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Optical Heritage Museum: An Interactive Touch

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CHALLENGE CONVENTION.
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Executive Summary

Optical Heritage Museum (OHM) was established in 1983 with the aim to preserve, promote and display historical artifacts of the optics industry and educate all of its vital role optics has played in societal development. Over the years, the museum has grown in its physical space along with exhibit development to engage audiences in innovative, effective methods. Clark University's School of Professional Studies department and curator of Optical Heritage Museum, Mr. Whitney's Whitney, have establish a collaboration that has spanned over two semesters with the goal to support and aid in improving OHM. Our capstone group was assigned the task of improving marketing strategies for OHM, which altered its focus on developing strategies and knowledge on improving the museum's interactivity amongst its exhibits.

The OHM Capstone group reviewed the previous capstone's focus on mobile app development along with the OHM's current focus on improving foot traffic and self-guided ability of the museum. Our project goal was designed to assist OHM in developing effective, best practice technological solutions for exhibits along with providing assessments on current best practices in the museum industry, including current products being used, cost-structures and possible funding sources for such products. To achieve this goal, our group developed a two-pronged research approach, first gathering all relevant web-based research on current products being used within the museum industry of the northeast, i.e. AR, VR, QR, web-design, and interactive-exhibit technology. Second, our group developed a field-research strategy to conduct visitations on several regional museums with relevant technological solutions or similar demographics to OHM. From this research, the deliverables we hoped to supply our client with include the following: interactive product list, cost-structures of various products, recommendations list, funding profiles, and the framework for a mobile app.

Through our research, we discovered several products being used within local and regional museums that are successful in designing and implementing interactive exhibits. Our group's final recommendations are the following:

1. Implementation of Navigational Flooring
2. Re-evaluate Funding Search & Explore Expansion and Co-location
3. Implement Online Exhibitions and Website Updates
4. Design and Implement Mobile Tour Experience through QR access

With consideration given to OHM's preference to improve the self-guided nature of the museum and utilize technology to create further interactivity, the above recommendations support this goal collectively and address increasing needed publicity and foot traffic.

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Chapter 1: Optical Heritage Museum Overview and Project Goals

Optical Heritage Museum Background

Optical Heritage Museum (OHM) officially opened its doors on June 18, 1983, a day which was celebrated as the 150th anniversary of the birth of American Optical (AO), signifying their diligence to preserve optical artifacts and history. With its original location in the main plant of AO on Main Street, Southbridge, Massachusetts, OHM has grown to acquire thousands of optical artifacts with the goal to promote the history of optics and optoelectronics along with the education of the vital culture of glassware. With support from Zeiss (Australian-based optical company), OHM has furthered its development through its established museum in its current location where it showcases thousands of items ranging from microscopes, lensometers, multi-focals, antique spectacles, and others. Over the years, OHM has amassed one of the world's largest collection of spectacle frames and optical products, leaving the nonprofit at a tipping point of exhibit development and moving the museum into the 21st century.

In its current state, OHM, staffed and led by Mr. Whitney's Whitney of Zeiss, has established the museum's mission to preserve, educate and research the history, growth, culture and contributions of the optical industries since the 19th century. The Optical Heritage Museum is a non-profit organization sustained by individual donors and corporate funding from Zeiss and others to achieve their mission of promoting optoelectronics and optics preservation along with continuous optical education. The museum represents a proud part of the local community's history and connection to American Optical's global contributions in the optics industry in the 19th and 20th century. However, OHM is facing continuous challenges in developing and broadening its reach within its own community and beyond.

Challenges Facing OHM

Optical Heritage Museum's vital role in preserving optical history along with educating future generations on the significance of AO's contributions is not in question, neither is the fascinating exhibits and lively tours offered by staff. What is troubling the museum involves a combination of geographical constraints, lack of effective publicity to draw in local foot traffic, and lack of technical knowledge to implement innovative exhibit solutions. Although the museum generates buzz when visitors witness all that OHM has to offer, it has proven difficult for the staff and the organization to increase public awareness and attraction. Through recommendations from the Fall 2017 Capstone team, discussions with OHM and Mr. Whitney along with recommendation from Zeiss, our capstone group has pin-pointed several obstacles.

First, the location and visibility of OHM to the surrounding community has presented challenges to achieving higher foot traffic from within and outside the town of Southbridge. Touching on its geographical location, Southbridge's proximity to Worcester (2nd largest city in New England) is not in question rather the lack of public transportation from the city to the town is lacking. Bus transportation requires several transfers to reach Southbridge from Worcester, otherwise private transportation is needed to access the museum. Compounding the geographical constraints involve the lack of visibility from the street, including lack of signage that could stand out to the residential make-up of the surrounding neighborhood. Potentially an easy fix, the lack of visible signage to distinguish OHM from several other companies located in the same building proves to be difficult. Worsening its visibility is the location of the museum being surrounded by residential homes rather than commercial buildings or recreational amenities. The museum is located a few minutes off main street, but lack of directional signs demonstrating the

existence of the museum coupled with the residential make-up of its immediate surroundings create a detrimental effect on OHM.

Second, current publicity efforts by the museum are a start but need improvement. From a visitor's perspective, browsing of the OHM website proved to be difficult because several websites are offered when a simple Google search is conducted. From here, navigating the website is not difficult, however the presence of how to connect to social media or other forms of publicity is not positioned in a noticeable manner. Upon navigating the website, several hyperlinks were broken or simply reloaded the previous screen of the user who was searching. Finally, the existing links that worked, such as videos on certain aspects of the museum, forced visitors to jump to a separate tab or website, taking online visitors away from the main source.

Third, the immediate resources of the community are not being tapped into by OHM according to discussions with staff. At this point, the museum will eventually require manpower to carry out future developments, whether it be technical support or physical space help or volunteer hours around the museum. There was no indication of any volunteers being solicited from the local public-school system for potential aid. Also, no indication was given regarding possible partnerships being established between local colleges and universities to contract student-workers in developing the interactive strategies or ideas OHM has generated thus far. Overall, there is a wealth of volunteer power in the area that would be extremely beneficial.

Fourth and finally, the current layout and use of exhibits along with the lack of interactivity implemented within the museum does not do the exhibits or museum industry justice. Discussed by Mr. Whitney and other staff of OHM involved the overwhelmed feeling visitors may feel when entering exhibit rooms within the museum, i.e. unless a tour guide points it out, visitors have trouble deciphering what to concentrate on first. Where the museum is

lacking is the implementation of interactive exhibit systems to increase the engagement between exhibits and visitors, provide additional guidance for self-tours and create a further engaging experience. Interactive exhibits are linked to increased stimulation and engagement in a person's experience, thus creating a more positive experience overall (Sandifer, 2003). The lack of audio-guided exhibits, hands-on activities, and technology-driven experiences leave a self-guided tour far from the experience of tour-guided encounter, according to our visit and several visitors' accounts along with the staff's own admission.

Overall, there are obstacles for the museum that are easily addressable and others which are not, but the current history preserved by the OHM holds potential to appeal to their target audience of students, families and community members. Easily witnessed in Trip-Advisor accounts, those who visit OHM praise the guided tours given by staff, specifically Mr. Whitney, where exhibits and artifacts are "brought to life" through his shared experiences and storytelling style of tour-guiding. There is a great deal of potential for OHM to improve its exhibits, museum layout and opportunities to take advantage of its communities' resources. The goal of our project to assist OHM is the initiation of that very process.

Purpose and Impact of OHM Capstone

Optical Heritage Museum plays an integral role in preserving precious historical artifacts and tales of the optical industry but is facing challenges in bringing that preservation into the 21st century through effective, innovative solutions. The OHM Capstone group was assigned to this project by the School of Professional Studies, housed by Clark University, to assist in generating implementation strategies along with supplying credible information to inform OHM's decision-making in how to improve the interactivity of the museum. Our project goal is to assist OHM in developing effective, best-practice technological solutions for exhibits along with provide

assessments on current best practices in the museum industry, including current products being used, cost-structures and possible funding sources for such products. To achieve our project, we have agreed in our project charter with OHM to provide several deliverables upon project completion, which including research based on current technological practices being used in regional museums, product list with cost structures, recommendations list, and funding profiles for capital budgeting exploration.

We hope our capstone project will serve as the initial resource guide to assist OHM in their pursuits of introducing interactivity amongst their museum's exhibits in a cost-effective, successful manner. With the scope of our project, our hope is to provide a comprehensive project which offers viable solutions to address their interactivity challenges, visibility challenges and use of communal resources available to the organization. Optical Heritage Museum provides an invaluable service to the community which needs support in achieving its mission to do so. With collaborative efforts between OHM, the OHM Capstone team, and the School of Professional Studies, we hope this project's efforts will serve as the groundwork and framework for future projects and recommendations that are pursuable and feasible.

What's to Come

In the coming chapters of this report, our group will overview the scholarly research and trends of the museum industry that lay the foundation for current best practices. The connection of scholarly research with our project's methodology and goals will demonstrate the critical relationship best practices have with previous work conducted on the museum industry. After this overview, the methodology of our web-based research and field-research will be detailed for replication and future improvement purposed. Next, our results from both our web-based research and field-work will be covered in detail, including the development of the promised

deliverables to the client (i.e. cost structure, recommendations list, funding profiles, etc.). Finally, our capstone team's final recommendation along with personal reflections on the process will be shared to sum up significant findings of this project.

