MEDIEVAL MEDIA

Worcester Community Project Center | Worcester Art Museum

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Abstract

The Worcester Art Museum has hopes to attract more families, children, and millennials to the museum using interactive exhibits. Our project goal was to collect data on the effectiveness of various aspects of exhibit design for the WAM to use in future exhibits and to propose improvements for the current Medieval Gallery. We assessed the effectiveness of audience engagement of the Medieval Gallery and non-renovated exhibits. To do this, we created various data gathering tools such as observational rubrics and path tracking methods. After obtaining all of this information, the team designed and piloted a new digital media element to the medieval exhibit. Our work was completed through the Worcester Community Project Center with plentiful help from our Sponsor, Jeffrey Forgeng.

Acknowledgements

Our project group would like to thank the many individuals and groups who contributed to our project or assisted us over the course of our work.

First, we would like to thank our sponsoring organization, Worcester Art Museum, and its entire staff for giving us this project and providing us their input every step of the way. We would especially like to thank our sponsor, Jeffrey Forgeng PhD, MA, BA.

Next, we would like to thank our project advisors, Corey Dehner, PhD, JD, BA and Derren Rosbach PhD, MS, BA.

We would also like to thank Devon Kurtz, Director of Audience Engagement at the Blackstone Heritage Corridor, Robert Kiihne, Director of Exhibits at the U.S.S. Constitution Museum, and Denise LeBlanc, Director of Education at the Acton Discovery Museum, for all their input regarding interactive and digital museum exhibit design.

Finally, a special thanks to all of the children, families, and groups that participated in our surveys and provided us the data we needed to bring our project to its fruition.

Executive Summary

Public museums serve to preserve the works of art and cultural artifacts from civilizations across the globe. The goal of these museums is to educate the public about art, culture, history, and science. The Worcester Art Museum (WAM) strives to enrich the public with over 35,000 objects and artifacts. In addition to these artifacts, the WAM has begun to integrate interactive elements into their exhibits. The Medieval Gallery at the WAM contains several different interactive elements. While working with Jeffrey Forgeng, Curator of Arms and Armor at the Worcester Art Museum, we focused on the interactive elements in the medieval gallery to develop exhibit evaluation methods and a prototype iPad game.

The goal of this project was to provide the Worcester Art Museum with a detailed analysis of the interactive elements found within the Medieval Gallery, as well as a prototype iPad trivia game, "Test Your Knightly Knowledge." The goal of our interactive element analysis was to determine the current state of the medieval gallery and provide the WAM with methods to evaluate exhibits. The goal of the iPad game was to engage visitors and provide supplementary information about medieval times. In order to reach this goal we needed to complete five objectives:

1. Develop a set of methods for evaluating future exhibits.
2. Assess the effectiveness of audience engagement of the new Medieval Gallery.
3. Compare the assessments of the different interactives in the Medieval Gallery.
4. Design and pilot a new digital media element in the Medieval Gallery
5. Analyze the effectiveness of the digital media pilot

To achieve these objectives, we observed visitors within the Medieval Gallery and the Asian galleries, visited local museums, interviewed professionals in the field, and conducted surveys of WAM visitors.

After completing preliminary observations, we developed a rubric that we used to complete observations in the Medieval Gallery. Using this rubric allowed us to collect both quantitative and qualitative metrics about the interactives found in the gallery. From this data, we concluded that the frequency of usage of the interactives greatly depends on accessibility. We recommend that interactives in the Stained Glass Medieval Gallery are separated and the Spanish Ceiling Medieval Gallery iPad is moved to a standing kiosk. The rubric and the surveys were given to the WAM at the completion of our project, and can be adapted for use in any gallery. From interviews with professionals in the field, we concluded that textual content along with the interactive must be presented in a structured and simplistic format. From this, we recommend that a structured and simple text panel be added to the Enameling Interactive. Utilizing the findings from the data collected, we developed an interactive iPad game, to be used within the Medieval Gallery. At the completion of the prototype period, we concluded that elements that encourage education through entertainment, such as the "Test Your Knightly Knowledge" game, are just as effective as strictly educational elements, but appeal to younger audiences. Overall, we recommend that the Worcester Art Museum continue with adding interactive elements into their exhibits to appeal to both younger and older audiences.

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Chapter 1: Introduction

Public museums have been around for several centuries to preserve the works of art and cultural artifacts from civilizations across the globe. These museums strive to educate the public about art, culture, history, and science. Museums like the Ashmolean Museum in Oxford, United Kingdom, and the Louvre in Paris, France, were some of the first public museums, created to educate the masses and share the cultures of lost civilizations and time-periods (About Us, 2017). Unfortunately, many of the visitors to these museums in the decades following their opening were those of higher affluence and social standing. Museums would like to see more visitors like any other business or institution (Tlili, 2007). Modern day museums desire a broader demographic that were not just comprised of the socially elite classes of citizens. One important aspect in designing exhibits to attract a broader demographic is exhibit evaluation, or determining the success of the exhibit at enticing the audience. Ideally, exciting and enticing exhibits will attract more visitors to the museum, and encourage return visits.

Since the economic recession of 2009, museums like the Worcester Art museum, have been attempting to get more visitors in their doors and retain their audience so they can continue educating the public for years to come. Centuries have passed since museums were just collections of art and artifacts, and as such, museum culture has been constantly changing in attempts to stay relevant. With the ubiquity of information attainable from the internet, the original lure of being able to see previously unimaginable artifacts in museums is now a moot point. In addition, applications like Netflix or YouTube are capturing the attention of the masses, and museums now must engage their audience to regain their attention, as well as educating them.

The Worcester Art Museum is looking to continue providing fun and entertaining elements along with the exhibits they have to offer. The new Medieval Arms and Armor Gallery installed in the fall of 2016, was the focus of our research project. This report contains the three following chapters: Background, Methods, and Findings. The background contains vital information to better understand why the Worcester Art Museum wants to go through this process. It discusses the importance of museums throughout history and the shift of social function museums face in the modern era. The importance of exhibit design and the factors that affect how exhibits are designed will then be described to highlight what factors need to be considered to develop an appropriate approach to modernizing the Worcester Art Museum. Chapter 3, Methods, provides detailed explanation of the process used to complete the project. We collected data through observation and surveys and analyzed the data collected through these various methods. Additionally, following our analysis, we designed a digital media prototype to pilot in the Medieval Gallery of the Worcester Art Museum. Data was collected on the prototype, and used to evaluate its effectiveness. All the research we conducted allowed us to provide the Worcester Art Museum with findings and recommendations, which can be found in Chapter 4.

Chapter 2: Background

The Worcester Art Museum, in their desire to identify the current effectiveness of the current Medieval Gallery, requested that a detailed analysis of their exhibit be performed. To do this, however, we must first understand what functions museums have had in society, and how these functions have shifted as they transition into the digital age.

Museums have been an integral part of society since the 17th century (About Us, 2017), bringing both entertainment value as well as being a center for education. By fostering critical thinking, and provoking questions such as "why was this created?" and "who created this?", museums create an immersive learning environment for visitors of all ages. Originally kept as private collections seen only by the rich and elite, museums slowly began opening to the public in an attempt to share these collections with a wider audience (Tlili, 2008). As society advances, modern museums begin to face challenges as they compete with other newer forms or education and entertainment, and they must shift their focus to remain a cornerstone of education within their communities.

2.1 Importance of Museums

Many museums are designed to appeal to people of all ages. Museums have so much to offer individuals no matter their age due to the size of their collections on display. They offer people access to the past, allow for the development of different perspectives, and learning (Scott, 2006). The traditional role of museums was to collect artifacts and preserve them so that the public can reap the benefits, and this still holds true today (Arinze, 1999). However, museums have also taken on a different role in the 21st century. They are becoming "agents of change and development," and encouraging progress and change in society (Arinze, 1999). By presenting artifacts and pieces of history, museums create a physical representation of the past. This allows people to measure human progress and creates a sense of belonging (Scott, 2006).

Museums can also act as a vehicle to increase tolerance and understanding. In children especially, learning about the history behind different groups of people can foster a "greater understanding between peoples and nations" (Arinze, 1999). Becoming educated on different cultures, and how events in the past have shaped what they are now, increases a person's ability to feel empathy for others, especially those with different backgrounds. It is often difficult to understand the process of change in the moment, and museums can offer some perspective as to how change has happened before (Scott, 2006). It may also be difficult to see the bigger pictures of the relationships that humans have with one another, and a graphical representation of this in museums may allow for more social awareness. Emmanuel N. Arinze spoke about this in a public lecture, saying that "museums do promote unity in the society by using their resources to ensure understanding and appreciation for the various groups and cultures that exist in that society," (Arinze, 1995, pg.3). In doing so, museums can have a positive effect on the community by educating them culturally, as well as academically.

Lastly, museums offer visitors a chance to learn about the past and the world around us. While museum environments can encourage children to learn, people of all ages have a chance to learn while they walk through a museum. These exhibits provide a tangible experience to learn outside of the traditional classroom setting (Scott, 2006); however, in the case of adults, learning from a museum is a lot quicker than if you were to look everything up in a library (Scott, 2006). The integration of culture in education is also important (Arinze, 1999). Allowing children and adults to educate themselves in the context of culture is important for fostering empathy and understanding. Museums should be accessible to all age groups, and provide a location for future generations to learn about our present (Arinze, 1999). Without museums, society would be

diminished. Museums provide a unique and interesting excursion that is universal, no matter your age or where you come from, there is always something to gain from visiting a museum.

2.2 Creation of Public Museums

Although museums have always been important, the first museums looked quite different than museums look today. Early museums were restricted to the elite, and the Ashmolean Museum was the first to allow the public access when opened on May 24th in 1683. Located at the University of Oxford in England, the museum allows the contents to be viewed by the general public and allows everyone to reap the benefits they provide (About Us, 2017). However, when it first opened, it was only a small collection of objects of interest and paintings displayed in a large paneled gallery. Patrons could browse objects including Guy Fawkes's lantern, which has an intriguing history behind it (About Us, 2017). Guy Fawkes was arrested for high treason after being caught attempting The Gunpowder Plot to murder James I of England in 1606. He was found in the basement of Parliament the night before the plot was scheduled to happen, with the lantern. The lantern has an intriguing feature, where an inner cylinder would rotate to conceal the light, thus making the holder invisible in darkness (MacGregor, 2012). This story is an example of how museums display a variety of artifacts with a wealth of history attached to them, just like the lantern, which the public can benefit from experiencing.

The Worcester Art Museum (WAM) was established by Stephen Salisbury in 1898 and has grown to become the second largest art museum in New England. With over 35,000 pieces of art consisting of paintings, sculptures, decorative arts, photography and more, the WAM is an important part of culture in Worcester, Massachusetts (Worcester Art Museum, 2000). The WAM has also accomplished several impressive feats throughout the years, including being the first museum in America to purchase a work by Claude Monet, and the first museum to bring a

medieval building to America (Worcester Art Museum, 2000). Over the years, the WAM has renovated its galleries, and the building, to bring the museum to what it is today (Sheenan, 2011). In 2014, the WAM acquired a collection of medieval artifacts from the recently closed Higgins Armory that was in Worcester, Massachusetts. With the Medieval Gallery boasting its newly integrated arms and armor collection, as well as the many other galleries on display, the WAM continues to educate the public on important and interesting historical cultures and events.

2.3 Museums of the 21st Century and the Challenges They Face

Historically, museums have been a center for learning and culture, but with the increasing popularity of the online entertainment platforms, modern museums must shift their focus to not only be a resource for education, but to provide this education in a way that is entertaining and engaging for museum visitors. Museums in the United States have experienced a decrease in visitation since the early 2000s, primarily from the younger generation (Shu, 2015). This decrease in interest leads to a decrease in revenue, and the lack of visitation will also decrease the aid they receive in the form of grants and donations. Museums must now focus on new ways to educate and engage their visitors in an effort to overcome new economic obstacles presented to them as their function in society shifts.

2.3.1 Economic Factors Affecting Museums

With the surge of online entertainment platforms during the 21st century, museums must compete against other forms of education and entertainment to continue to remain relevant. While museums are a great resource for education, most information that is found in a museum can be found on the Internet, leading to a decline in museum visitation. The educational value of a museum is greater than the sum of all the information available within the museum, but education alone is not enough to draw visitors to the museum. Communities benefit greatly from local museums, but a large amount of these benefits are not monetary. There are five main

categories of value that museums bring to their surrounding community, as shown in Table 1. (Frey, B. S., & Meier, 2006, Pg. 6-7)

Option Value	People value the possibility of enjoying the objects in a museum sometime in the future.
Existence Value	People benefit from knowing that a museum exists but do not visit it themselves now or in the future.
Bequest Value	People derive satisfaction from the knowledge that their descendants and other members of the community will in the future be able to enjoy a museum if they choose to do so.
Prestige Value	People derive utility from knowing that a museum is cherished by persons living outside their community. They themselves need not actually like the museum, nor even visit it.
Education Value	People are aware that a museum contributes to their own or to other people's sense of culture and therefore value it.

