - Is the feature easy to use and user freindly? Will someone be able to figure out how to use it without any instructions?		X	
Interactivity - Does this feature let the user interact with the art around them?		X	
Relevance to Mission - How does this feature accomplish it's mission?		X	
iPad Applications	**High**	**Med**	**Low**
Sustainability - How easy will it be for WAM staff to interact with the app once we're gone. Either add more content or fix issues		X	
Accessability - Is this feature easily able to work with the accesabilities that the iPhone offers?			X
Cost - How expensive will it be for the WAM to implement a given feature		X	
Audiences - Does this feature cater to only a certain type of audience or will it be able to cater to most all audiences?	X		
Ease of Use - Is the feature easy to use and user freindly? Will someone be able to figure out how to use it without any instructions?	X		X
Interactivity - Does this feature let the user interact with the art around them?	X		
Relevance to Mission - How does this feature accomplish it's mission?	X		

Google View	High	Med	Low
Sustainability - How easy will it be for WAM staff to interact with the app once we're gone. Either add more content or fix issues		X	
Accessability - Is this feature easily able to work with the accesabilities that the iPhone offers?			X
Cost - How expensive will it be for the WAM to implement a given feature			X
Audiences - Does this feature cater to only a certain type of audience or will it be able to cater to most all audiences?		X	
Ease of Use - Is the feature easy to use and user freindly? Will someone be able to figure out how to use it without any instructions?			X
Interactivity - Does this feature let the user interact with the art around them?		X	
Relevance to Mission - How does this feature accomplish it's mission?		X	