Chapter 2: Literature Review and Trends in the Museum Industry

The museum industry is growing, and growing fast, falling in lines with similar educational efforts by various institutions to provide a form of preservation and education spanning across generations (American Alliance of Museum, 2017). Optical Heritage Museum engages in that very effort, however is admittedly in a static position in their growth as well as their knowledge on current industry trends along with technological advances of the recent decade. There is a disparity between the thousands of items and the history they hold for a visitor to learn and the portrayal of these exhibits in an engaging, interactive fashion. Through review of the previous capstone's report along with discussions with Mr. Whitney and staff, the obstacles for the museum was defined as lacking interactivity and technological support amongst exhibits. Although the current state of the museum lacks interactivity, TripAdvisor reviews and personal accounts rave about the personal tours given by my Mr. Whitney along with the space being conducive for the exhibits on hand. Through our own observations, these personal accounts, and the recommendations shared with our group from Mr. Whitney, we narrowed our research down to increasing interactivity and engagement within the museum along with technology being used to create a self-guided tour experience.

The research focus we developed involved literature centered on museum industry theory, visitor engagement, current practices within the museum industry that are classified as "interactive exhibits", and best practices in transitioning exhibits to incorporate technological innovations. Sources for research included Clark University Lib-Guides, Google Scholar, and Worcester Consortium Libraries, covering journal articles, books, online databases and website-based information. Our team also incorporated anecdotal accounts from several museum curators we met through the span of the project, specifically their knowledge on how the industry has

changed over the last few decades regarding technology and engagement. Through findings in several areas of the museum industry, our scope of the project narrowed to include AR, VR, QR, web-based, and alternative technologies for possible avenues OHM to explore. Due to the varied costs of these products and the funding constraints many non-profits face, our research prompted our group to include exploration of possible capital budgeting opportunities for the museum to solicit, adding to the promised deliverables. Overall, our literature review is comprehensive of theory-driven philosophies, engagement and current practices of incorporating interactive exhibits throughout the museum but lacked in scholarly articles touching on the use of innovative technology (i.e. AR, VR, QR tech). Our hopes are for OHM to use this relevant literature to guide their implementation of future interactive exhibits.

Theory-Driven Philosophies

All practices implemented within museums are derived from the overall philosophy the museum believes in which guides its actions, the mission statement if you will. Theoretical frameworks are the source from where these philosophies are constructed, which is no different when accounting for a museum's perspective on interactive exhibits. The main objective of OHM is to educate all visitors on the history and current trends of the optical industry, serving as a bridge between the past and the present through teaching. Styles or "methods" of teaching can be classified into various pedagogies, or the method and practice of teaching (Mason 2006). Within museum industry research, pedagogies are a common framework which guides the approach many museums take when implementing interactive exhibits. According to Mason (2006), interactive exhibits consist of some technological medium, physical exhibit on display, and a device the visitor can operate. The goal of interactive exhibits is to increase engagement from the audience and increase visitation time, similar to what OHM seeks to implement. Several

interactive pedagogies have developed over time when approaching interactivity and the exhibits purpose. These pedagogies include the didactic expository model, stimulus response model, discovery model, and the constructivism model (Mason, 2006). Each pedagogy purposes the interactive exhibit to invoke a response or action from the visitor, increasing engagement levels.

The didactic-expository and stimulus-response models were developed early on and were the first pedagogical styles implemented with interactive exhibits. Referring to Mason (2006), interactive exhibits hold the potential to increase the democratic process between the museum and the visitor to strive beyond a simple "look, don't touch" atmosphere, ultimately empowering visitors to experience a meaningful interaction. The *didactic-expository model* serves as an authoritative role where museum/curators act as the communicators of knowledge through interactive exhibits, with the goal being the exhibit is directing visitors on what to do, what they are learning and what they should be feeling (Mason, 2006). This model focuses heavily on communicating knowledge to the visitor but leaves no room for outside control or unintended outcomes. Separately, the *stimulus-response model* is a behavioral model which bases an interactive exhibit to elicit responses from the visitor through its transmission of knowledge to the visitor and rewarding of their behavior if they act correctly or punishing their behavior if they answer incorrectly (Mason, 2006). An example would be the Museum of Tolerance in Los Angeles, where interactive multimedia stations hold question-answer experiences, with correct actions being rewarded and wrong actions being condemned (Mason, 2006). Both models are traditional in their purpose where it transmits knowledge to the visitor with little room for expansion or new meaning being developed.

Two contemporary models receiving more attention recently involve the discovery model and constructivism model. The *discovery model* is the popular pedagogy of choice in current

interactivity practices within museums because it allows for a two-way process between the exhibit and the visitor. This model strives for visitor engagement to include an interactive component through a mean-making process, leaving room for the exploration and control on the visitor's side to direct the outcome of the interactive exhibit (Mason, 2006). A discovery-based exhibit can be found in various children museums where building blocks of a material that is reflecting in the exhibit are provided, but no end outcome is suggested rather an exploration of what can be constructed from the materials provided, allowing for various possibilities (Haywood & Cairns, 2006). An up and coming pedagogy is the *constructivism model*, a method which relies heavily on the use of open narratives to incorporate the visitor's cultural background in their interactive experience (Mason, 2006). This open narrative is used to achieve two things, allow for incorporation of the visitor's cultural background and to provide the opportunity for the visitor to document their experience for future visitors to witness (Mason, 2006). Mason (2006) points to the Eternity Gallery in the National Museum of Australia, where computers are used to provide video histories where the visitor is given the chance to insert themselves within those video histories to be a part of the display. Overall, the goal of both models is to provoke a mean-making process where the visitor takes ownership in some capacity over the exhibit's outcome.

The four pedagogical models discussed offer a framework to guide the implementation process and purpose development of an interactive exhibits. They also offer the opportunity to choose which response you are trying to elicit from the visitor you are looking to attract and engage. Drawing from pedagogical frameworks will serve in defining the purpose of an interactive exhibit, but also assists a museum in determining which exhibits fit better for a specific approach. Pedagogical styles also are helpful knowing that they are based on the exhibits

themselves, allowing a museum to use multiple pedagogies to guide several exhibits, but it is important to keep to the philosophy of the museum and be careful in not disorienting visitors.

Engagement

Research focused on interactivity within museums is almost always linked to engagement, in other words the effectiveness of an interaction between a visitor and an exhibit in relation to a museum exhibit (Haywood & Cairns, 2006). Given that exhibit interactivity is directly linked to visitor engagement, we thought it best to delve into current literature focusing on what factors improve engagement within interactive exhibits. Engagement within the museum industry is normally measured with average time spent per visitor per exhibit, with an increase of nearly 3 times the average when an exhibit holds an interactive component, confirming the necessity for interactivity within a museum (Sandifer, 2003). Considering what improves engagement of an exhibit, several exhibit characteristics have been found to hold attention of small groups, specifically family members. On the other hand, geared toward youth, engagement has been found to increase when it allows this population to utilize their imagination within their interaction of the exhibit, thus demanding the exhibit to be more open-ended and allow for a narrative-driven experience (Haywood & Cairns, 2006). Both elements of engagement stem from theoretical underpinnings as well, linking the idea that philosophies when constructing exhibits is imperative to consider.

Critical to improving engagement is the defining of what characteristics of an exhibit will increase visitation time amongst visitors, specifically groups in this case. Sandifer (2003) touches on several exhibit characteristics that have been found to hold attention of family groups for a longer duration than alternative factors. Those factors included the exhibit being *multi-sided* (allowing for a group to huddle around it) and allow for *multi-users* (interaction from several

individuals simultaneously) (Sandifer, 2003). Other factors include *accessibility* (utility across age ranges), *multi-outcome* (outcomes are complex and diversified, generates discussion), *multimodal* (digestible for various learning styles and knowledges), *readable* (text is arranged effectively), and *relevancy* (provided linkage to visitor's existing knowledge) (Sandifer, 2003). All seven factors are not mandatory to increase the visitation time from groups, however visitation time and attraction power increased when several of these factors were offered within the exhibit (Sandifer, 2003). Similar to various studies on engagement, visitation time improves when open-ended exhibits exist that present the opportunity for users to control possible outcomes of the interaction, which is at the core of the discover and constructivism interactivity models (Mason, 2006).

Looking toward how youth engagement is affected by interactive exhibits, it has been touched on that the incorporation of their imagination is key in achieving greater attention power and increased visitation time (Haywood & Cairns, 2006). Relating directly to the up and coming constructivism model used when purposing interactive exhibits, the use of open-narratives is the strongest factor in achieving higher engagement levels from youth (Haywood & Cairns, 2006). This is critical to recognize in the planning of interactive exhibits because despite the intended effects of what the interactivity component is attempting to achieve, allowing for an open-narrative experience provides necessary agency to dictate the outcome of the interaction (Haywood & Cairns, 2006). In two studies conducted by Sandifer (2003) and Haywood and Cairns (2006), it was discovered the physical presence of an exhibit is imperative, compared to a computer-generated or abstract exhibit, in order to facilitate the desired mean-making process which draws in youth's attention. Finally, the desired outcome designed by the museum for the

exhibit is not imperative rather allowing youth the opportunity to utilize their imagination to achieve alternative outcomes is linked to higher engagement levels (Haywood & Cairns, 2006).

Overall, engagement is necessary to increase visitation time and positive interactions with exhibits from the visitor's perspective. The research available on engagement is critical to link to theoretical frameworks used when developing interactive exhibits because together they provide the philosophy through which your exhibits are guides as well as the exhibit characteristics to achieve the desired outcome frameworks are attempting to achieve. It is also crucial to link both because it demonstrates continuity between exhibit characteristics and the purpose of the exhibit to increase visitation length and attention power.