Table 1: Five Categories of Motivations of Museum Visits (Frey, B. S., & Meier, 2006, Pg. 6-7)

Many of the values that museums bring to their community do not involve people physically visiting the museum. Rather, these values focus on community members being pleased that the museum exists, without any effort to go to the museum or encourage others to visit the museum required. While museums are often appreciated in their community for any of these reasons, this appreciation does not necessarily lead to revenue for the museum, and without an adequate number of visitors, museums will have to eventually close down due to this loss of income. Museums are facing an economic struggle due to a rapid decline in interest, specifically in the younger generation, and museums must now change the way they present their exhibits and educate visitors to compete with other forms of entertainment.

2.3.2 New Ways to Educate Visitors

As museums attempt to compete with other forms of entertainment, they must alter how exhibits are presented to provide new learning opportunities for their visitors. Many museums have shifted their focus towards families with children, hoping to create fun and educational learning opportunities that will be appealing to both parents and children (Shu, 2015). This has

led to many studies on how children best learn, to design exhibits with children's interest in mind. It has been found that the most learning occurs when children interact directly with the exhibits (Puchner, 2001). More specifically, hands on exhibits allowed children to learn from a cause and effect relationship, leading to them retaining more information than if they only observed the exhibit without any interaction. It has also been noted that children's learning was increased when an adult was directly involved with their experience with the exhibit (Puchner, 2001). Museums must focus their efforts on creating exhibits that are not only fun and interactive for children, but they must also appeal to adults. Maintaining this balance will lead to an increase in museum visitation, thus resulting in more revenue for the museum.

While the technology boom is partly responsible for the decline in museum visitation, museums should try to take advantage of new technology as a tool when designing exhibits. The US National Research Council has concluded that effective learning falls into one of four categories:

Learner Centered	It builds on the skills and knowledge of knowledge of students, enabling them to reason from their own experience
Knowledge Centered	The curriculum is built from sound foundation of validated knowledge
Assessment Centered	Assessment is matched to the ability of the learners, offers diagnosis and formative guidance the builds on success
Community Centered	Successful learners form a mutually promotive community, sharing knowledge and supporting less able students

Table 2: Four Categories of Effective Learning (Sharples, 2006, pg. 4)

Museums should take note of these categories, and ensure that exhibits fall under one, or more, of these categories. By following this metric, exhibits will hopefully educate those interacting with them even more than was previously possible.

Using technology to enhance exhibits can also have a positive impact on the educational value of an exhibit by helping it meet one or more of these types of learning. In *A Theory of*

Learning for the Mobile Age, Mike Sharples suggests that any technology being integrated into an exhibit be tested against the following criteria (Sharples, 2006, pg. 5):

- Is it significantly different from current theories of classroom, workplace or lifelong learning?
- Does it account for the mobility of learners?
- Does it cover both formal and informal learning?
- Does it theorize learning as a constructive and social process?
- Does it analyze learning as a personal and situated activity mediated by technology?

These criteria are simply one opinion on what makes a successful exhibit, but the main ideas can be applied to any museum. The focus should be on educational value, however, not at the cost of alienating the museum visitor. Technology is a powerful tool that can be used to attract more museum visitors, presenting exhibits in a more exciting way, while also enhancing the lasting educational value of such exhibits.

2.3.3 Successful Examples of Modernized Museums

Some museums have been successful in increasing attendance by integrating interactive components. When analyzing techniques for developing a successful exhibit in a museum, those types of museums set the pace for the rest of the museum community. The Hunt Museum in Limerick, Ireland, is a great example of a museum with successful interactive exhibits that are fun for both adults as well as children (Ciolfi, L., & Bannon, L., 2002). The Hunt Museum features numerous "hands on" exhibits, which are fun as well as educational for museum visitors of all ages. One exhibit that stands out is the Archaeology Workshop, an exhibit targeted towards children that simulates archaeological digs. Featuring sandboxes based off the Stone Age, Bronze Age, and the Medieval Age, children are encouraged to dig through the sand and uncover

"artifacts" from the respective eras. These "artifacts" are not actually real artifacts, but replicas, however this does not detract from the fun and educational value for the children. Children who spend time at this exhibit can enjoy a fun activity while also having a lasting educational experience. The museum breaks children into teams, and encourages the children to document their findings from the digs. Once they have found all objects in the sandbox, the children are given a chance to guess which era their "artifacts" are from (Ciolfi, L., & Bannon, L., 2002). This hands-on experience helps the children form positive memories associated with their learning, and leads to an exhibit being seen as more successful.

While most hands-on exhibits at museums are targeted towards children, the Hunt Museum features interactive exhibits designed with adults in mind as well. Museum visitors may choose to participate in one of the museum's "handling sessions". These sessions give visitors an opportunity to touch and handle real museum artifacts, under the supervision of the museum's education officers (Ciolfi & Bannon, 2002). It is important for museums to cater to all age groups and demographics so that they will have the widest appeal possible, and exhibits like this do a great job at raising interest as well as improving learning.

When designing an exhibit, it is crucial to observe examples of successful museums/exhibits, using these examples to better tailor their own exhibit to the needs and desires of the museum visitors. With the ever-increasing popularity of technology, as well as a change in the way education happens, the museum's role in society is beginning to shift, and this must be considered when attempting to design a successful exhibit.

2.4 Shifting Functions of Museums

Museums currently have a stereotype associated with them, being thought of as quiet, solemn places that people go to reflect or become educated on culture and art. As mentioned

earlier, museums were previously collections of art and artifacts that were on display as testaments of wealth and culture to the person(s) who owned the collection. As time went on museums became public places for the masses to become culturally educated and to intermingle between differing classes of wealth; however, they were still just items in a collection rather than an experience for the audience. When attending a museum, a visitor expects to observe the exhibits and keep their opinions to themselves. The typical museum visitor is pictured as an older person with a higher education, who would enjoy past exhibit design methods (Tlili. 2007). The movement by museum professionals is now to bring education and entertainment together in museums. It is challenging for museums to compete with new technology and emerging entertainment. If all the visitors do is observe and reflect upon the art and culture, only a select group of visitors would attend. Not only does the movement of museum function bring in new ideas, but also new visitors.

2.4.1 New Target Audiences

The function of museums has been shifted in the modern day, and some museums are now targeting new audiences. The Cooper-Hewitt museum in New York City had low visitation rates so it was shut down for three years to do an entire museum renovation. During this renovation, they implemented digital media throughout the entire museum. Each visitor is given a pen to use for the various activities and their drawings are saved to the pen (Chan, 2015). This is proof of the adaptation to the technology boom that millennials and children are greatly invested in (Bull, 2010). Centuries and even decades ago, museums did not have accommodations for children, but there is now a large movement to attract families with children to museums. A prominent goal of museums is to educate visitors, and bringing in children and creating a fun way to educate them on culture and arts is all part of the new function of museums. Families comprise more than half of the visitors to the nation's museums. Museum

professionals are taking the time to understand what families want in exhibits, and this is a combination of education and entertainment for their children (Borun et al, 1998). Education and entertainment are often treated as separate entities. Modern museums are trying to simultaneously integrate education and entertainment into their exhibits.

Families are not the only demographic that would be attracted to more entertaining exhibits. These exhibits would also attract the attention of millennials, or persons between the ages of 20-30. A social aspect of bringing an educational and entertaining exhibit to a museum could help the millennial generation become more educated with art and culture. With the efforts moved towards families with children and millennials, museums will start to implement more attractive exhibits to this group.

The new target audience of museums often requires an evaluation of the current practices and exhibits of the museum. Integrating visitor perspectives into the museum exhibits is becoming more and more of a popular method to exhibit design. In an article written by Marcia C. Linn from the University of California, Berkeley, she describes how it is important to learn what the different purposes of museums are. They are as follows:

Learners	Attend by choice and freely choose their activities
Visitor Groups	Generally, families or peers, who often have both social and educational agenda
Financial Arrangement	In general, depend on support from visitors, community groups, government agencies so forth
Multiple Functions	Often including preservation of artifacts, of historical knowledge, and provision of public understanding of recent advances in knowledge

Table 3: Museum Purposes (Linn, 1983, pg. 120)

Now that the modern museum function is changing, the museum director's objectives are going to fall more under categories one and two. The new visitor agenda will play into the fusion of education and entertainment in museums.

2.4.2 Education and Entertainment

There are many reasons why the new target audience of museums is families with children. This demographic comprises more than half the visitors of the United States' Museums (Borun et al, 1998, pg. 1). A year study at the National Research Center of Arts, found that the more people were taken to museums as children, the more likely they were to visit as adults (Wollins, 1989). The study also found that children caused the family to have longer conversations with the pieces because of their young, explorative minds and in turn this will increase linger time. Linger time is the amount of time spent involved with an exhibit or with a specific item within the exhibit. Linger time can serve as a rough measure of the potential for learning (Lyons, 2008). The social aspect of the museum is more apparent when children are involved, because explanations and interpretations are needed to explain the exhibit (Borun, 1998). Social inclusion is another drive for functional change in museums. The atmosphere of the museum was not seen as a place for children due to their typical active behavior (Tlili, 2008). In adding new exhibits which engage children, the museum participation agenda is expanding the experience to all groups of people. Museums are trying to be more socially inclusive and are being used as an "agent of social change" (Tlili, 2007, pg. 273). The social inclusiveness will bring educational entertainment to more demographics, and bring to light the museum's importance.

Importance of Education and Entertainment

Museums are often funded by the government to bring life enriching opportunities to the nation (Tlili, 2007). Museum's serve to fulfill this purpose, enriching their visitors with arts and

culture. They are trying to become "agents of lifelong learning" (Tlili, 2007, pg. 277). An example of how to incorporate this concept is by holding community events. Community events at a museum will bring lifelong learning to the unusual visitor demographic and encourage them to visit museums more often. Classes taught by museum staff will encourage visitors to learn. Taking multiple classes will create a habit of learning that visitors can bring that knowledge to the community or their family. Shifting the learning agenda will bring communities together.

The PISEC (Philadelphia-Camden Informal Science Education Collaborative) group comprised of seven museum and research professionals conducted a study on family learning in museums. They embarked on the project to answer the research questions: "How can family learning in museums be measured and identified? What attributes of museum exhibits encourage family learning?" (Borun, et al 1998, pg. 1). The PISEC study identified seven characteristics of successful family exhibits based on their field observations, shown in Appendix A. These characteristics may seem obvious, but they are only recently becoming the new trend in museum exhibits. Up and coming museums need to take advantage of these trends to create family-friendly museums (Borun, 1998).

Another study done at the Exploratorium in San Francisco delves even deeper into the human mind and what exhibits will attract the desired audience. The study looked at trying to eliminate "museum fatigue" which is when visitors "can only engage deeply with exhibits for a limited period (typically 30 minutes) before they lose their focused attention…" (Allen, 2004, pg. S20). Not only was the study on adults who wanted to support their children's learning, but on the millennial generation. This type of design is called "user-centered design" and is used in many other museums, not just the one at the Exploratorium. Human's natural desires and psychological tendencies were studied to bring exhibits closer to this goal of "user centered

design" (Allen, 2004, pg. S21). For example, a successful exhibit was discovered when a tank of nocturnal frogs was put on display. These frogs were not present when visitors viewed the exhibit but their absence sparked a lot of reflection and theories from visitors. Allen describes the visitor's reactions to the frog exhibit:

> *"Apparently, visitors recognized the exhibit as an example of something where one had to wait and watch in order to be rewarded by a frog sighting, and within this framework they accepted the challenge and used it as an opportunity to share stories and knowledge. Exhibits that make visitors really think and learn about the exhibits prove to be the most successful" (Allen, 2004, pg. S23).*

This kind of reaction from visitors is what makes the museum more engaging, entertaining, and educational.

Simultaneous Integration

Millennials are stereotypically known to enjoy media and technology (Bull, 2010). This is because millennials have grown up within the digital age and are experienced with technology and media. There are so many forms of technological entertainment today, museums must now try to compete for their audience's attention. Two professors of learning and education at Northwestern University and University of Wisconsin, respectively, studied the impact of two related digital media annotation systems "VideoTraces" and "ArtTraces" on the visitor experience (Stevens, Toro 2003, pg. 25). The intent of these two systems was to stray away from the typical read and learn agenda and to add some entertainment. Traces records the interactions and thoughts the visitors have with the exhibit through saved digital recordings provided by the museum and recordings and motions created by Traces. The two subject groups studied were a father and son and two friends in their 20s. Both groups reacted with great interest and varying opinions that sparked reflective conversation with the other member of their group. Traces was a

successful digital implementation at the museums studied, the Pacific Science Center and the Seattle Art Museum.

Using digital media and entertaining but also educational museum exhibits, museums functions are shifting their focus. With the new target audiences being families with children and millennials, museums can serve as a social hub and an enjoyable way to become educated on culture and arts. Implementing digital media and interactivity in exhibit design are the new motivation to build a museum community that reap the benefits of the new societal function of the modern museum.

2.5 Importance of Exhibit Design

Audience engagement has become an important aspect of exhibit design in museums within the last century. The design of an exhibit directly affects its audience and plays an important role in educating and interesting visitors. The shifting functions of museums has caused them to rethink how they go about exhibit design. In doing so there has been a new rush of museums wanting to make their exhibits more interactive in order to meet that goal, but much research is still being done on the subject. In order to broach this new topic, we must look at the past and present in order to discuss future improvements to exhibit design that can be accomplished.

2.5.1 Past Approaches to Exhibit Design

Since there wasn't a large focus, there was never a lot of thought put into the design of the exhibits holding the art other than just to categorize them by time period or artist, et cetera. Modern exhibit design evolved over time as a way for the curator to turn these exhibits into an emotional and educational journey for the audience. Unfortunately, most exhibits in the past century have been designed as follows: Whomever has the most money to give or is the owner of the collection being used will decide what the theme of the exhibit they want to see is. Then, it is

the curation staff's job to find the necessary artwork and design an exhibit around that theme (Wells et al., 2013). Nowhere in this process does the audience get recognized. Museums that design exhibits this way do not create exhibits for the audience, they create exhibits for themselves or their benefactors. This, according to Wells, is the current issue with how exhibits are designed. Wells argues that the exhibit should be made with the audience in mind from the beginning and that all of the administrative duties, like finding the funding or the pieces that need to be collected for the exhibit, should come later (Wells et al., 2013). In doing so, museums would ensure that their exhibit designs will appeal to visitors.

Another issue to the current way that exhibits are designed are the exhibit curators and designers themselves. While curators insist that the exhibit is designed for the general public, these designers and curators tend to design more to align with their own interests, viewing the public's interests as "out of line with their own" (McLean, 1999, pg. 86). Conversely, due to an increasing number of marketing advocates assuming the public is some variation of "Joe-Sixpack," the creation of exhibits tailored to this demographic is appealing in the short term, but without the intellectual depth expected of museums these exhibits do no better than the former (McLean, 1999). McLean argues that the problem stems from museum curators being out of touch with their audiences and not understanding that creating exhibits with visitors in mind is not the same as a "give-'em-what-they-want" style of design (Mclean, 1999, pg. 87). What exhibit creators need to do is take steps towards analyzing their audiences, survey the local community to find what interests them, and then design exhibits that target these interests. In presenting interesting exhibits to visitors that can relate to the subject matter, this will cause an influx of visitors and the subject matter will allow for discussion and reflection, which is an important aspect to the education presented by the exhibit.

2.5.2 Current Gold Standard

The goal for museums is to engage the audience with their exhibits, educate them, and facilitate discussion on the art or artifacts on display. This makes for healthy debate or inquisitive thought to make visitors want to learn more about the information in the exhibit and spark more interest in the subject matter. Creating exhibits that can do this, as previously discussed, has been difficult for a number of institutions. To aid museums in creating engaging exhibits, PISEC found what many consider to be the Gold Standard of exhibit design, and while their research was on science museums in particular, the guidelines can be used as a general guide for any type of exhibit. PISEC found that successful exhibits were those who had the seven characteristics described in Appendix A.

Their research found that by incorporating all seven of these characteristics into an exhibit, the exhibit was more attractive and engaging to visitors, specifically families. This comprehensive list covers all the aspects that make for a good exhibit design as described above. Making the exhibit able to handle multiple visitors at once, easy to interact with by visitors, and easily readable make for an enjoyable experience for all age levels and demographics. Incorporating intellectual complexity, as well as tying in information relevant to the audience, will facilitate discussion and spark interest in the audience. These characteristics allow for exhibits that are designed for the general public, and will be sufficiently interesting and educational enough to meet all of the requirements that modern museums desire to accomplish.

Unfortunately, in their research, it was found that out of over 250 exhibits in the Franklin Institute Science Museum in 1997, only 6% of these exhibits utilized all seven of these characteristics (Borun et al, 1998). Many museums, like the Franklin Institute, have not made the

push to design their exhibits with this Gold Standard in mind, but with the push towards more interactive exhibits in the past decade, these institutions might begin to follow these guidelines.

2.5.3 Interactivity in Exhibits

In recent years, the push towards more interactive exhibits has made it difficult for exhibit designers to properly incorporate these elements into exhibits without it feeling forced. Digital media in museums, in some cases, has become more of a replacement for the text or infographics that used to present information on the elements within the exhibit. Mobile tablets have simply taken the place of informational placards, but this does not constitute interactivity (Meecham, 2012). In adding interactive elements to an exhibit, one must understand that the purpose is two-fold: to facilitate the interaction not only of the audience with the exhibit, but also with each other. Museums, specifically art museums, are meant to spawn discussions and inquisitive thought on the elements within the exhibit. Adding interactive elements can make this easier to accomplish, but exhibit creators need to understand how to do so effectively.

According to Skydsgaard, there are four fundamental principles when designing a museum exhibit: curiosity, challenge, narratives, and participation. Each of these four aspects are important in their own right, and all four need to be considered when designing exhibits that are meant to engage the audience effectively. (Skydsgaard, 2016)

Curiosity is the idea that visitors to museums are influenced in what exhibit they attend by their inherent curiosity of that exhibit. Curiosity can be incited by objects foreign to the visitor, information that they can relate to, and eye-catching or intellectually stimulating pictures or effects (Skydsgaard, 2016). This aspect of design is most important in capturing the attention of the audience, and is ultimately what draws visitors to the exhibit.

Challenge is the idea that exhibits must present information that prompts strong reactions from the audience, either physically, intellectually, or emotionally (Skydsgaard, 2016). By challenging the visitors, museums can further engage them in the exhibit and prompt discussion on the topics presented. Once thoroughly engaged in an exhibit, visitors are more likely to absorb the information present, and they can do this much more easily when the exhibit presents a good narrative.

Narrative, much like how humans have learned for centuries, involves the information being presented by the exhibit to follow some sort of storyline or dialogue. In doing so it is easier for the visitor to understand and retain the information, as well as giving them a talking point in which to further engage with others inside the exhibit. When used in conjunction with challenging exhibits, narrative devices can stimulate reflection and debate about difficult topics that would otherwise be ignored (Skydsgaard, 2016).

Finally, *participation*, which is comprised of both physical and dialogic interactivity, is one of the most important aspects of the design concept. Physical interaction with the exhibit has been proposed to be very helpful in mental engagement for learning, and helps visitors to not only intellectually learn about an exhibit, but also to experience it with other senses as well. Dialogic interaction, which can be incited using the previously mentioned methods correctly, is important in sharing and constructing new knowledge gained from an exhibit (Skydsgaard, 2016). This has been shown to engage younger visitors, which are important aspects to consider in reaching out to new demographics.

Interactivity in Art Exhibits

Alternatively, to the points presented by Skydsgaard with respect to interactivity, Meecham suggests that the way that art is presented isn't necessarily static (Meecham, 2012). She cites

Ron Burnett's ideas, saying that imagination is more of a primary role in interactivity than physical activity. In her argument she states that, "it is not the technology that enables interactivity, but the activity itself" (Meecham, 2012, pg.108). In this regard, the dialogic interactivity, or the interaction between visitors via discussion, of the exhibit should take the forefront as a key role in designing art exhibits.

Successful Interactive Exhibits

The Institute of Computer Science - Foundation of Research and Technology --Hellas, Greece (ICS-FORTH) performed an experiment to design different prototypes of interactive museum exhibits to research how effective these types of exhibits would be. These exhibits used various technologies to create a fun and educationally enriching experience for the visitors that were taking part in the experiment (Grammenos et al, 2011).

The first prototype was called "Panoptes", and this exhibit allowed users to navigate through different artifacts and works of art digitally, all while being presented information about the specific piece being displayed (Grammenos et al, 2011). The exhibit had two touch-screen displays, one that would present the art/artifact, and another that would act as an information kiosk. The interactive abilities of this exhibit allowed visitors to tap on various "hotspots" on the display with the art, and informational text bubbles would appear on screen next to the hotspot (Grammenos et al, 2011). Tapping on the display not on a hotspot would highlight all the hotspots for that particular image. This allowed the visitors to gain as much or as little information as possible, all while highlighting what the information refers to, and being able to tap into the visitor's natural sense of curiosity.

The second prototype was an exhibit called "Polyapton" (Grammenos et al, 2011). This exhibit would present visitors with a large touch-panel that would display a piece of art or an

artifact. When the piece is touched, the image shatters into several puzzle pieces, allowing the visitors to rebuild the art in a fun collaborative manner. Once rebuilt, the screen would display information about the artifact underneath the image. Pressing hotspots on this image would bring up movable, resizable informational text bubbles that gave a description about the hotspot selected. Using the included "flashlight" acted as an X-ray vision laser, allowing the visitor to see inside the artifact and read additional information about what was inside the artifact. Lastly, a paper ring allowed visitors to zoom in on particular parts of the artifact being displayed, giving them a closer look at the piece.

The results of the study showed that every exhibit was successful in engaging and educating the visitors. The overall opinion of the participants "ranged from positive to enthusiastic" (Grammenos et al, 2011, 180). Even through technical errors, as to be expected with prototype systems, the visitors did not get frustrated and give up, rather, they continued their attempt to use the system due to the enjoyment the exhibit gave them when functioning properly. It is this kind of reaction and enjoyment that the Worcester Art Museum is attempting to attain in redesigning their exhibits.

2.6 Worcester Art Museum

Museums that have existed for a long period of time, like the Worcester Art Museum, are now looking to institutions like ICS-FORTH to help discover what direction they should be taking in redesigning their exhibits to stay modern and continue attracting new visitors. Since 1898, the Worcester Art Museum has stood as a local monument to past cultures across the world. Boasting more than 35,000 works of art, spanning across 50 centuries of varying cultures, this institution is a cornerstone of Worcester's cultural education. Founded by Stephen Salisbury III, the Worcester Art Museum was created as an educational and cultural institution "for the

benefit of all the people" (Worcester Art Museum, 2000). The Worcester Art Museum, for most of its lifetime, presented its collections in a very traditional manner. Almost entirely comprised of static exhibits of different art and artifacts, the Worcester Art Museum are looking now for change. Much in the same way programs like ICS-FORTH seek to integrate new interactive elements to exhibits, the Worcester Art Museum seeks to do the same in order to draw in more visitors, specifically those of younger demographics.

The Worcester Art Museum, in 2012, ran a "$1.5 million deficit on a $9 million budget" (Edgers, 2012), quite the difference from the early 20th century when as many as 200,000 visitors attended each year (Edgers, 2012). The museum is attempting to remedy this by getting more visitors in the door, and to accomplish this task they are slowly beginning to renovate existing exhibits, as well as add new interesting ones to the roster as well.

2.6.1 Previously Successful Exhibits

The Worcester Art Museum, for many years, has not deviated from the traditional style of art presentation in their exhibits. This all changed in 2013, when the museum unveiled its [remastered] exhibit, an exhibit which took art from their Renaissance collection and put a new spin on the presentation. This new gallery boasts "richly colored walls (milky lime and tomato soup red)" with the paintings being "grouped together in clusters," with each painting jutting out from the wall at "angles that become more pronounced the higher up they are" (Smee, 2013). In addition to the unique arrangement of the art, not a single piece has a title, nor a description. This is to incite discussion on the paintings and promote more complex thought on the intentions of the artist when painting his/her masterpiece.

A previous research project from WPI students analyzed the success and effectiveness of the new gallery changes in [remastered] compared to the traditional Renaissance exhibit (Davis

et al, 2015). Their analysis found that the [remastered] gallery was a successful pilot of an interactive gallery which promoted visitor reactions. However, the interactive elements of the gallery needed work, as items like the informational iPad kiosk failed to work a lot of the time and that frustrated the guests who wanted more information and could not obtain it (Davis et al, 2015).

2.6.2 Medieval Gallery

The Medieval Gallery was not always present in the museum. Obtained in 2014, the collection originally belonged to the Higgins Armory. From its founding in 1931 until 2004, the Armory was the only museum in the United States entirely devoted to arms and armor (Edgers, 2013). In 2013, the Armory closed due to lack of funding, but its' over 2,000 objects and 24 full suits of armor have been obtained by the Worcester Art Museum and a portion are on display within the Medieval Gallery.

The museum is attempting to create new exhibits with new "alternative design approaches that encourage new ways for visitors to interact with and participate in daily uses of the gallery" (Worcester Art Museum, 2013). To this end they are seeking to incorporate interactive elements into their Medieval Galleries in order to entertain and educate visitors in new and creative ways. To do so they draw on the experience from other renovated galleries they have worked on, as well as from research that has been done in creating interactive elements to museum exhibits.

The Medieval Gallery has three main interactive components: an armored gauntlet, an armored helmet, and multiple iPads containing information about the different pieces on display. The gauntlet and helmet are meant for visitors to try on. The iPads have information about all the weapons and armor on display.