Development & Implementation Do's & Don'ts

Finally, the last element to current museum industry research focused on best practices and pitfalls to avoid when implementing interactive exhibits. First touching on the what to avoid, Allen & Gutwill (2004) discuss the five common pitfalls found in science museums, notorious for interactive exhibits, revolving around overwhelming the visitor, allowing for over complexification and distraction from purpose. The first three pitfalls included the presence of multiple options with equal importance, allowing for secondary features of the exhibit to override its primary feature or purpose, and creating impossible tasks to achieve the desired outcome, risking the chance of confusing and deterring visitors (Allen & Gutwill, 2004). The remaining two pitfalls include allowing for interference from multiple users and encouraging users to disrupt the purpose of the exhibit display, ultimately increasing distractibility rather than increasing engagement (Allen & Gutwill, 2004). To avoid such pitfalls, it is cautioned in the designing of an exhibit to limit functionality, possibly segment the exhibit into multiple stations and create a hierarchical order of relevance for features of the exhibit (Allen & Gutwill, 2004).

Avoiding pitfalls in the designing of an exhibit is crucial, however the development and implementation in an effective and productive manner is key. Pekarik, Button, Doering, Sharbaugh and Sutton (2002) touch on a framework of best practices when designing and implementing an interactive exhibit in order to achieve its purpose and increase engagement. Their framework includes understanding the definition of interactivity, knowing its purpose and target population as well as creating a user-friendly development process, and ensuring continuous evaluation of the exhibit post-implementation (Pekarik et al., 2002). As discussed earlier, interactive exhibits consist of some technological medium, physical exhibit on display, and a device the visitor can operate (Mason, 2006). When planning the exhibit design, asking questions about the target population, its purpose, best method to accomplish its purpose, number of users and cost are the first step in development (Pekarik et al., 2002). During the design phase, ensuring there is content supplementing the exhibit, integration of interactivity in the overall design, prototype testing and reliability testing will mean the difference between achieving what was planned initially or failing before you get started (Pekarik et al., 2002). Finally, evaluating effectiveness of the exhibit through examining its purpose, meaning to visitors and durability over time will provide a measure of success (Pekarik et al., 2002). Overall, evaluation is also possible through surveying if the exhibit is achieving higher visitation lengths and attention power compared to surrounding exhibits.

To Keep in Mind

To best serve our client, the project scope focused on all aspects revolving around implementation of interactive exhibits within their museum. Our project team determined the best use of the literature review would be to focus on the elements involved in interactive exhibits that must be addressed when designing and implementing to provide context and best

practices when considering our recommendations. This direction narrowed our focus to only include scholarly research and best practices on theoretical frameworks which interactivity is guided by, what factors are critical in achieving effective interactive exhibits (i.e. engagement, visitation length, attention power), and what to avoid and what to seek when designing/implementing such exhibits. Limitations to keep in mind include our lack of inclusion on how museums deal with geographical and funding constraints, which we plan to address in our results section. Other limitations include the recency of our articles due to the majority of our research pre-dating the current decade. Finally, scholarly research existing on current technologies being used that related to our choices of technology to focus on also limited the literature review to a strict focus on interactive exhibits as a whole rather than specifying one technological approach to interactivity.

Chapter 3: Methodology

Design

Based off previous literature, AO Fall 2017 Capstone's report, and recommendations from OHM, we developed a 2-pronged approach for data collection: 1) web-based research 2) museum visitations. From the previous capstone's report and the elements discussed in previous literature as necessary components in creating successful interactive exhibits, we designed several research areas and questions for our online based research as well as museum visitations. Listed below are the areas of interest we took note of:

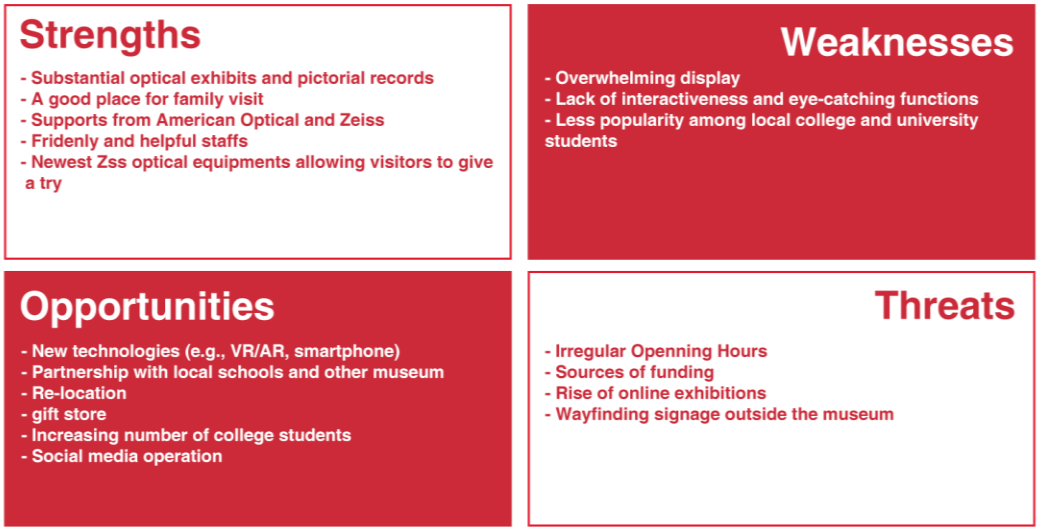
1. Display/Organization of Exhibits (i.e., Navigational flooring, Audio)
2. Technology being used (i.e., app guiding tour, VR helmet)
3. Interactive function (what is interactive and what is its purpose)
4. Why this specific exhibit?
5. Institutional Partnerships
6. Exhibit Layouts
7. Events/Marketing
8. Anything Else?

Deliverable Development & Analysis

After going through the various technologies for the museum to improve their visitations, we were able to determine strengths and weaknesses for several of the technological options we researched. From here, we were able to determine which technologies deserved attention within our deliverables. We were also able to determine the nature of our deliverables dependent on the information gathered from our research and museum visitations. The cost structure analysis for the different technologies have helped us develop a table with estimated costs which cover each

technology considered for implementation. Although different sets of combinations of the technologies can be used by the Optical Heritage, the cost structure details those products which offer the most cost-effective options for OHM. Accordingly, we also developed funding profiles for possible capital budgeting opportunities within the area that demonstrated a history of funding museums within Worcester County. Overall, we developed a cost structure table and capital budgeting profile sheets to support OHM's search in budgeting and gaining access to possible funding opportunities.

Through our SWOT analysis (see chart below), our group compiled a recommendations list of various suggestions which came across the team during the capstone period. The list contains all recommendations from our group according to cost-effectiveness, suggestions from Mr. Whitney himself, the prior AO capstone group as well as what our field research indicated as critical for other museums in their success. For example, we recommend implementing the technologies using the companies such as OnCell which are dominant in the market for providing mobile tour solutions to museums. Alternatively, implementing a solution using the students who are studying in nearby colleges will be beneficial for the students to get real experience within the community but offers cost-effective man-power for OHM to utilize.



Data Analysis

Through museum visitations, qualitative data was collected through question prompted field notes. By looking for patterns and coding the data, this descriptive, unstructured data was able to be transformed into a simple checklist table to demonstrate all technologies and components being used or not used by regional museums (See Appendix D). We typed all written museum visitation notes in Microsoft Word and identified themes which best represent the descriptive nature of qualitative data collected from museum visitation. These themes include:

1. Display of Exhibits
2. Technology being used
3. Interactive function
4. Institutional Partnerships
5. Events/Marketing
6. Others

Technology products and services observed in our museum visitations were also categorized in terms of basic techniques they utilized (e.g., website, mobile apps, video and audio, and AR/VR). We sorted all field notes to filter out duplicate and irrelevant descriptions and made sure all remaining notes correlated to one of six themes above. Categorized data were also compared with those in the field notes of Optical Heritage Museum to help our writing of the recommendations list. Data gathered from secondary sources, i.e., online research and SWOT analysis conducted by American Optical Capstone Team Fall 2017, were included in our data analysis as well. Structured in our recommendation list, we ranked recommended actions for implementation according to their feasibility, which was determined by the following factors:

1. Accessibility to resources
2. Cost-effectiveness
3. Relevancy
4. Estimated length of implementation process

The ranking serves as criteria in our later development and evaluation of all deliverables. It cooperated with the feasibility study and cost structure of each deliverable to decide which deliverable is recommended for the Optical Heritage Museum as a short-term solution, and which is relatively of less significance or harder to implement and thus should be included into the Museum's long-term plan.

Materials

Materials used for the project involved several handouts and info guides from OHM, several videos supplied by Mr. Whitney from his personal website, previous scholarly articles focused on the museum industry, and Google drive account with all documents. The first handout from OHM included their brochure produced by Zeiss, which outlined the purpose of OHM, its layout along with exhibits within each room, small descriptions of exhibits, and social media as well as geographical information. The second handout included the American Optical Company pamphlet, overviewing the history of American Optical Company. Previous scholarly articles consisted of several reports on interactive exhibits being implemented within Worcester County museums, such as the SPS 2017 Fall AO Capstone Group and the WPI 2014 student-based project group. Finally, our capstone Google drive account served as the database with all relevant documents, notes, updates, deliverables, co-op assignments, and miscellaneous docs.

Ethical Concerns

Our project team experienced little to no ethical concerns throughout the project, attributed to the efforts of both our group and OHM in their flexibility of how to carry out the project and its purpose. Initially, the project scope involved marketing and publicity-related tasks, which presented a challenge given Zeiss's control over all social media, publicity and marketing efforts of OHM. Understanding this would have complicated our project with several ethical concerns, we agreed in January to shift our focus from marketing to field-based research on exhibit improvements. Through our field-based research and web-based research, our capstone group was able to avoid requirement for Human Subjects Testing approval through choice of no formal interviews, which decreased potential ethical concerns up front.

Chapter 4: Results & Findings

The following section will cover all web-based research findings, museum visitation findings, recommendation list findings as well as cost structure findings. Each area holds several sub-section fields, for example, web-based findings consists of AR, VR, QR, website, alternative technology, and capital budgeting opportunity research findings. All research results discuss relevant research to OHM, thus not all findings discovered throughout our research or museum visitations is detailed with the hopes only relevant information is detailed for the client's use. Discussed first is web-based findings, followed by museum visitation results, then cost structure results, next is recommendation results, with final limitations and restrictions being discussed.

Web-Based Findings

AR Research (Augmented Reality). Augmented Reality (AR) is a technology that calculates the position and angle of a camera image in real time and adds corresponding multiple sensory modalities, including visual, auditory, haptic, somatosensory, and olfactory through images, videos, and 3D models (Schuettel, 2017). Augmented reality technology not only displays real-world information, but also displays virtual information at the same time. In visualized augmented reality, the user uses a helmet display to overlay the real world with computer graphics to see the real world around it. The goal of this technology is to display the virtual world on the screen and let people experience a virtual element within their natural environment. With the increase of computing power of portable electronic products, it is expected that the use of augmented reality will become more and more widespread.

***Advantages and Disadvantages*.** With the continuous advancement of technology, the improvement of the hardware performance of mobile terminals and the large-scale adoption of smartphones have brought new experiences and ways for museum education. Thanks to the

portability of smart phones, people can receive information and share it quickly and easily. Augmented reality can add or complement elements (sound, video, graphics, and GPS data) to the real-world environment, which improves the user's subjective experience. In addition, smartphones can provide a variety of display methods, and museum collections can be used for OHM tours in the form of mobile terminal displays of museum information. This can solve the problem that the current exhibition methods are not rich enough, and human-computer interaction methods are not humanized enough. Furthermore, Museum AR technologies do not require a headset which can save on expenditures, not to mention it allows visitors to interact a great deal more with the exhibit. However, AR technology may present a challenge for visitors without AR or mobile device experience and this may lead to help and assistance being needed. Additional personnel support may be needed if visitors are using this technology. Moreover, mobile devices may interfere with the visitor's experience, not to mention insufficient personal mobile phone memory space limits the download of AR applications (Neuburger, 2016).

Currently, The Cleveland Museum of Art utilizes AR software successfully, specifically ArtLens 2.0, which is an AR application which includes all exhibits and connects to the ARTLENS Gallery experience in the Cleveland Museum (ArtLens, 2018). It is the use of image recognition software to identify the museum's two-dimensional works of art. It respects the preferences of tourists and enhances the interaction between tourists and exhibits (Ding, 2017). This app can be installed for free on IOS and Android systems. Visitors simply need to scan exhibitions they are interested in by using their phones or tablets. The ArtLens app uses Bluetooth technology to connect to the museum's iconic ArtLens wall and all ArtLens exhibition interactive shows (ArtLens, 2018). The ArtLens application enhances the visitor's museum experience by providing options for designing personal tours, augments reality with tools to

better understand artwork, and guides users through interactive real-time maps. The ArtLens application can be used on site or outside of the Museum. Five main categories of “Search”, “Galleries”, “Tours”, “You”, and “Museum” make tourists more in-depth and more attractive to visit the museum. The ArtLens application has been downloaded more than 70,000 times on IOS and more than 9,000times on Android since 2013 (Ding, 2017). The reason ArtLens is continuously improving can be linked to developers collecting users’ feedback and making adjustments in time. For example, according to the user's feedback, the download speed of the application become much faster, only 30 seconds. And the space occupied by this program has become suitable (ArtLens, 2018).

AR in Optical Heritage Museum. AR could be used as a virtual tutorial of OHM's exhibits. Each theme would have a QR code next to an exhibit. Visitors could use their mobile phones to scan a QR code. Then visitors can see a three-dimensional narrator on the screen of the mobile phone. The three-dimensional narrator could give a voice to explain the information of this exhibit. Through mobile audio and screens, visitors can learn about the history of this exhibit. This technique can be accomplished using the ARVR editor provided on the 951AVR platform (ArtLens, 2018). This editor is free, suitable for windows system, and size is 168MB. This editor can develop AR and VR. Developers do not need high technical expertise because its graphical editing interface can be operated through dragging and dropping with mouse which can quickly complete the scene and create AR applications. This editor also supports lots of free materials and the final AR applications can run on multi-platforms, such as Android and IOS (Dou, 2017).

There are equipment composition costs, such as the need for this app to be designed in a Windows system computer which costs roughly $1000. ARVR Editor as a development platform

is free to install. Free three-dimensional characters can be downloaded from websites. Museum staff need to take some time to create audio introduction for exhibits. So, there is no cost on development resources. The Internet connectivity may cost 100 dollars for each month. In summary, the initial setup cost for the virtual tutorial scheme is approximately 1,100 dollars (ArtLens, 2018) (See Appendix B).

***OnCell Outsourcing*.** OnCell provides mobile tour solutions for museums. It can develop a variety of services, such as DIY app builder, native apps, web apps, audio tours, and games. It offers a state-of-the-art technology platform that provides location-specific interpretation for visitors. Visitors use their mobile phones to explore the museum and OnCell provides a feature-rich application building platform which offers museums various mobile tour options. The app builder, audio tours, and interactive tools can give OHM the ability to create mobile solutions that can attract more visitors. OHM can benefit a lot from OnCell while an app can utilize innovative features and new technologies. OHM can update their app as needed with new content at any time. Using this app can understand visitors better through app usage statistic and surveys. Visitors can spend more time at museum and it will allow mobile fundraising campaigns within the app. Visitors also can have better experience by offering educational and wayfinding content (See Appendix B).

VR (Virtual Reality). Working in tandem, our senses of sight, smell, taste, touch and hearing not only help us perceive the world around us but also give us the ability to experience the effect our actions have on this world. When we substitute the physical inputs, we gather through our senses with computer-created simulations, it tricks our brain into believing that we are physically present in a completely different reality. This phenomenon is what we call a

Virtual Reality. In other words, it is a believable, interactive 3D computer-created world that you can explore so you feel you really are there, both mentally and physically.

In the context of present day VR head-mounted displays (HMDs), it is predominantly our senses of sight and hearing that are being fed computer simulated data. Either through 3D modelled environments or 360-degree recordings of real-world locations, VR HMDs help transport the user to an entirely new location, completely blocking out the real world in the process (Dou, 2017). The more realistic the images and audio fed to the user, the more convincing is the illusion – the more the user feels like they are actually 'immersed' or 'present' in this new world. Looking around, the user has a genuine sense of scale of their new surroundings. VR technology is continuously getting better. In addition to key breakthroughs made in simulating sight and sound, there is considerable progress being made in simulating touch, smell, and taste as well as reducing headset size.

Full-Immersive VR. For the complete VR experience, we need three things. First, a plausible, and richly detailed virtual world to explore; a computer model or simulation, in other words. Second, a powerful computer that can detect what we're going and adjust our experience accordingly, in real time (so what we see or hear changes as fast as we move—just like in real reality). Third, hardware linked to the computer that fully immerses us in the virtual world as we roam around. Usually, we would need to put on a head-mounted display (HMD) with two screens and stereo sound, and wear one or more sensory gloves. Alternatively, we could move around inside a room, fitted out with surround-sound loudspeakers, onto which changing images are projected from outside.

Non-Immersive VR. A highly realistic flight simulator on a home PC might qualify as non-immersive virtual reality, especially if it uses a very wide screen, with headphones or

surround sound, and a realistic joystick and other controls. Not everyone wants or needs to be fully immersed in an alternative reality. An architect might build a detailed 3D model of a new building to show to clients that can be explored on a desktop computer by moving a mouse. Most people would classify that as a kind of virtual reality, even if it doesn't fully immerse you. In the same way, computer archaeologists often create engaging 3D reconstructions of long-lost settlements that you can move around and explore. They don't take you back hundreds or thousands of years or create the sounds, smells, and tastes of prehistory, but they give a much richer experience than a few pastel drawings or even an animated movie.

Collaborative VR. Although “Virtual world" games like Second Life and Minecraft meet the first four important VR criteria (believable, interactive, computer-created and exploratory), they do not meet the fifth of full immersion. One thing they do offer that cutting-edge VR typically does not is collaboration, or the idea of sharing an experience in a virtual world with other people, often in real time or something very close to it. Collaboration and sharing are likely to become increasingly important features of VR in future.

Web-based VR. Virtual reality was one of the hottest, fastest-growing technologies in the late 1980s and early 1990s, but the rapid rise of the World Wide Web largely killed off interest after that (Dou, 2017). Even though computer scientists developed a way of building virtual worlds on the Web (using a technology analogous to HTML called Virtual Reality Markup Language, VRML), ordinary people were much more interested in the way the Web gave them new ways to access real reality. These new ways involve how to find and publish information, shop, and share thoughts, ideas, and experiences with friends through social media.