The main deliverable for this project was a set of methods to be used when evaluating galleries in the museum, as well an interactive media prototype. Using these methods, our project provided the museum with analyses and suggestions for use in the permanent medieval exhibit. Installing an interactive media prototype will generate increased interest in the gallery from families with children, as well as millennials. In the next chapter, we explain our methodological approach to this project.

Chapter 3: Methods

3.1 Introduction

After inheriting the Arms and Armor collection from the now closed Higgins Armory in 2014, the Worcester Art Museum (WAM) has reinstalled its Medieval Galleries to incorporate arms and armor. The WAM and their arms and armor curator, Jeffrey Forgeng, are hoping that there will be a renovated Medieval Gallery by 2020. The goal of our project was to analyze the current state of the interactives within the gallery, and to design and pilot a new interactive digital media element to the exhibit in order to make it more engaging.

To accomplish this goal, we achieved the following five objectives. We first established a set of tools to analyze the current state of the Medieval Gallery. We analyzed the different interactives within the medieval gallery and compared them to one another. Then, we designed the methods to give the Worcester Art Museum the tools necessary to continue analyzing their exhibits following the completion of our project. Finally, once we collected all the data on from the Worcester Art Museum and three other local museums, we designed and implemented an interactive trivia game for the Medieval Gallery to pilot a different form of digital media in the exhibit. We then evaluated the effectiveness of the pilot and provided suggestions for interactive exhibit design at the Worcester Art Museum and specifically within the Medieval Gallery.

We ensured that all participants in our research were fully informed of this project and had the opportunity to decline to participate if they so desired. Our research methodology was approved by the Worcester Polytechnic Institute Institutional Review Board on March 3rd, 2017.

3.2 Project Objectives

Objective 1: Develop a set of tools for evaluating the effectiveness of interactive exhibits.

To develop our data collection and analysis methods, we first needed to gain a better grasp of the general exhibit design process. To do this, we conducted participant observation at four other museums and interviewed with the curatorial staff of the institutions.

Visiting other museums provided us with first-hand experience with the exhibits and design process of the museums. We visited the U.S.S Constitution Museum, the Acton Discovery Museum, the Russian Icon Museum, and the Country Music Hall of Fame. The U.S.S. Constitution Museum is a highly interactive museum, which gave us valuable insight on how to engage the WAM's target audience. We interviewed Robert Kiihne, the Director of Exhibits at the U.S.S. Constitution Museum, and sought information on his exhibit design approach. See Appendix D for our curator interview questions. The Acton Discovery Museum, although a science museum, features interactive exhibits geared towards families with children, and thus served as a great resource for us. We interviewed Denise Leblanc, Discovery Museum Director of Education, and she provided us with information about her philosophy on exhibit design and the museum's approach to actively engaging the visitor. We also interviewed Devon Kurtz. Having worked in exhibit design for a few decades, we felt that Mr. Kurtz would be a useful source of knowledge. Starting with his work at the Old Sturbridge Village through his work at the Higgins Armory and now the Blackstone Valley Visitors center, he has an extensive background working with different institutions. The Russian Icon Museum was a much more modern museum than the Worcester Art Museum, so observing the design, layout, and interactives offered some interesting contrast. Lastly, the Country Music Hall of Fame in Nashville, Tennessee had a very sophisticated network of digital interactive exhibits that proved useful as a first-hand example of extensive digital media.

We used participant and passive observation to collect data on the current museum practices. With participant observation, we assumed the roles of visitors to the museum and observed our own reactions to the exhibits (Spradley, 2016). This allowed us to become more acquainted with the exhibit before we began observing others interacting with the exhibit (Spradley, 2016). With passive observation, we observed visitors to these exhibits and took note of the interactives visitors seemed to enjoy most.

To analyze the effectiveness of the digital elements of the Medieval Gallery, we designed and implemented telemetric data collection tools into their existing iPad interactives. Telemetry is the process of collecting data on the use of a software application. Each interaction with the iPad was recorded, allowing us to evaluate how visitors are interacting with the iPads. This anonymous data collection on the use of the iPads aided in supporting the data collected we collected through observations. We used Microsoft Excel to determine the most and least popular elements of the iPads, and general amount of usage. It also gave us a framework to assess the effectiveness of the digital media pilot we implemented in the gallery. We discuss the pilot and telemetry framework will be discussed in detail in Objectives 4 and 5.

Objective 2: Assess the effectiveness of audience engagement of the new Medieval Gallery

To evaluate the effectiveness of Worcester Art Museum's audience engagement, we conducted several observations of museum visitor behavior in the Medieval Gallery. We conducted passive observations, which entailed observing visitors from the point of view of a bystander, meaning that the visitors being observed were not aware that they were being observed. This allowed us to collect data on the visitors' natural reactions. We conducted the observations on five Saturdays and one Thursday afternoon, as visitor attendance data analysis showed these were the museum's busiest times on the weekend and during the week,

respectively, shown in the visitor attendance graph in Appendix G. It is important to sample the widest variety of WAM visitors possible to get a diverse array of participants. We did this by marking down the approximate ages, genders, and whether they were in a group, and reviewed our data to ensure a broad selection. We sought insight into what types of interactivity families, children, and young professionals find most engaging and interesting. We structured the observations using a rubric that we created through preliminary observations and input from our sponsor, the WAM Curator of Arms and Armor (see Appendix B). The rubric consists of observation points and a field for the observer to record what they are seeing. This rubric is broken up into each interactive found in the Medieval Gallery, and allowed us to make detailed notes on each individual exhibit piece. These categories helped us to decide which types of interactive media is the most successful in attracting and holding visitors, based on total instances of interaction, as well as average linger time.

We also collected headcounts of the number of visitors in the Chinese Gallery, Indian Gallery, and Japanese Gallery, as well as the Medieval Gallery. We took a headcount of each gallery on a specific time interval during each session. The counts were all performed at the same time each session to have an accurate comparison of the foot traffic in each gallery. We then used this data to compare the popularity of the newly installed Medieval Gallery to these other, non-renovated galleries.

Path tracking was also conducted on three separate Saturdays to determine the route visitors were taking through the Medieval Gallery. Visitors were selected randomly as they entered the gallery, and their path was recorded, along with places in the gallery which they stopped to either look, interact, or talk with another visitor about the exhibit. We believed that path tracking was important to determine what aspects of the exhibit visitors were attracted

towards. A sample selection of the path tracking data from both galleries can be found in Appendix C.

Finally, we distributed written surveys to assess the effectiveness of the Medieval Gallery. We distributed 57 surveys on three different days to visitors who interacted with the "Art Cart". We asked them about what they enjoyed about the Medieval Gallery, what they would change, and what they would like to see more of. Please see Appendix D for the visitor survey questions. Visitors who interacted with the "Art Cart" were more likely to provide useful feedback, as they spent a larger amount of time in the gallery than those who did not participate in the "Art Cart". The "Art Cart" features a variety of reproduction armor pieces that the visitors may touch and try on, so we felt this would be an effective way to reach our target audience with surveys, since it is very attractive to families with children.

We analyzed the survey data using anecdotal responses to help determine how effective the temporary exhibit is. Through isolating key words, we determined key themes and trends specified by the visitors that participated in our surveys. Plotting the results in Microsoft Excel tables and graphs allowed for easy visual analysis by our team, advisors, and sponsor. A word cloud was also generated, which indicates which words were said most often by survey participants.

Objective 3: Compare the assessments of the different interactives in the Medieval Gallery

We analyzed the observational data by coding each datum and separating them into categories. We then used Microsoft Excel to identify the most common trends in museum visitor activity and assessed how each interactive element in the Medieval Gallery compared to each other. We approximated ages of the visitors we observed so we could identify which aspects of the interactives are popular with which general age groups. Estimating ages is a difficult and

arbitrary, but it was important in identifying what age groups were interacting with the different interactives. We used this data to help isolate the interests of our target audiences: families with children and young adults.

Objective 4: Design and pilot a new digital media element in the medieval exhibit.

After we analyzed all the data collected in objectives 1-4, we began designing and implementing a form of digital media that we introduced into the exhibit as a pilot program. In designing this pilot, we used the data collected from our analyses of the Medieval Galleries to decide what elements from the medieval exhibit should be incorporated in this interactive prototype. Our analysis of interactive exhibits at the Acton Discovery, U.S.S Constitution, and Russian Icon museums contributed to the prototype design. The work of The Institution of Computer Science, Foundation for Research and Technology Hellas (ISC-FORTH) and their interactive exhibit prototypes were especially helpful in aiding our design of the digital media prototype for the medieval exhibit (Grammenos et al, 2011).

From our interviews with Robert Kiihne and Denise LeBlanc, we learned that children are interested most in gameplay elements within museums and that children learn more when actively performing the actions themselves, physically or mentally, rather than being taught in a lecture style. With this in mind, a trivia game was a reasonable choice for a game about historical artifacts, like the art and armor on display. The design we decided to implement was an updated version of a trivia game called “Test Your Knightly Knowledge”, which was first created and used at the Higgins Armory. We used the same set of questions that were used in the old game, but revamped the design of the game, specifically for the iPads located in the WAM Medieval Gallery.

In designing the game, we decided that a scoring system in conjunction with a leaderboard would be more appealing to competitive players who want to continue playing to increase their ranking. The leaderboard was designed in such a way to have the most recent score show up higher in the event of multiple players with the same score. This way, it could keep dedicated players wanting to continue coming back in order to keep their score at the top of the leaderboards. It also provided the opportunity for players to have a sense of victory if their score tied with someone else, as their score would still appear at the top of that block of players.

To appeal to casual and dedicated players alike, we added several game modes with individual leaderboards on each. The game modes are “Page”, “Squire”, and “Knight” difficulties. Each mode has a different number of questions to answer, increasing in number as you go from “Page” to “Knight”. The framework for the game was designed in such a way that adding, removing, or editing the questions for each mode is very simple, so any alterations are easily implementable if the WAM decides to continue using the game in their galleries.

Finally, to prevent players from entering profane names for their scores in the leaderboards, we implemented an extensive profanity filter. This filter contains over 750 variations of different profane words to test against, allowing the leaderboards to remain family friendly always. This was an especially important concern given that a large focus was put into making this game child friendly.

Objective 5: Analyze the effectiveness of the digital media.

We assessed the effectiveness of the digital media using the same observational analysis and surveys described in the previous objectives. In addition to observation and surveys, we implemented a framework to the iPads located in the two Medieval Galleries, designed to provide us with telemetric data, or data collected on the use of the application. Data, such as

what information are they looking for, approximately how many people are using the iPads, is there a section of the application that is significantly clicked on more than others, etc. will be collected using this framework. We incorporated this framework the existing program that the Worcester Art Museum uses to capture information on when users navigated to a different page in the application, as well as what page they navigated to. This telemetric data provided us with information such as which functions of the digital media were used most often, what time of day the application was used and the location of the iPad. We also integrated our telemetric framework into the trivia game we created to track information, such as what game modes were being played, if players were quitting in the middle of a game in progress, approximately how many people were playing the game, etc. This, along with survey responses, allowed us to effectively analyze the effectiveness of the pilot. From this data, we deduced what elements are the most effective at engaging the users, as well as what the peak times of visitor usage was. We designed this framework to ensure that it was impossible to collect personal data on the users of the applications.

The telemetry framework we created for this iPad application was designed to be modular, so that the WAM can take the framework we developed, and implement it in any other iPad interactive at the museum with only minor changes needing to be made to the code.

Using these methods, we have collected significant amounts of data, which we then analyzed to generate our findings and recommendations for the WAM.

Chapter 4: Findings & Recommendations

Our project goal was to analyze the current state of the Medieval Gallery at the Worcester Art Museum (WAM) and to design and incorporate some form of interactive digital media to the exhibit to make it more engaging. To do so, we worked closely with the WAM staff members and followed the methodology detailed in the previous chapter. The information we gathered led us to the following recommendations and conclusions. In this chapter, we discuss the findings derived from our research, explain the supporting evidence for each finding, and offer recommendations to the Worcester Art Museum. Reference Appendix F for a museum gallery map.

Finding 1: The frequency of usage of the interactives depends greatly on their accessibility.

Interactive placement that encourages group interaction such as allowing use while standing, or in an open area, receives significantly more usage than placement that isolates the visitor, such as requiring being seated in an armchair. During five days (four Saturdays and one Thursday), we observed 361 people visiting the medieval gallery. We noted that the majority of visitors came in a group, rather than by themselves. As a result, the interactives that encouraged group interaction were more successful.