Equipment. Virtual reality calls for supplemental equipment for fluid operation, which include head mounted displays (HMD’s), immersive rooms, data gloves, or wands. There are

two big differences between VR and looking at an ordinary computer screen: in VR, you see a 3D image that changes smoothly, in real-time, as you move your head. That's made possible by wearing a head-mounted display, which looks like a giant motorbike helmet or welding visor but consists of two small screens (one in front of each eye), a blackout blindfold that blocks out all other light (eliminating distractions from the real world), and stereo headphones. The two screens display slightly different, stereoscopic images, creating a realistic 3D perspective of the virtual world (Dou, 2017). Immersive rooms are an alternative to putting on an HMD is to sit or stand inside a room onto whose walls changing images are projected from outside. As you move in the room, the images change accordingly. Similarly, data gloves can also be used, which are ordinary gloves with sensors wired to the outside to detect hand and figure motions. Even simpler than a data glove, a wand is a stick you can use to touch, point to, or otherwise interact with a virtual world. It has position or motion sensors (such as accelerometers) built in, along with mouse-like buttons or scroll wheels

Pros and Cons. Like any technology, virtual reality has both good and bad points. The promise of VR has loomed large over the world of computing for at least the last quarter century—but remains largely unfulfilled. While science, architecture, medicine, and the military all rely on VR technology in various ways, mainstream adoption remains nonexistent; we're not routinely using VR the way we use computers, smartphones, or the Internet. But the 2014 acquisition of VR company Oculus, by Facebook, greatly renewed interest in the area and could change everything. This social networking site’s basic idea is to let people share things with their friends using the Internet and the Web. What if you could share not simply a photo or a link to a Web article but an entire experience? Instead of sharing photos of your wedding with your friends, what if you could make it possible for people to attend your wedding remotely, in virtual

reality, in perpetuity? These are the sorts of social, collaborative virtual reality sharing that social networking sites are thinking about exploring right now. The New York City Museum of Contemporary Art conducted its first virtual reality exhibit using OptiTrack motion capture technology and the Oculus Rift headset, showcasing the increased use by museums. The future of virtual reality may be an avenue OHM should explore through its expected and hoped expansion.

QR (Quick Response). As the digital aspect in the museum space continues to evolve, we're confronted with the ongoing question of how to better assist the visitor. Museum experimentation with QR codes has shown to improve visitor's ability to swiftly and efficiently pull up elongated information about a physical object by scanning a QR code with their smartphone or use museum provided device. The QR code was often positioned near or on the object label. On paper, this approach sounded simple, and many museums jumped on board with a positive outlook about the potential. Our approach uses QR to explain the details of the exhibit without utilizing unnecessary space and also help the flow of the exhibits be in the clean and mannered way. The development of an application can be done to better suit the devices of the visitors and also give the option to the museum dedicated devices available.

One area QR can be useful is through its use of iBeacon technology. This technology utilizes Bluetooth and QR coding to automatically pick up objects around a person and pull contextually-based information (Dou, 2017). Although using iBeacon can help the visitor to retrieve automated information of the exhibit, we believe there will be some difficulty using iBeacon with all exhibits in current building of the Optical Heritage Museum. The lack of space between the displays will make it difficult to distinguish between adjacent exhibits. Although the iBeacon can detect the distance with great accuracy, in OHM's case it will be difficult to do so.

One way to mitigate this risk is use iBeacon for different sections of the museum. Thus beacons can be used to distinguish the sections of the museum and can be used to trigger the various interactive routines of the parts.

Website-Based Research. ***Webpage Reformation*****.** During review of Optical Heritage Museum's current website, our team found several suggestions we felt should be cataloged for our client to review. First, the website has broken links which is the lifestyle function. After that, we believe discover function and explore function could be combined as one function. As of now, discover function shows the map of OHM with several pictures to show what is included in the certain room, while explore function provides a link to google map to take the VR tour based on google street view. The VR tour could also be combined through using Google street view container. This technology could embed a window on the web page to prevent visitors jumping to multiple web pages while they take the VR tour, not to mention this technology is free. Through fixing broken web links and combining the discover and explore into one function, the user's experience will become easier and quicker. Additionally, adding a volunteer function may provide a method for who recruiting needed help. Adding an additional button to provide contact information of OHM and payment link for donors to will also streamline needed contributions to the museum. These changes are relatively quick and may increase satisfaction of museum website visitors, creating a good impression and enhancing the website's functionality.

Embedding YouTube Videos**.** It is cost effective to use YouTube as the video source to implement visible videos on the website and is the easiest and most common solution to embed a video onto a website. YouTube videos do not need website owners to host a server, and implementation is simple through the addition of several lines of code to add the video on the site with the desired size of the video window. Nearly all of the museums we visited utilized

some exhibit videos on their website. The current link forces website visitors to leave the museum's site and jump to others website such as YouTube site, which may create distraction because of advertisements and irrelevant content. By embedding videos as customized windows on the website, this issue can be addressed.

The cost of the YouTube Website video player is cheap. First, Google provides free instructions for customers to embed videos, after that, the cost of making videos is cheap with a variety of editing tools available, such as Corel VideoStudio X10. To purchase this tool, the price is $100, with training courses available on YouTube. Although YouTube videos have some disadvantages, such as advertisements, it is still a cost-effective measure to make current site become a more interactive website (See Appendix B).

***Online Exhibition*.** It is one of the best ways of disseminating digital information on any area including exhibiting culture and heritage, archives, library information, marketing, trade shows, conference exhibits and educating visitors 365 days in a year. Online exhibition includes two schemes, hybrid and virtual display only. Most of the museums, which have online displays, have chosen hybrid. Hybrid means museum keep their physical space operating, while at the same time, they use online display as a tool to do more introduction of their content. The representatives in this type of museum are the Louvre Museum, Smithsonian National Museum of Natural History. The Louvre provide specific VR tour to show the items and the Smithsonian provide a lot of references that can be a reliable reference site. For the full digital museums, they do not provide any physical places for display, rather every item which museum owns will be scanned, given descriptions, and then posted online. Museum who use this method to display usually own items related to digital arts, such as Digital Museum of Digital Arts.

According to the comparison, we think hybrid digital museum is an ideal way for Optical Heritage Museum to expand and develop in future.

There are several advantages of developing online exhibition publicity. Museum are committed to sharing their remarkable resources for the advancement of knowledge and the nourishment of the human spirit (Mason, 2006). To enhance this aspect, the trend for small museums is to operate online. The Web enables curators to provide a hierarchy of descriptions for the artifacts, targeting materials to different age groups and educational or interest levels through detailed content. In order to start the online exhibition step by step, OHM could consider that post some of their cultural relics such as John Fitzgerald Kennedy's last sunglasses order or the first pair of glasses on the moon.

Online exhibits are also useful for museums with space limitations. Over 3000 items are on display in the current physical space, and due to insufficient room visitors may be overwhelmed by the number of items crammed into a single area. Online exhibits can be a bridge that provide the deep resource or research study to the physical items. In the virtual space, descriptions and explanations can be comprehensive through captions or labels, not to mention links can connect to source documents, in-depth articles, longer scholarly interpretations, related materials, and relevant collections in other institutions.

The cost of the online exhibition is dependent on how extensive OHM would like these exhibits to be. For current items on their webpage, there is no extra cost, rather just time to change the contents online. Use the free web page after combining sections to post some of key items. For the further online publicity, the cost of start is around 3000 dollars, this number is the popular price to modify the web module, increase functions, and added new database. Another technology called 3D scanner could help museum create a spherical photo of items, allowing

visitors to view items without blind points and as a three-dimensional shape. The cost of making 3D pictures are relatively cheap, with the scanner costing around $800 (See Appendix B).

Alternative Technology Research. ***Wayfinding/navigational floor*****.** The Navigational floor, or wayfinding floor, is a type of directional signage through use of floor graphics. Navigation from place to place is a fundamental human activity and an integral part of everyday life, and it is especially important when people are entering an unfamiliar and complex environment (Designworkplan, 2018). Because wayfinding signs assist staff and visitors in going where they need to go quickly and safely, hence their increased uses in places such as offices, hospitals, storage and supermarkets to increase the efficiency of work. Wayfinding systems could also be seen in public places, including educational campuses, theaters, transportation facilities and museums, in which signage primary serve to 1) create a sense of safety and security and reduce confusion 2) take precaution for the unlikely event of emergency.

Many techniques and devices could be adopted to achieve the purpose of wayfinding, including graphic communication (e.g., map), visual clues (e.g., signs), audible communication, tactile elements and the mobile-based guide which came to the market in recent years (Designworkplan, 2018). Among them, physical graphics are commonly used as the primary and even the exclusive wayfinding system in many built environments. For years, walls, ceilings and free-standing options have been the go-to place to adopt wayfinding signage. However, with a growing advancement in media technology and within the print industry, the floor also become the carrier of wayfinding signage (MXdisplay, 2018). While some floor signage are made parts of the flooring itself in architectural design, most of floor wayfinding systems are applications to the floor without causing any permanent changes. The newest version of the wayfinding floor is clear, flexible and pure vinyl (PVC) product which allows second-surface printed graphics using

the LED UV technology (MXdisplay, 2018). It can handle heavy foot or even vehicle traffic. A standard wayfinding floor graphic can last 2 – 4 years, while a high-quality product could last 8 – 10 years.

Despite advances in technology, including AR/VR/QR options, the floor graphic remains important in building wayfinding system, because of benefits other methods of wayfinding do not have. It is a friendly and creative way of navigation when compared to traditional signage (e.g., wall-based or standalone signs) which also creates more novelty. And it is easy to read and comprehend where visitors only need to follow the printed route on the floor to reach their destination. Installation is quick and easy along with removal as well because wayfinding floor uses vinyl as its primary material, which is flexible and removable. It will not distract visitors' attention from exhibits. "The best signage is almost invisible – people see it but it's taken for granted." (Weiss, 2013) A serious problem signage might run into is that they would become sources of a distraction if they are too close to exhibits or paintings, but floor graphics reduce this potential problem. It can be integrated with new technologies, such as AR and QR code scanning, so any visitor could use the camera from a smartphone or tablet to scan the graphic pattern on the floor to link to website pages, videos or even 3D models. Finally, it is low-cost because the wayfinding floor cheaper than digital wayfinding and it requires fewer skills and tools for design and implementation. Digital wayfinding system might need months of app development and software/hardware installation, and each step would generate a considerable amount of expense.

***Display cases with LED lighting*.** From the environmental design point of view, presenting a display is more than just presenting it. Instead, it is an art that contains both aesthetic and mechanical qualities, and an art of how to make audiences see different things and move around different things with comfort and interest (Mason-Middleton, 2012). Display cases (showcases, display cabinets or vitrines) are commonly used as a display solution in museums, exhibitions and galleries. A display case is a cabinet with one or often more transparent glass or plastic surface so that visitors could view the displayed object (MXdisplay, 2018). In general, there are two types of display cases, freestanding and built-in. Freestanding display cases are mounted in standalone cabinets, while built-in display cases may be mounted on the wall, or be hung from the ceiling, and in some occasion, built into the floor (Campbell-Dollaghan, 2014).

Typically display cases are products of specialist companies with a background in woodworking or welding. A single freestanding case could ship pre-assembled or knockdown (in pieces to be assembled by the customer), while built-in cases are often customized to best fit the space. Display cases with LEDs provide a spotlight to highlight a single exhibit. A 4.5 watts

LED bulb could provide an equivalent amount of brightness (220 lumens) of a 25 watts standard bulb (Display Smart, 2015).

Capital Budgeting Opportunities. Through our funding research, several organizations were found to be possible sources of capital budgeting opportunities, all located within the Worcester area where each organization serves Worcester County organizations. Each organization listed below has been linked to allotting grants to museums within the past 3 years or is listed as accepting of grants from organizations in the museum industry. Through the Foundation Directory, our capstone team was able to collate relevant information to create a funding profile for the following 5 organizations:

1) The George F. & Sybil H. Fuller Foundation
2) The Fred Harris Daniels Foundation
3) The George Alden Trust
4) The Stoddard Charitable Trust
5) The Wyman-Gordon Foundation

Each funding profile includes information on the organizations' location, website, what programs have been previously funded, types of support they fund, grant application requirements, potential deadline dates, and previous organizations funded in the last 3 years (See Appendix C).

The 5 organizations listed are potential foundations or trusts OHM could solicit for capital budgeting opportunities for a few reasons. First, specific grants have been given to Worcester County nonprofits within the last three years from two of the 5 organizations. The George Sybil Fuller Foundation has allotted six-figure grants to both the Worcester Art Museum and the Worcester Historical Museum within the last few years, whereas the Fred Harris Daniels

Foundation extended a small grant to the Worcester Natural History Society dba Ecotarium in the last two years. Second, the remaining three organizations included museums and education in their scope of which programs they fund, not to mention dozens of grants have been allotted to nonprofits all around Worcester County. Third, these foundations are Worcester County specific in their pursuits to support nonprofits with potential funding opportunities, which suggests a reduction in competition for larger agencies that fund projects on the national or even state level.

Museum Visitations

Boston Museum of Science. The Boston Museum of Science (BMS) is a science museum located in Boston, Massachusetts. This museum's success is seen through its 1.4 million visitors, 50,370 member households, and 161 corporate members in the year of 2017 (Museum of Science, 2018). The endowment market value in June 30, 2017 had achieved 146 million dollars. This is an increase of 39% over the same period of last year (Manchester, 2017). After visiting this museum, our team found that there are many areas OHM could look to for a model of improvement.

First, the organization of exhibits in BMS is effective. There is a carton map sign on the wall with audio guide at the entrance, allowing visitors a basic understanding of the museum. The entire museum is divided into three parts (Green Wing, Blue Wing, and Red Wing). Each hall has signage to direct visitors, every exhibit has audio descriptions. There is use of tall glass and wood display cases to display exhibits, which help exhibits look very clear and in order. Each hall has one or more games for visitors to engage in.

Second, in terms of technical use, it has a lot of machines used to display more specific details of exhibits, through three-dimensional images, pictures, text descriptions, and audio. The audio tour makes exhibits vivid, friendly, and clear. It also established 4-D Theater to engage

visitors, however it does not use very complicated techniques (such as Augmented Reality) to display. Excessive technical support can confuse visitors, which BMS avoids.

Third, it has many interactive functions. Visitors can experience scientific principles and build dynamic models by themselves, such as engineering a bridge support. The Particle Mirror exhibit is the most attractive exhibit. Visitors can physically interact with the simulations they create. Each theme pavilion also has many card games to improve the interaction, such as finding the difference, matching items, and sorting samples. More than that, BMS provides several illusions to generate curiosity from visitors, a format OHM may potentially look into if they move forward with the optical illusion room.

This museum is well funded and has various partnerships, such as MathWorks, WCVB, and MIT, which improve its publicity, technology, interaction, and innovation. It also holds summer courses to increase student interaction. Moreover, it often organizes some activities to improve its marketability, such as live presentations through Monday to Friday, weekends, school vacation week, and holidays. It also cooperates with Boston Marathon. Much of this is due to its advantage in geographical location. It is located on the banks of the Charles River. Visitors sit on the benches of the museum and they can admire the wide riverside of the Charles River, not to mention is in close proximity with a great deal of community resources and potential partners. (See Appendix E)

Harvard Fogg Museum. The Harvard Fogg Museum, located in Cambridge, Massachusetts, and housed by Harvard University, is a medium-sized museum with the goal of education and preservation of the arts dating back to the middles age to present times. On recommendation from Mr. Whitney from OHM, we included this museum in our museum visitations. The Harvard Fogg Museum holds operational hours from 10-5 every day, with

holidays off, and operates on traditional methods of the museum industry with little to no interactive exhibits implemented, with the exception of an XO game where humans may play against CPU's or other humans. Although our visit turned up little in regards to interactive strategies to learn from, it did pose a few interesting developments, specifically in regards to how personnel are utilized within the museum space and how co-location benefits foot traffic intensity. First, a lack of directional floor and non-existent navigational flooring contributes to possible confusion from the visitor's perspective. This confusion was only mitigated through the excessive use of museum personnel within each exhibition room, which is helpful but also a potential waste of resources given the heavy reliance on employees this strategy requires. Second, this museum's co-location efforts with the two other Harvard art museums along with its partnership with Harvard University promotes and draws in its majority of foot traffic. Given the lack of interactive exhibits housed in the Harvard Fogg Museum suggests its location is what compensates for this. (See Appendix E)

Manchester Historical Association. The Millyard Museum, housed by the Manchester Historical Association, is a medium-sized museum located in Manchester, New Hampshire, with the goal of education and preservation of local city history. Given its similar demographics regarding size, goal and use of technology lend itself as a useful comparative example. The Millyard museum runs open hours Tuesday-Saturday, from 10-4, with a small admission fee to enter ($5) and self-parking meters along the entire factory building. History covered within the museum stemmed from the birth of Manchester as a settlement back in the 1700's with the struggles between Native Americans and Westernized civilizations being covered first all the way through current famous persons who lived within the city. In regards to technological use to increase interactivity between the museum and visitors involved a guided mobile tour prompted

through a QR code which links to the website-based tour, several hands-on exhibits (Build-a-Brick, Waterpower Generator), audio-prompted devices, LED video displays and an interactive wall of famous figures from the city. All exhibits were guided by navigational directioning which was located on the walls and embedded within the mobile tour.

What remains of relevance to OHM involved the Millyard Museum's use of a mobile-guided tour supplemented by audio guidance and chronological floor layout with navigation directionals. Through the admission fee, the mobile app tour is achievable by the museum through its contract with OnCell, which provides development and maintenance of the mobile tour. The tour itself consists of several prompts on the main screen, with the primary option for starting the mobile tour. The makeup of the tour consists of a slideshow with one image of the main component of the exhibit accompanied by a small description of the exhibit and an audio file ranging from 1:30 to 2:30. A visitor must choose when to play the audio file, when to change slides and must be wearing some headset or headphones in order to utilize the tour from a mobile device (headsets are available for rent). Although many hands-on activities were scattered through the museum, such as an LED light up screen to demonstrate the effect a hydroelectric generator on the local river flow, the mobile tour did not prompt visitors to engage in such exhibits. Overall, the Millyard museum offers OHM a good reference for several interactive products that can be implemented as well as strategies on how to improve on the implementation of such products, if OHM chooses to implement a mobile tour supplemented with navigational flooring as well as hands-on activities. (See Appendix E)

JFK Presidential Museum. The John F. Kennedy Presidential Library and Museum is a presidential library and museum of John Fitzgerald Kennedy (1917-1963), the 35th President of the United States. It is a 10-acre museum located on Columbia Point in the Dorchester

neighborhood of Boston. It has a collection of valuable historical materials chronicling the life and administration of JFK, along with significant changes taken place in mid-20th century America. The Museum is open seven days per week, from 9:00 a.m. – 5:00 p.m. Upon our visit, the Museum is holding *JFK 100 – Milestones & Mementos*, a special exhibition commemorating President Kennedy's centenary in which visitors have chance to appreciate precious exhibits that will not be displayed on other occasions, including family items from Kennedy's childhood and adolescence. The Museum is inside a two-floor building where the grand floor consists of the exhibition area and a pavilion for viewing beautiful Boston seaside, while a theater located on the second floor, which plays an introductory film about Kennedy every 30 minutes.