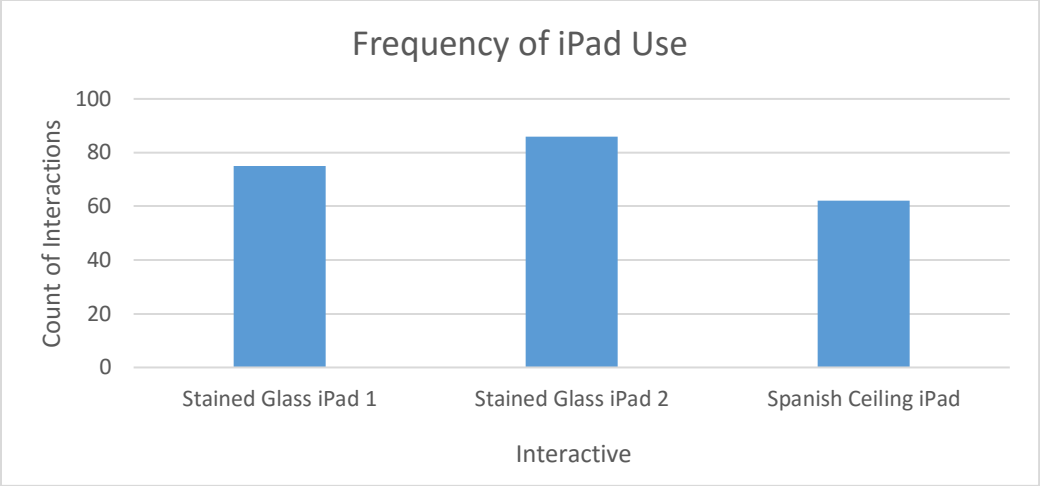

Figure 1: Frequency of iPad Use

As seen above in Figure 1, the iPad in the Spanish Ceiling Gallery (SC iPad) had a low frequency of usage compared to other iPads in the Medieval Gallery. The SC iPad contains four videos on different artifacts within the exhibit, ranging from three to six minutes long, and a Medieval themed coloring book activity. The SC iPad is placed on a table in the center of the room that is low to the ground, surrounded by large armchairs with wide armrests, as seen denoted by the letter A in Appendix F. It is positioned in a way that makes it very difficult for multiple visitors to view it at once, due to its proximity to the ground and being surrounded by large chairs. The wide armrest of the chairs further isolates the visitor from both their group and other museum visitors.

Referring to Figure 1, the Open Storage iPads (OS iPad) has significantly higher frequency of usage compared to the SC iPad. The Stained-Glass Gallery contains two iPads, that feature categorized repositories of information describing the purpose and function of items on display and in storage. Both are attached to podiums along the wall, allowing for use while standing, as seen denoted by the letters B and C, respectively, in Appendix F. There is enough

space for multiple visitors to view the iPad at once, and many groups were observed using the iPads together. This increase in interaction compared to the Spanish Ceiling Gallery is likely due to the placement not isolating, and being more accessible, to the visitor. The iPad feels more seamlessly integrated with the rest of the exhibits in the gallery.

Our observations also revealed that many people in the Stained-Glass Gallery gravitate towards the interactives, which are all located on one side of the room. This causes many visitors to walk right past many of the pieces the gallery has to offer. We noticed that the placement of the interactives affected the pattern in which museum visitors move around the gallery.

Given the aforementioned observations, **we recommend that the permanent medieval exhibit designers separate the interactives and place them evenly around the gallery, and to mount the Spanish Ceiling Gallery iPad on a podium, in a similar manner to those found in the Stained-Glass Gallery.** As stated before, we observed that many people gravitate towards the interactives. Moving the interactives could affect the path visitors take through the gallery, causing more visitors to appreciate all elements in the exhibit rather than the pieces adjacent to the interactives. The SC iPad does not see as much usage as the OS iPad, and we believe this is due to placement and that the user must be seated to use the iPad, so mounting the iPad on a podium, in a similar manner to the Stained-Glass Gallery, is likely to lead to an increase in usage.

Finding 2: Interactives are most successful when they are clear and self-explanatory to the targeted audience.

Complicated and complex interactives can deter museum visitors from using them while simple and easily comprehended interactives attract visitors towards them. In our interview with Robert Kiihne, director of exhibits at the U.S.S Constitution Museum, he explained that

whomever is using the interactive must be able to easily comprehend the material presented. If the exhibit is not self-explanatory and requires extensive reading and learning prior to the use of the exhibit, it has a chance of deterring casual visitors. According to Kiihne, the main goal of interactives in conjunction with exhibits is to provide further educational information to visitors. If the interactive is not self-explanatory then the educational content provided by the interactive will not be as accessible to the visitor as it could be (Robert Kiihne, personal communication, March 24th, 2017).

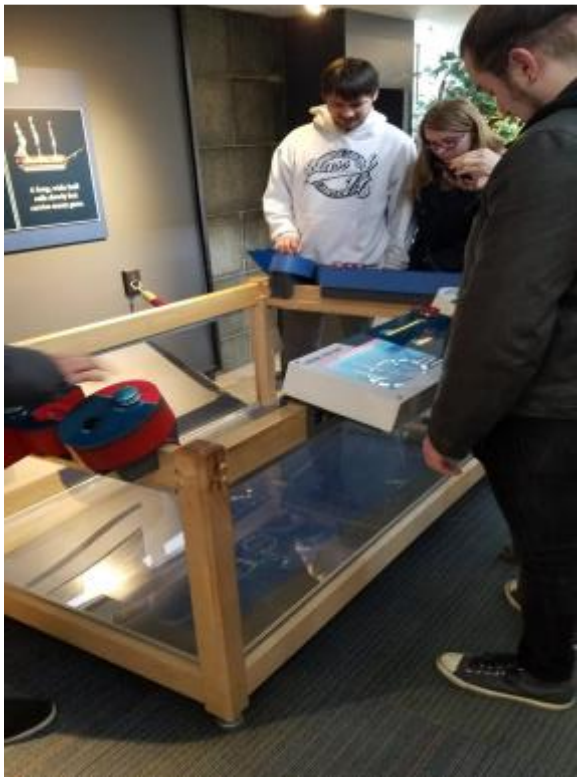

Figure 2: "Design your Warship" Game at the U.S.S. Constitution Museum

We observed the function of easily accessible interactives during our visit to the U.S.S Constitution Museum. The U.S.S Constitution Museum features a multitude of different interactive pieces, and one that stood out among the rest was the interactive "Design your Warship", as seen in the Figure 2, above. The game featured simplistic controls and a large screen, making it easy to quickly begin playing the game. Visitors design a ship by selecting

length, width, and number of cannons. Game play provoked questions such as the advantages or disadvantages to the different metrics the user could select from. Surrounding the game were text panels featuring brief explanations of what went into designing a ship, as well as how different factors affected the performance of the ship. This was a very successful exhibit, according to Kiihne, due to being quickly understood and accessible, as well as providing brief, yet detailed information about the subject if a visitor wished to learn further (Robert Kiihne, personal communication, March 24th, 2017).

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Figure 3: Please Touch Label

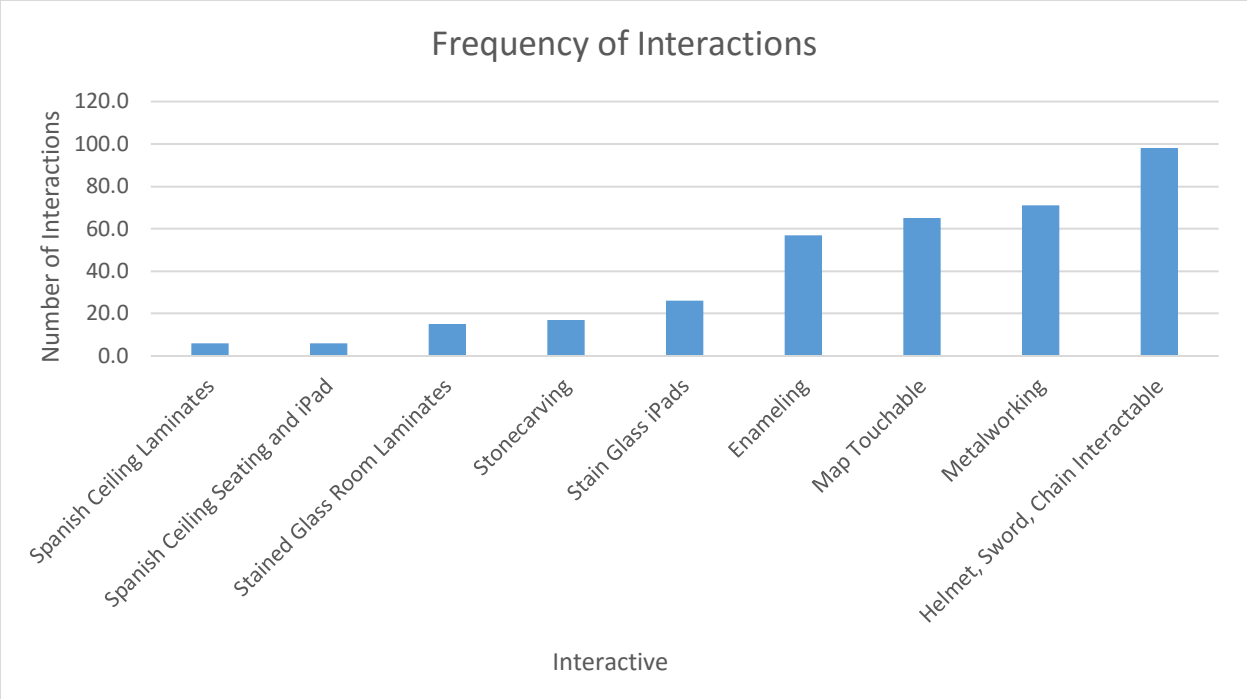

Figure 4: Frequency of Interactions of the Interactives in the Medieval Gallery

As seen in *Figure 4* the Helmet, Sword, and Chainmail interactive was by far the most popular interactive exhibit in the Medieval Gallery at the Worcester Art Museum. The exhibit features minimal text, drawing all attention to the interactive pieces. Museum visitors can touch/try on a reproduction helmet, feel chainmail, as well as grasp the hilt of a sword. The WAM uses a paw print graphic, as shown in *Figure 3*, to symbolize when you can touch an exhibit element. This allows visitors to quickly understand when an exhibit element is interactive, and immediately begin interacting with it, without need for additional reading. This interactive not only was very popular, but also had a high linger time, signifying that the exhibit was intriguing enough to hold the visitor's attention. The success of this interactive can be attributed not only to the entertainment value, but also to the presentation, allowing quick understanding of how to interact with the exhibit.

From the observational data that we gathered using our rubric, the laminates had the fewest instances of use, and when they were used, visitors only lingered for 30 seconds on average. Part of this may be due to placement. The laminates are located behind the visitor when they enter through certain entrances of the Medieval Galleries, making it easy for the visitor to pass by without seeing the laminates, as seen denoted by the letters D and E, respectively, in Appendix F. The low linger time may possibly be due to the laminates requiring the visitor to carry them around while they explore the gallery to receive the full experience. Each laminate features extended information on individual pieces in the gallery, however they are not located near the pieces they describe, in most cases, forcing the visitor to carry multiple laminates with them if they wish to use them.

In addition to this, the laminates are bulky and take up a lot of space when compared to the iPads. Each laminate only contains information about one piece in the gallery, so multiple laminates would be needed to access all the information they provide. While the laminates present information in a similar manner to the Stained-Glass Gallery iPads, the physical nature of them was not as popular as other interactives to the 361 of visitors we observed.

Consequently, **we recommend that the permanent Medieval Gallery designers consider swapping out the laminate interactives for a digital kiosk, like the existing iPads, that is easier for a museum visitor to use and quickly understand, as this would lead to more use.** Implementing an analogous interactive with a higher proven audience satisfaction will potentially increase the number of visitors that access the information presented on the laminates.

Finding 3: On average the exhibit designer has one to two minutes to captivate the audience with their exhibit

After conducting detailed visitor observations of the Medieval Gallery, we found that the average linger time of the 361 visitors we observed using the interactive exhibits was 89 seconds (approx. 1.5 minutes). This means that interactives have roughly one minute to captivate the audience and educate the audience on whatever the topic may be. The observations were conducted on four Saturday afternoons and one Thursday afternoon. Saturdays were chosen as they are the busiest day of the week for the Worcester Art Museum, and Thursday was chosen as it is the busiest weekday, based on visitor entrance data provided collected by the Worcester Art Museum.

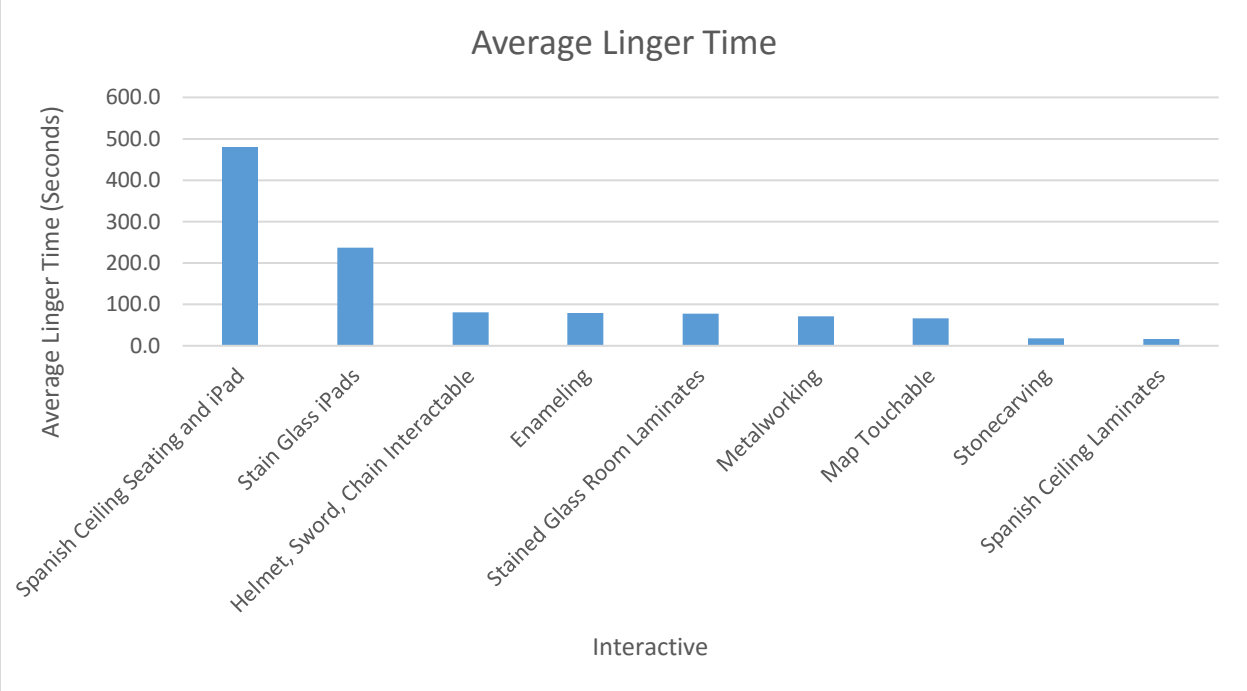

Figure 5: Average Linger Time Per Interactive:

Not only did our observational data, seen in *Figure 5* above, yield this finding an interview with Robert Kiihne provided us with similar information. He has an extensive

background in interactive exhibit design during his time as Director of Exhibits at the U.S.S. Constitution Museum. Mr. Kiihne also explained during our interview with him that the understanding of the interactive must be immediate to fully engage the visitor. Any complications that hinder the understanding of the game will discourage visitors and decrease linger time (Robert Kiihne, personal communication, March 24th, 2017).

Robert Kiihne also discussed the idea of "rapid prototyping" during our interview. By using cheap materials, it is possible to quickly develop a basic prototype of an exhibit piece with minimal cost, allowing the museum to pilot the prototype with museum visitors, so that they may receive immediate feedback to incrementally improve the exhibit piece. This can then give the designer the information about the prototype such as: ease of understanding, time to captivate, and accessibility by different audiences. The designer can then incorporate this feedback into the final product (Robert Kiihne, personal communication, March 24th, 2017).

We recommend that WAM rapid prototype interactives to gauge the speed of understanding and the general linger time of the exhibit element. Rapid prototyping will ensure the time and money put into developing it further will be worthwhile. Placing a prototype in the hands of a museum visitor would also allow feedback on whether the piece is easy to understand, or if it needs to be adjusted so that it is easier to comprehend.

Finding 4: Exhibits are more successful in engaging visitors when they contain both child and adult friendly features

During our discussion with Robert Kiihne, he stated that museum exhibits are moving towards engaging entire families. He said, when developing an exhibit, you must ask yourself "Can you engage the group?" and use that mindset moving forward. The content at the U.S.S. constitution museum itself backed up our findings as we observed children interacting with the

child friendly labels below the adult friendly captions. The engagement of the flip up descriptions drew children in as well. These flip up descriptions provided a sense of mystery, with the reward being an interesting factoid about the subject matter.

Figure 6: Child and Adult Friendly Displays

Not only do exhibits benefit from separate child and adult friendly features, but also from features that are cohesive to both parties simultaneously. For example, the "Design Your Warship" interactive game, described in Finding 4.2, was a great illustration of this. While we were playing, there were also children with their parents operating the other ships. This game proved to be engaging to both the child and parent interacting with it.

The last supporting evidence we found was through our background research. The PISEC study identified seven characteristics of successful family exhibits based on their field observations, shown in *Appendix A*. One of the characteristics identified was that it needs to be "accessible" or comfortably used by children and adults. Another characteristic, being "multi-

modal", appeals to different learning styles and levels of knowledge. This brings our research and methodology full circle, because children and adults have different levels of learning styles and to make a successful "family" exhibit, it must cater to both.

Consequently, we recommend that WAM incorporate more child friendly content into the exhibit along with the adult content in the text panels. The text panels at the WAM are detailed and from our observations we concluded they are almost always used by adults. The interactives that are most popular with both children and adults are the ones that can incorporate the adult's desire to read the text panels with both the children and adults desires to use hands on exhibits. Examples of this information are presented in the chart below. The interactives were grouped in sections: "Laminates" refer to the laminated sheets of paper with information on them, "iPads" refer to iPad applications, "Helmet, Sword, Chain" refers to solely the interactive that you can try on a helmet, and "Hands on" refers to all other touchable exhibits.

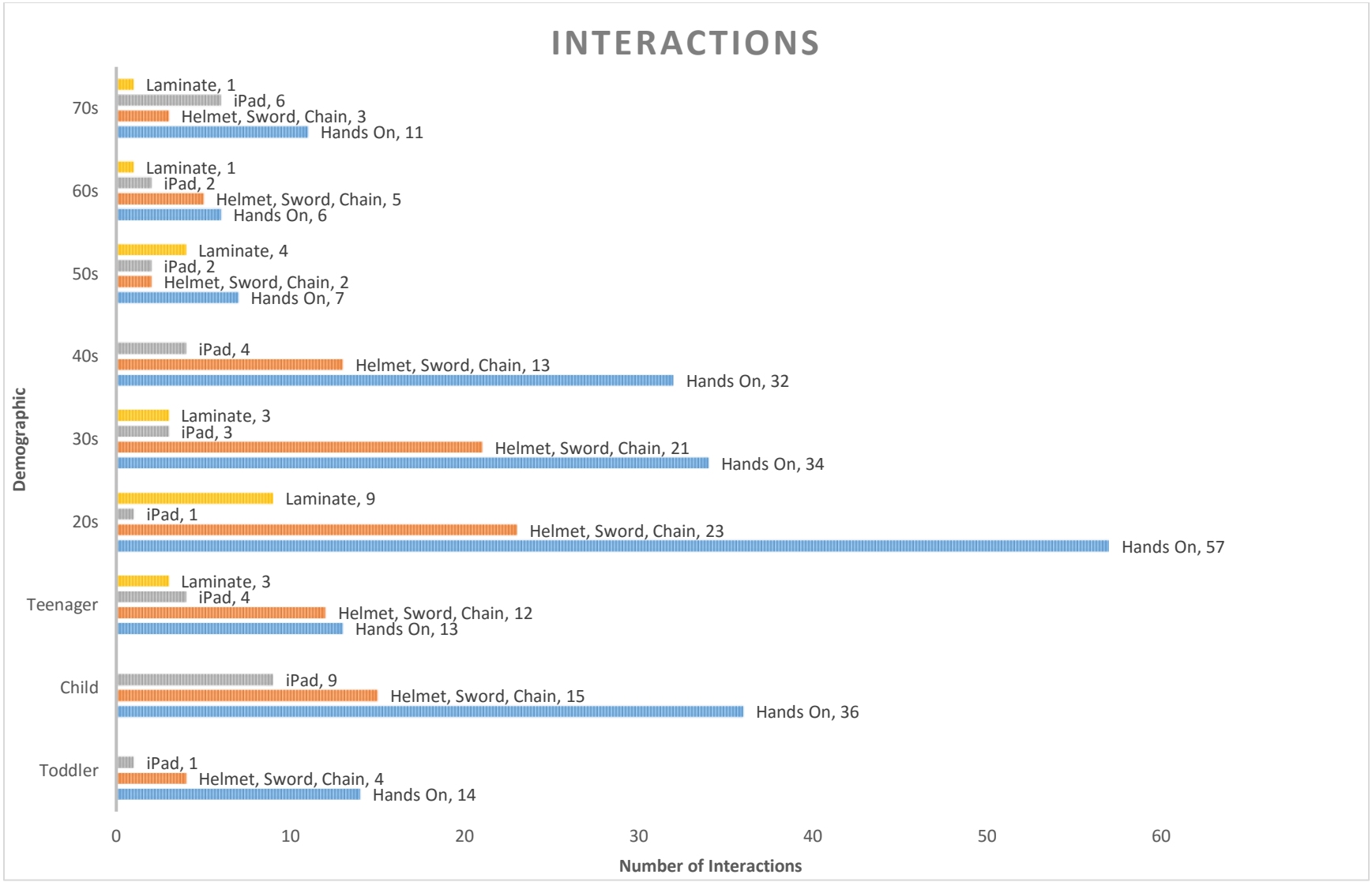

*Figure 7: Number of Interactions (*Note: Interactives were categorized in the following categories – "Hands On," "iPad," "Helmet, Sword, Chain," and "Laminate")*

The hands-on exhibits are the most popular when it comes to the frequency of interactions in every category. The laminates have the most usage by visitors around the age of 50, while other age groups have very little laminate usage compared to other interactives.

Finding 5: Textual educational content must be presented in a structured and simplistic format.

Lengthy text panels can be daunting and unfriendly to visitors. From our observations, as described above, most visitors who stopped to indulge the lengthy text panels were of the 40+ age groups.

Our interview with Devon Kurtz led us to very useful information about exhibit design. Mr. Kurtz explained how the text panels must not be too wordy, stating that they must be navigable for multiple levels of users. For example, if a text panel has a title, subtitles, subsections, and then the body of the information, there are many levels of interest it can entertain. For the casual reader, the titles and subtitles might be enough to satisfy them. For someone who would like to dive into the material further, the subsections and body of the information would be ideal (Devon Kurtz, personal communication, March 20th, 2017).

Our interview with Mr. Kurtz, as well as our observations, highlighted the role fonts and colors play when designing an exhibit. At both the U.S.S. Constitution Museum and the Russian Icon Museum in Clinton, MA, the text panels had more to them than just a block of text. The titles were colored in a way that was visually pleasing, and the subtitles were either a different font or a different color to break them up. Please see the images below indicating successful

examples of simplistic, structured museum text panels.

Figure 8: Simplistic Structured Text Panels

The recommendation we have for the Worcester Art Museum, after exploring a more organized and enticing text panel, is to redesign the enameling interactive so that it incorporates text panels. The enameling interactive has a lot of instances of interaction, but linger time is low, adding a label with a description of the exhibit could lead to an increase in linger time, as there is currently no text description of what is being shown in the interactive. The information is available through the Spanish Ceiling iPad, but adding a text panel to describe the enameling process will make the information more accessible, and hopefully, further engage the visitors. The draw power is there, as shown by instances of interaction in *Figure 4*, but the linger time is less than other hands on interactives.

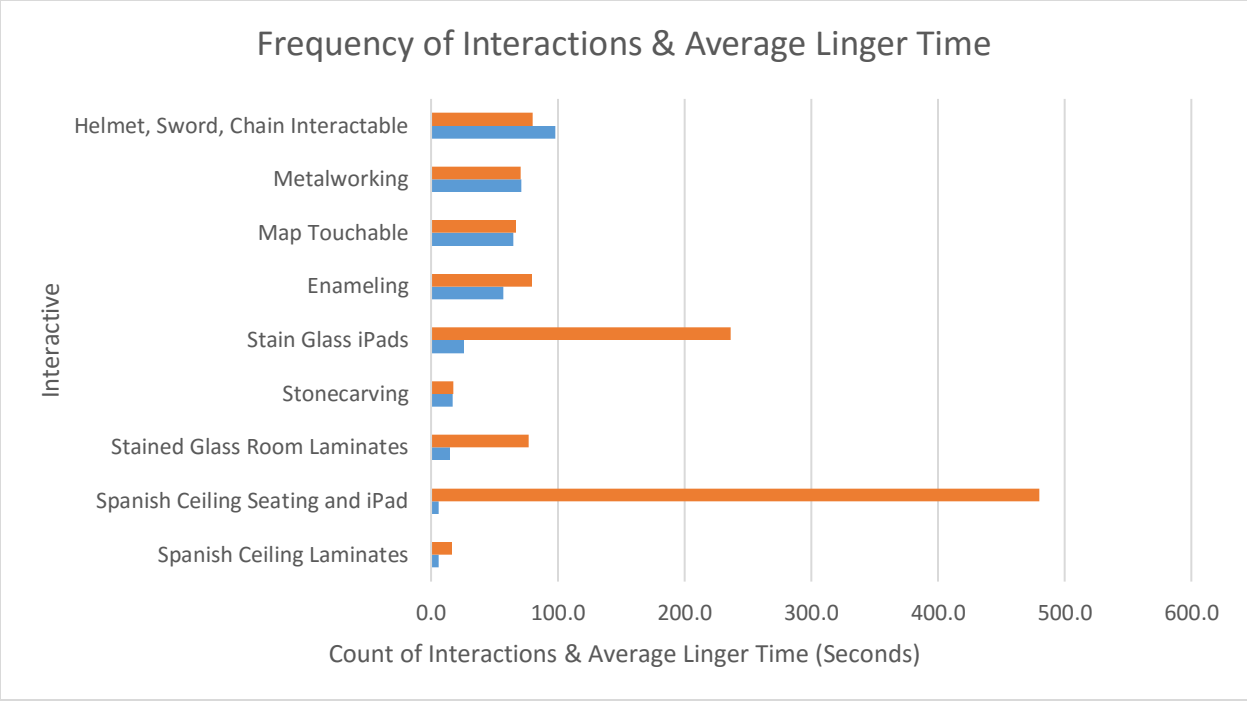

Figure 9: Number of Interactions and Average Linger Time

As displayed in *Figure 9*, the instances of interaction with the enameling exhibit are on the higher side compared to the other interactives. The average linger time is in the middle, and with an engaging text panel we believe the enameling exhibit could be even more successful.