The philosophy of "Less is more*"* guides the display of all exhibit*s*. A single or a group of relevant exhibits are placed in a freestanding or a wall-mounted glass display case and are highlighted by LED spotlights. Printed labels, photographs and video records serve as supplementary materials to explain the story behind an exhibit. The exhibition, following a chronological order, is split into several different areas to represent important stages through Kennedy's whole life, including his days in Harvard University, the presidential campaign, Project Apollo, Cuba Crisis and the assassination on November 22, 1963. Multimedia and web-based technologies are utilized within the museum, which include: 1) Vocal devices playing records of Kennedy's public speeches 2) LED screens showing records of historical events (the first televised presidential debate in 1960) 3) Digital signage and educational programs 4) touchscreen panels 5) website-based interactives.

As part of the Presidential Library System, J. F. Kennedy Presidential Museum has the partnership with another Presidential Library. Members of any President Library operated by the National Archives enjoy free admission upon entering J. F. Kennedy Presidential Library and

Museum. The Museum is financially supported by The John F. Kennedy Library Foundation. The Foundation assists the Museum in the planning and establishment of its long-term strategic goals and provides financial and creative resources. Its partnerships demonstrate the need to tap into similar industry-focused organizations for funding. (See Appendix E)

Worcester Art Museum & Worcester Historical Museum. Both the Worcester Art Museum (WAM) and Worcester Historical Museum are medium-sized museums located within Worcester, MA, with their focus on the preservation and education of art and history, respectively. Given these were both museums of exploration from the previous capstone, we thought it best to revisit each location and build of previous research conducted in Fall of 2017. WAM keeps 10-4 hours from Wednesdays-Sundays, while Worcester Historical Museum keeps hours from similar hours but Tuesday-Saturday, with hours extending on occasion due to special exhibitions or events, and both charge admission fees. Similarly, both museums offer present examples of organizations transitioning from traditional exhibit formats to include interactive functions throughout. As was seen in other museums as well, both museums offer examples of active partnerships with community agencies or local organizations which supplement their events and special exhibitions. Given the vast youth agencies located in Worcester coupled with the growing after-school programs, both museums have dedicated events to host children, with WAM holding sessions for family to view exhibits and then make their own art at the end of the tour and Worcester Historical Museum encouraging historical depictures during special events, then displaying children's examples.

Geared towards their newly adopted interactive approach, both museums offer hands-on activities to provide a stimulating and interactive experience for all age groups, with WAM also offering a mobile-audio tour and Worcester Historical Museum offering several interactive items

built into their exhibits. WAM has recently implemented a mobile-audio tour, which can be connected to through their website, in order to supplement their permanent exhibitions. It flows from floor to floor, with the choice of which exhibits to play audio files depending when you pass them. It offers an unobtrusive learning experience through audio files in order to supplement the visitors' visual experience, but it can be frustrating for visitors to constantly change exhibits on their phones. For the Worcester Historical Museum, the previous capstone team touched on their various wall displays accompanied by LED screens and interactive wall prompts as examples. We revisited such examples and confirmed the several exhibit items which provide this interactivity, including wall prompts, specimen drawers, punch-in clocks, button-prompted movie projections and payphone machines, were supplemented by events and exhibitions put on for the public. Both museums were able to tap into communal resources and populations in order to increase foot traffic, partnerships and community ties. (See Appendix E)

Product Cost Structures. Building off the previous capstone, our client preferred to receive explicit costs with the products we researched and found to be possibly options in future implementation. To best serve the needs of our client, our group created an automated excel spreadsheet where OHM can add their fixed costs in order to see the overall increase in their budget when viewing additional technology options to implement within a fiscal year. The Cost-Structure Spreadsheet (See Appendix) includes hardware/software, operations and administrative costs, with several subsets for each category of costs. Technology options we provided estimate costs for include the following:

1) AR (Augmented Reality) virtual tours
2) VR (Virtual Reality)
3) QR (Quick Response)

4) Website Infrastructure

5) Native Mobile App

6) Wayfinding/Navigational Floor

7) Display Cases with LEDs

The options with costs provided were chosen based on the initial agreement of technologies our group would explore, including AR, VR, QR, and website, coupled with explicit options that proved to be cost-effective and align with the OHM's strategy and mission.

Reviewing our cost-structure table, the options demonstrated for each category were the average of the cost-effective options available out on the market, where we will detail our general technological avenues. First looking toward VR, we assumed the only costs for this option would be $60 to purchase a VR headset, where the remaining operations and administrative costs were given $0 because Zeiss, parenting organization for OHM, already owns equipment and capability for creating VR tours. Second, AR costs were placed at $1100 overall, with $1000 cost stemming from development and another $100 for internet connectivity. Third, QR demonstrates a cost-effective approach with a small $100 maintenance fee, otherwise its use comes at a low to almost $0 price level. Fourth and finally, website costs were analyzed in regards to suggestions and alterations that can be made to the current OHM website, i.e. addition of video-based content, fixing links, etc. Costs for website updates totaled to $3,550, with $3,200 stemming from initial hardware and software purchasing, another $30 for software licensing and a final $320 for labor and IT operational costs.

Finally, the remaining three technological avenues covered within the cost structure involved specific products OHM should strongly consider implementing. The first of our recommended products is a Native Mobile app, with its total cost being $1200, however the set-

up fee is $900 with a $400 monthly maintenance fee. OnCell is the provider for this app, their fees are the costs listed within the cost structure table, and we thought it best to base our costs of OnCell to fall in line with our museum visitation, where this company provided the support and set up for the mobile app used in Manchester Millyard Museum. Second, we also strongly recommend OHM to consider implementing Wayfinding (Navigational) floors, which total a cost around $600-$800 for OHM, but vary in range depending on the size and complexity of the directional flooring a client wishes to order. Several companies in the region offering wayfinding flooring for such prices, including G-Floor & AlumiGraphic, C & G Partners, ICL Imaging, and DGI in Boston. Third and final, display cases with LEDs are our third recommendation to consider given the museum visitations proving this option to be a vital tools in museums. Costs for such cases vary, however the estimated costs for OHM ranges from $1,500 to $2,000, with materials starting at $1000 for a large case and $500 for a small case and operations stemming from annual use of light bulbs (See Appendix B).

Recommendations List. Based on the resource access, cost, and implementation length, our team developed and summarized recommendations for OHM, including short-term and long-term recommendations. Our Major recommendations will be discussed in the final section of our report, but several suggestions are available on our Recommendations List deliverables (see Appendix A) and deserve a quick overview. The first includes setting up an OHM gift shop. Based on other museums' experiences, gift shop could have extra incomes. For OHM, there is an extra room and the location of the room is close to the street, making it ideal for visitors to enter. The second includes a virtual tutorial scheme, which is relatively low cost with $1,120 setup fee. This program will be very good at capturing the attention of visitors, allowing them to immerse themselves in the knowledge of the exhibits, as well as extend the visitors' time in each

exhibition hall. Its disadvantage is its low implementation. The volunteer staff of the museum is relatively small, and it may require outsourcing its development, which will increase its costs. Other recommendations include re-organizing current exhibits to include either a hands-on function or interactive component. For example, several exhibits can be altered to fit this, including the drop-test machine to test strength of eye-glass wear, a microscope station where visitors can use the viewfinders, placing the town history book on a display pedestal, and several other suggestions which can be found in our Recommendations List (See Appendix A).

Limitations & Restrictions

Our project held unique protocols given restrictions placed on our group from the onset due to Zeiss's control over all marketing and publicity. Due to the levels of approval our group would have been forced to achieve to receive approval for any action in our project involving marketing or publicity, we shifted the scope of the project towards a research-based endeavor focusing on the physical space of the museum itself. This was the obvious restriction from the onset, however once our focus shifted to a literature and field-research strategy, we encountered several other limitations. Such limitations included the limited scholarly articles of the last 10 years regarding interactivity amongst small, suburban museums. Other limitations involved inability to meet one-on-one with most museum curators, geographical restrictions and the lack of physical meeting times with our client along with our commitments as students.

Looking towards our literature and website-based research, the obvious restriction our group faced was the lack of relevant research focusing on museum interactivity in small, suburban/rural museums. Peer-reviewed articles conducted their research in urban, large museums who were either funded by the state or wealthy, private investors. The lack of scholarly research led to our lack of emphasis on theories relevant to museum development. With the lack

of scholarly research, our group focused heavily on website-based research to fill in the gaps on AR, VR, QR, web-design and physical space trends within the industry. Overall, it was a small limitation that hindered our project slightly in linking best practices with a theoretical grounding.