Finding 6: Families with children are looking for museum exhibits that are interactive.

The 57 survey responses (Appendix C) showed a large amount of praise for the current interactive pieces in the Medieval Gallery, many noting that their children were very excited by the interactives. Even so, many visitors stated that they would like to see more interactive exhibits in the Medieval Gallery.

What do you want to see more of at the Medieval Galleries?
All good
Anything for engaging kids
Bat man costume, I especially wanted my grandkids to see it
Bottom armor, most of it is upper protection
Castles
Doggy armor, Japanese samurai's
Frescos
Hands on days
How armor was constructed, process how long it took to make items/shore
Knights/suits of armor
Liked the demo of armor trying it on
More
More displays of how the armor and weapons worked together
More examples, bigger exhibit
More exhibits in this room
More hands on
More interactive (touching) things
More interactive stations
Sick thing
The guns
Weapons
Women in medieval times
Yes, trying on helmet was fun. I think being able to interact with the relics is priceless.

Table 4: Survey Responses - What visitors would like to see more of in the WAM

The survey data shows that almost 60% of the people who took the survey were in the age range of 36-55, however it should be noted that almost everyone who filled out a survey was participating at the "Art Cart" with their kids. Many of the adults who took the survey filled out the survey with input from their children, which is why there are so many requests for more interactive elements. This trend of children and families gravitating towards interactives can also be seen from our observational data. Children had the most instances of interaction with elements that allowed them to touch the exhibit. This is shown in *Figure 7*.

While taking headcounts of visitors in the Chinese, Indian, and Japanese Galleries, it was also noted that not only were these galleries less populated than the Medieval Gallery, there were

almost no children present, compared to the Medieval Gallery which was very popular with young children. This can, at least in part, be attributed to the Medieval Gallery featuring multiple interactive elements, while the other galleries feature none. See below for head counts of visitors in the galleries at a given time.

Time	Stained Glass (Medieval Gallery)	Spanish Ceiling (Medieval Gallery)	Chinese	Japanese	Indian
1:40:00 PM	N/A	N/A	0	0	3
1:45:00 PM	7	8	2	0	4
1:50:00 PM	6	4	0	0	2
1:55:00 PM	13	2	0	0	0
2:00:00 PM	4	8	0	0	2
2:05:00 PM	3	0	0	4	0
2:10:00 PM	12	0	0	0	0
2:15:00 PM	0	0	0	0	0
2:20:00 PM	4	4	0	0	0
2:25:00 PM	6	4	0	0	0
2:30:00 PM	6	2	0	0	0
Star Wars Piano Performance					
Art Cart in Session					

Table 5: Head Counts in Galleries at the WAM

We recommend that the Worcester Art Museum increase the amount of hands on interactive pieces in the galleries. The current hands on exhibits are extremely popular with families with children, which was our target audience during this project. By continuing to develop fun interactive elements, the Worcester Art Museum can further attract families with children.

Finding 7: Interactive elements that encourage education through entertainment are just as effective as strictly educational elements.

In our interview with Devon Kurtz, he discussed the idea of "teaching with purpose, learning by accident" and how that mentality is important when designing an exhibit geared towards children (Devon Kurtz, personal communication, March 20th, 2017). The interactive exhibit will pique their interest, and then by interacting with the piece the visitor will learn, which for children is much more exciting than reading a text panel.

This philosophy was supported by our observations in the Medieval Gallery, as the more fun exhibit pieces such as the helmet, sword, and chain interactive saw significantly more use than the laminates, which while interactive, are simply text panels. The more information heavy interactives are not as appealing to children as they lack the "fun" aspect, while the interactives that encouraged hands on use were much more popular, and were more successful at attracting the target audience.

We also saw this in our visit to the Acton Discovery Museum. While there we noticed that almost all of their exhibits contained very little text explanations, and instead encouraged visitors to play around with the resources they were given in order to explore the space and learn through doing. Children were encouraged to come up with their own explanations to the phenomenon they were seeing, and to test their hypothesis in order to see if they were correct. This implicitly taught students the scientific method by using entertaining science experiments as a teaching medium. Teaching in this way can lead to a passion for learning and make visitors interested enough to go off and learn more on the subject matter presented to them, especially young children.

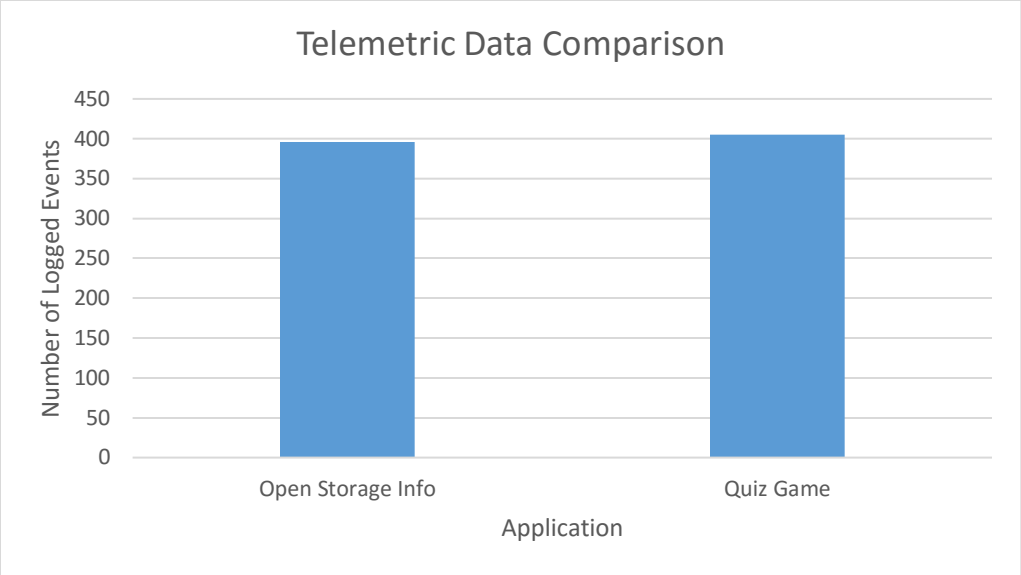

Figure 10: iPad Usage Comparison

As seen above in *Figure 10*, the new iPad game is just as popular as the other iPad application in the Stained-Glass Gallery, which features in depth descriptions of the different pieces in the Open Storage Exhibit.

During our observations, the iPads were mainly used by older museum visitors, and rarely used by children. Our goal with developing the iPad game was to create something that is both educational but also interesting to children. During our time at the "Art Cart" we noticed that use of the iPad game was almost entirely children, while the Open Storage iPad remained primarily adults.

The recommendation we have for the Worcester Art Museum is to create more interactives focused on educating through entertainment. The more entertaining interactives have seen much more use than the purely educational interactives, and continuing to develop fun and entertaining exhibit pieces will further attract families with children as the museum will be more exciting for young children. By promoting learning by accident, the WAM can make education a more pleasurable and lasting experience for its visitors, especially younger children.

Conclusions

To summarize our key findings, interactives must be quickly understood, available to all ages, and accessible to multiple people at the same time. This will make the entire exhibit more attractive to museum visitors and cause an increase in linger time. Our findings are supported by academic literature, interviews with experts in the field, observations, and surveys. Our deliverables to the Worcester Art Museum are tools that can be used to evaluate other interactive exhibits, data collected on the Medieval Galleries, and the "Test Your Knightly Knowledge" quiz game. The tools provided to the WAM include a rubric to evaluate individual interactives, surveys to distribute to visitors, and a telemetric framework for data collection on iPad usage.

For future work on similar projects, we recommend that when conducting observations, keep a count of all individuals who enter the gallery, and a count of those who interacted with the interactives, to obtain a percentage of visitors who utilize the interactives. Another suggestion for a future project would be to calculate the probability that any given function of the iPad application will be used by a visitor based on the telemetric data collected from that application. We also believe it is crucial to continue to evaluate exhibits to ensure that they are effective. If an exhibit is not effective it can negatively impact the visitor experience and thus deter repeat visits to the museum.

Museums are an integral part in society, both in bringing culture to a community, as well as providing leisure activity. We hope that these findings will assist the Worcester Art Museum in remaining successful as a piece of history in the Worcester community.

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Appendices

Appendix A: PISEC Chart

1	Multi-sided: family can cluster around children
2	Multi-user: interaction allows for several sets of hands (or bodies)
3	Accessible: comfortably used by children and adults
4	Multi-outcome: observation and interaction are sufficiently complex to foster group discussion
5	Multi-modal: appeals to different learning styles and levels of knowledge
6	Readable: text is arranged in easily-understood segments
7	Relevant: provides cognitive links to visitors' existing knowledge and experience

Table 6: PISEC Chart

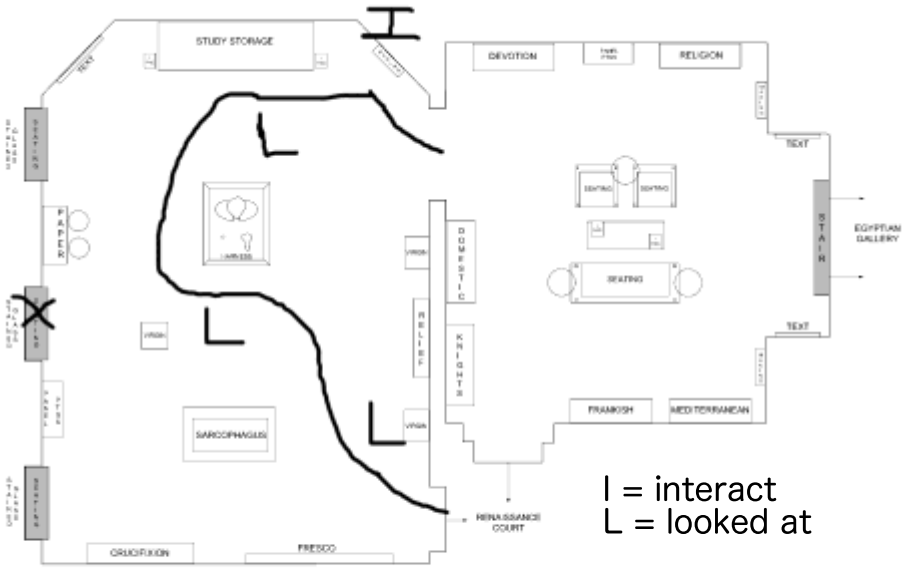
Appendix B: Observational Rubrics

Photo	Name	Linger Time	Interact	In a group? If so, comments	Notes on the Path	Looked at corresponding art?
	**Map Touchable**					
	**Stained Glass Room Laminates**					
	**Spanish Ceiling Room Laminates**					
	**Spanish Ceiling Helmutt**					
	**Spanish Ceiling Seating and Ipad**					
Ipads	**Stained Glass Ipads**					
	**Helmet, Chained Armour, Sword, Helmutt**					

Table 7: Observational Rubric

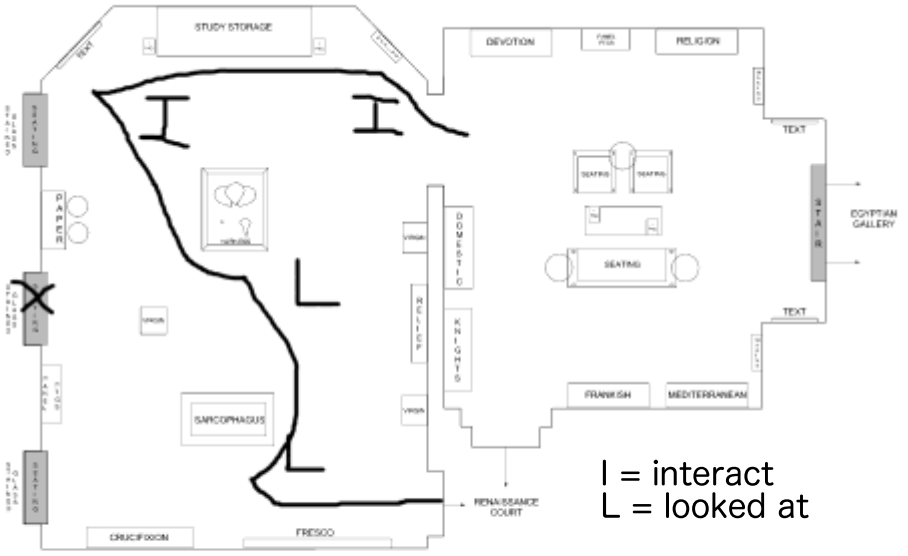
Appendix C: Path Tracking Data

Stained-Glass Medieval Gallery Path Tracking Example



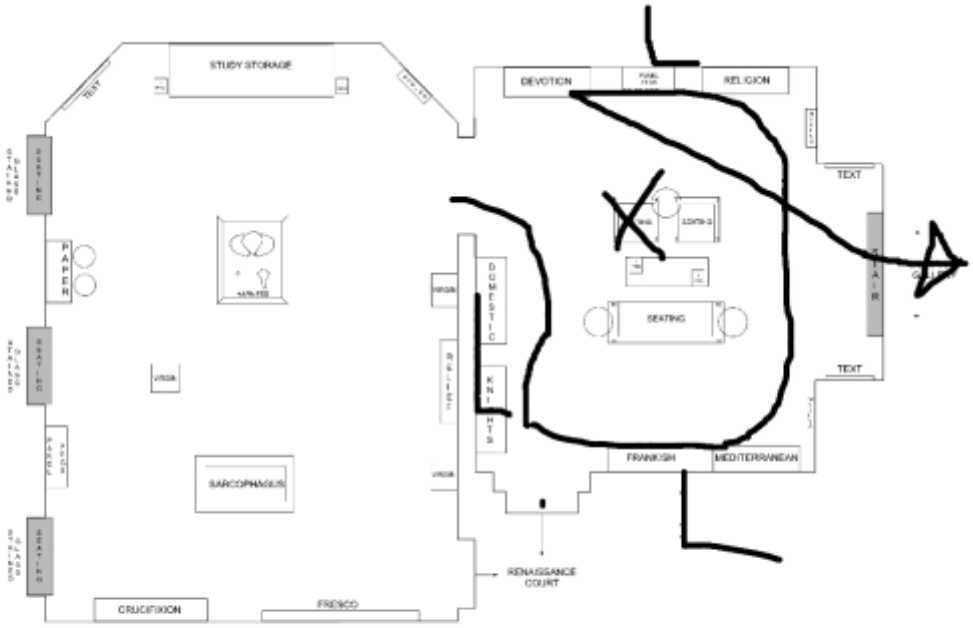
Demographic:

MEDIEVAL GALLERIES/PLAN
WORCESTER ART MUSEUM

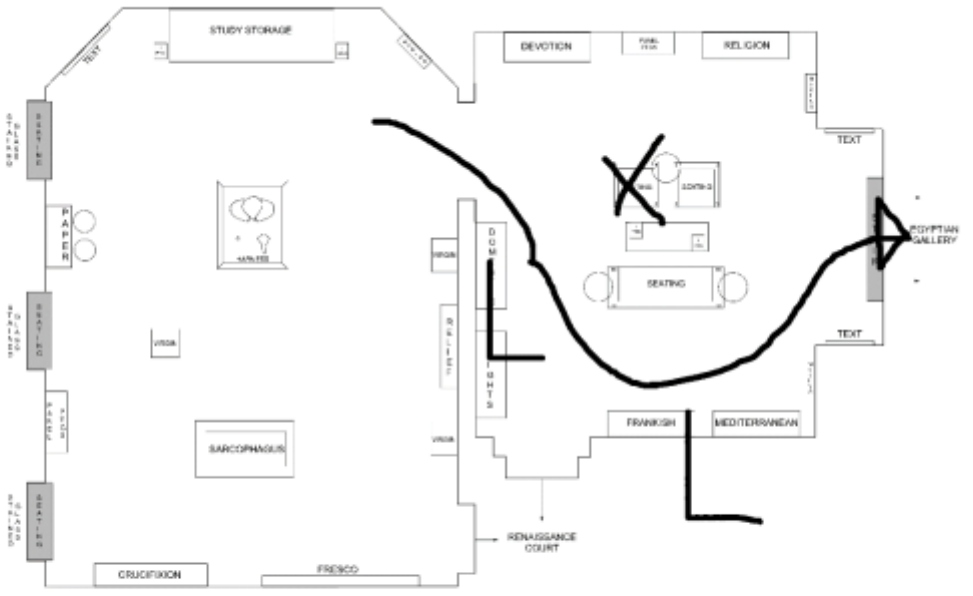


MEDIEVAL GALLERIES/PLAN
WORCESTER ART MUSEUM

Spanish Ceiling Medieval Gallery Path Tracking Example



MEDIEVAL GALLERIES/PLAN
WORCESTER ART MUSEUM



MEDIEVAL GALLERIES/PLAN
WORCESTER ART MUSEUM

Appendix D: Survey Questions

We are a group of students from Worcester Polytechnic Institute in Massachusetts. We are conducting observations of museum visitors in the exhibits to gather data about their behavior and interaction with the exhibit. We are conducting surveys of museum visitors to learn more about why visitors are attracted to the museum and how they feel about the exhibits. We are also conducting interviews with professionals in museum curation and exhibit design to learn about the best practices in exhibit design and interactive media. We strongly believe that this kind of research will ultimately enhance the museum experience for visitors and increase visitation rates of the Worcester Art Museum. Your participation in this survey/interview is completely voluntary and you many withdraw at any time. This is a collaborative project between the WAM and WPI, and your participation is greatly appreciated. If interested, a copy of our results can be provided at the conclusion of the study.

Museum Visitors at the Worcester Art Museum

WAM Survey: Medieval Galleries

1. What brought you to the WAM today

2. What did you enjoy about the Medieval Galleries?

3. What would you change about these exhibitions?

4. What do you want to see more of at the Medieval Gallery

Your Age (select only one)

□ 17 or less □ 36-45 □ 66-75

□ 18-25 □ 46-55 □ 76 or more

□ 26-35 □ 56-65

Your Gender

□Male □Female □Other

What do you want to see more of at the WAM?

Did you try the Knightly Knowledge Quiz game? If yes, what did you like or dislike about the game? Would you like to see more activities like this at the WAM?

Appendix E: Interview Questions for Museum Professionals

1. What started your interest in museums and their exhibits?
2. What is type of educational background do you have that led to your current position? How long have you been working with museums?
3. In your time at the Higgins Armory, what was your position and what did that entail?
4. What do you think are the most important factors in exhibit design?
5. In your opinion, what makes an exhibit successful?
6. Do you have specific methods you use for evaluating the success of an exhibit?
7. What type of experience do you have with interactive media in exhibits?
8. Which methods of interactivity have you found to work best/better than others?
9. Have you found aspects of exhibit design that leave a lasting impression with museum visitors?
10. When designing an exhibit, is there more focus on educational value, or on visitor engagement/interactivity?
11. In your opinion, how important are interactive elements in exhibits? What do you think about the trend of digital media being added to exhibits?
12. What aspects of the exhibits in the museum do you find visitors enjoy the most? Are they physically interactive or do they simulate discussion?

Appendix F: Museum Gallery Map

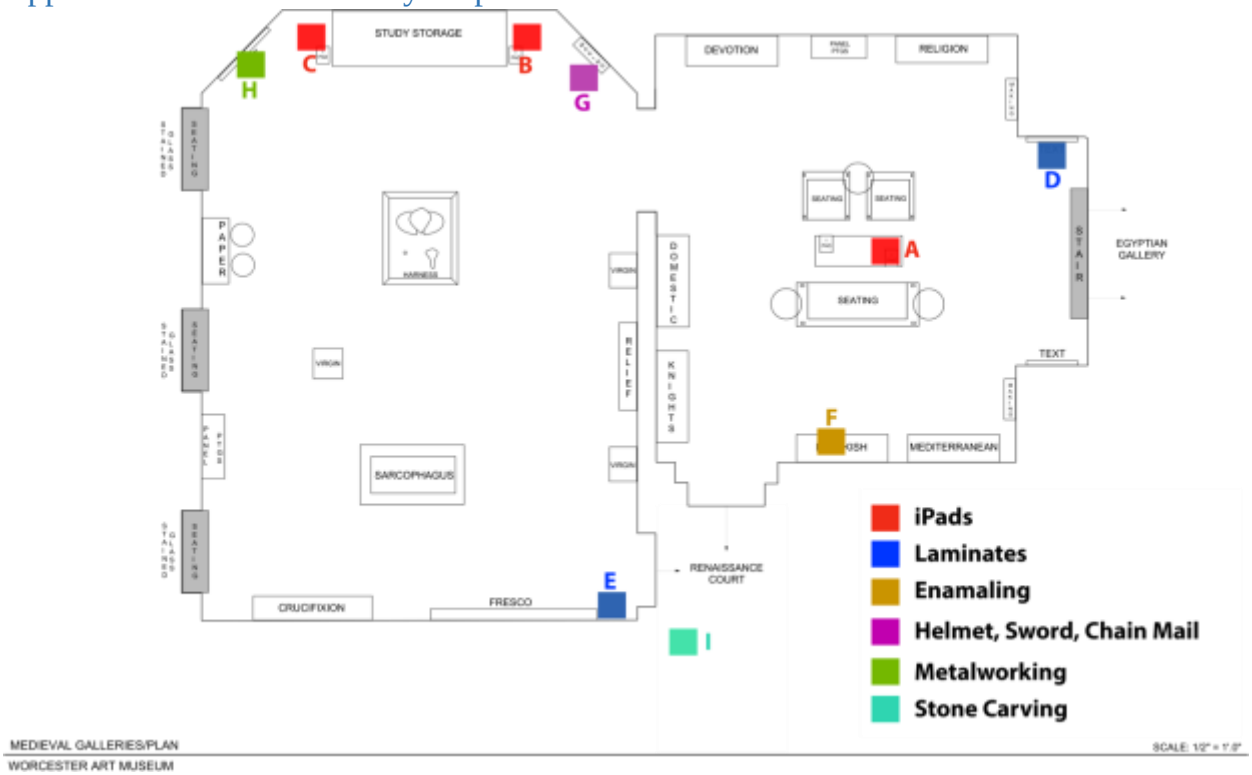


Figure 11: Museum Gallery Map

Appendix G: Visitor Data

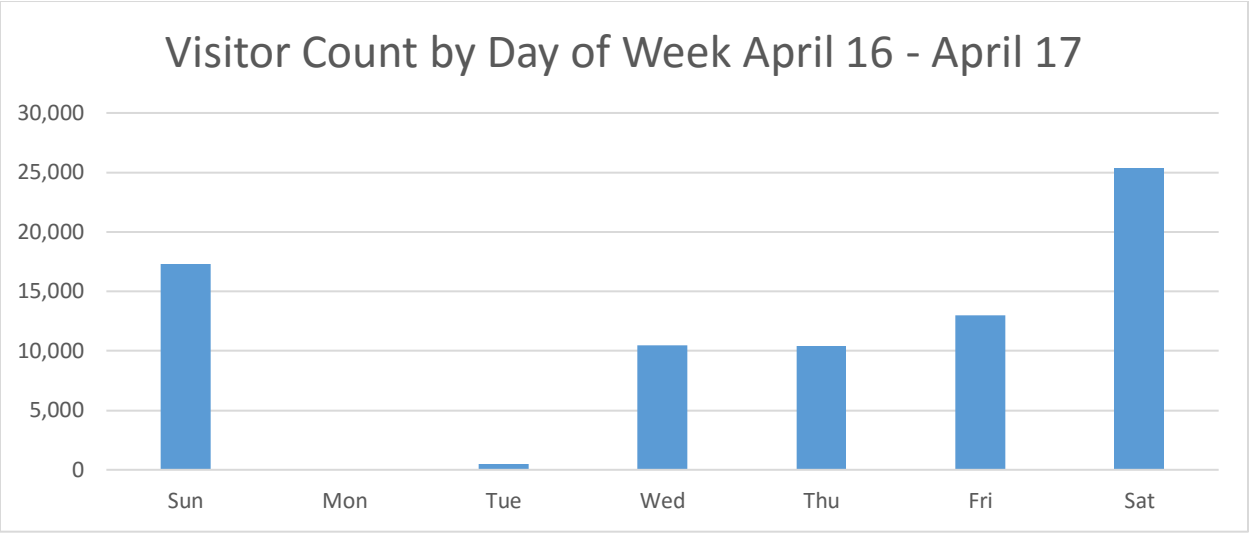


Figure 11: Visitor Count Graph