What created continuous difficulty through our field-research involved in the proximity of museums we selected for visitation along with the geographical location of our client. Our group was fortunate to have access to private transportation, however our client's location of 30+ minutes away from Clark University limited our group to only a few visits for comparison and implementation-planning. Subsequently, the museums we selected for visitation were largely over New England, all within a 2 and half-hour driving distance of Clark University, however forced visitations to remain at one per museum. Accompanying geographical constraints, we were also not allotted funding to cover our transportation expenses or admission fees to the selected museums, which played a role in our visitations because college students typically are well-versed in budget-constraints when making financial decisions. Finally, through our visitations, our window of visitation spread over a 6-week period to visit seven museums. This time-frame played a detrimental role in our inability to meet the majority of museums' curators, and when meetings were procured with curators, almost all lacked the specific IT or financial knowledge on interactive exhibits within their museum.

Overall, geographical location and lack of relevant literature played a significant role in restricting our access to necessary resources. The final limitation we endured throughout the 12-week project involved our role as student-workers, where at times other commitments (i.e. class, family, emergency, etc.) restricted our meeting access and communication. Vacation breaks (spring break, Easter holiday) played a minor role in restricting meeting times as well. Finally, each of our group members held full-time status as students (i.e. minimum 3-course load) and

plan to graduate at the end of the semester or during the summer. Balancing other coursework along with job searching and post-graduation planning presented additional stresses, however our group managed all this well and provided necessary much needed support.

Chapter 5: Final Recommendations & Concluding Statements

Compiled throughout our capstone project involved an overwhelming amount of information, practices and products used within the museum industry, as demonstrated within the results section. From this research, we hoped to provide a guide to the relevant products being used in regional museums which OHM could benefit from using. Not only are certain products best suited for OHM, but capital budgeting opportunities are available within their own county to possibly tap into for sources of funding for these products. To give OHM a general direction of what this project demonstrates, we have the following 4 major recommendations they should pursue, ranging from short-term to long-term recommendations, but all relevant and of most importance in comparison to rest of our research being presented. Our 4 major recommendations are as followed:

1) Implementation of Wayfinding Flooring
2) Re-evaluation of Capital Budgeting Opportunities and Expansion of local Partnerships
3) Implementation of Online Exhibitions along with Website Updates
4) Design and Implement Mobile Tour Experience through QR Access

These four recommendations will be outlined with their benefits and reasons as to why each one deserves serious consideration and is best suited for OHM to implement.

Major Recommendation #1: Wayfinding Flooring

As touched on earlier, wayfinding flooring is a heavily utilized product and technique throughout many industries, especially the museum industry. Given the cost variability available for this product along with its functionality to stand alone within the museum or be coupled with audio software or a mobile tour guide, this product offers a great deal of upside for what OHM is hoping to accomplish. As touched on by Mr. Whitney and fellow employees, the hope is to

improve the museum's self-guide tour functionality and allow for visitors to meander through the museum without a formal tour while still receiving the full experience. Wayfinding flooring offers a short-term solution where durable directionals can be installed for under $1000 to complement the set-up of the museum. This product also offers a variety of stylistic options as well, allowing for various portrayals to fit what OHM is trying to accomplish for an atmospheric feel when touring the museum. Lastly, touched on briefly, the option to integrate such flooring with AR/VR technology or a mobile tour guide in the future is what sets this option apart. In order to create a fully self-guided mobile tour with maximum engagement, this option must be considered with our final recommendation to implement a mobile tour.

Major Recommendation #2: Capital Budgeting Opportunities & Partnerships

Our second recommendation involves two areas to assist in achieving the implementation of interactive exhibits and products within OHM. We strongly suggest that any accomplishment the listed recommendations within our attached deliverable will come only with a re-evaluation

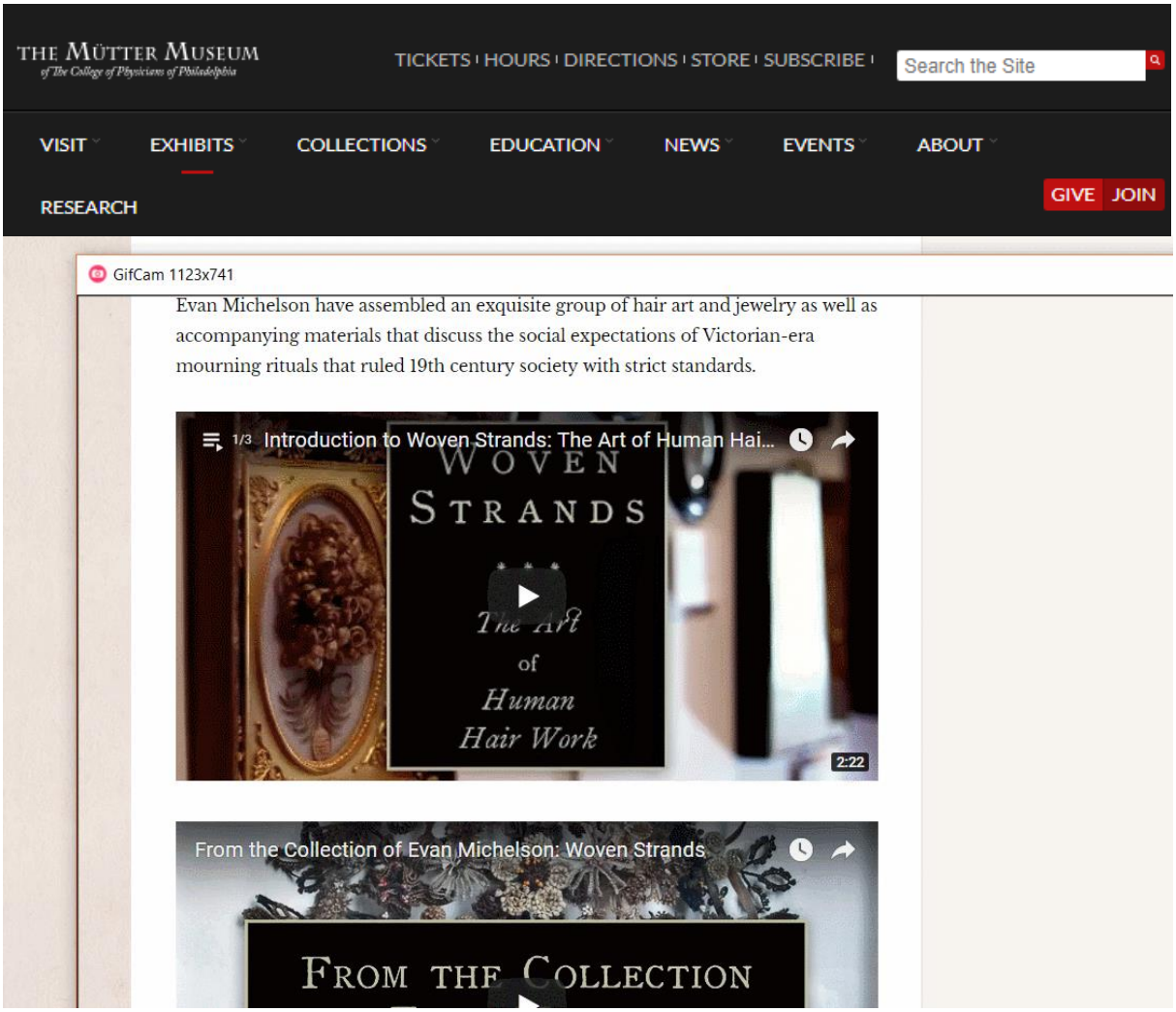
of capital budgeting opportunities within Worcester County along with exploration of new local partnerships is needed. First looking towards capital budgeting opportunities, as listed in our results section, there at minimum 5 available foundations or trusts willing to fund grant requests from museums. Even more importantly, both the George F. & Sybil H. Fuller Foundation and the Fred Harris Daniels Foundation have demonstrated recent support of local museum efforts within Worcester County, with the George & Sybil Fuller foundation funding $100,000 plus grants for both the Worcester Historical Museum and the Worcester Art Museum (See Appendix C). The remaining three foundations and trusts have demonstrated willingness to fund dozens of nonprofits throughout Worcester County over the past 3 years, with their grant programs including museums. With the attached funding profiles on each organization, the remaining groundwork is gathering the necessary application materials to be sent into the organization by the listed deadlines. This recommendation is critical to gain necessary funding for potential implementation plans of recommended technology products or to assist OHM in future expansion efforts.

Second, we urge OHM to tap into local institutions and organizations for possible partnerships to aid in their efforts to improve and implement interactive functions within the museum. Several institutions to possibly contact include: Southbridge Public Schools, Quinsigamond Community College Southbridge campus, Worcester Consortium Universities, Worcester Museums, local businesses and of course Clark University School of Professional Studies. Although some of the products in our recommendations list will require the work of independent contractors, a great deal of our recommendations could be achieved through the work power and intellectual ability of the mentioned institutions. For example, if OHM chooses to implement Wayfinding flooring, installation could be done by local volunteers from the

public-school system. Similarly, the moving of exhibits, re-designing of the flow and contents of each room within the museum could also be done with volunteer help. Looking towards the constructions of a mobile tour or website updates, contracting interns from local universities where students are in desperate need of internship experience would be beneficial to both parties. Even establishing partnerships with local business to do special-events or OHM sponsored nights would boost publicity within the town itself, drawing in local foot traffic within the museum. Without getting into all suggestions for partnerships and the benefits, OHM is only limited by its imagination when it comes to the use of possible partnerships.

Major Recommendation #3: Online Exhibitions & Website Updates

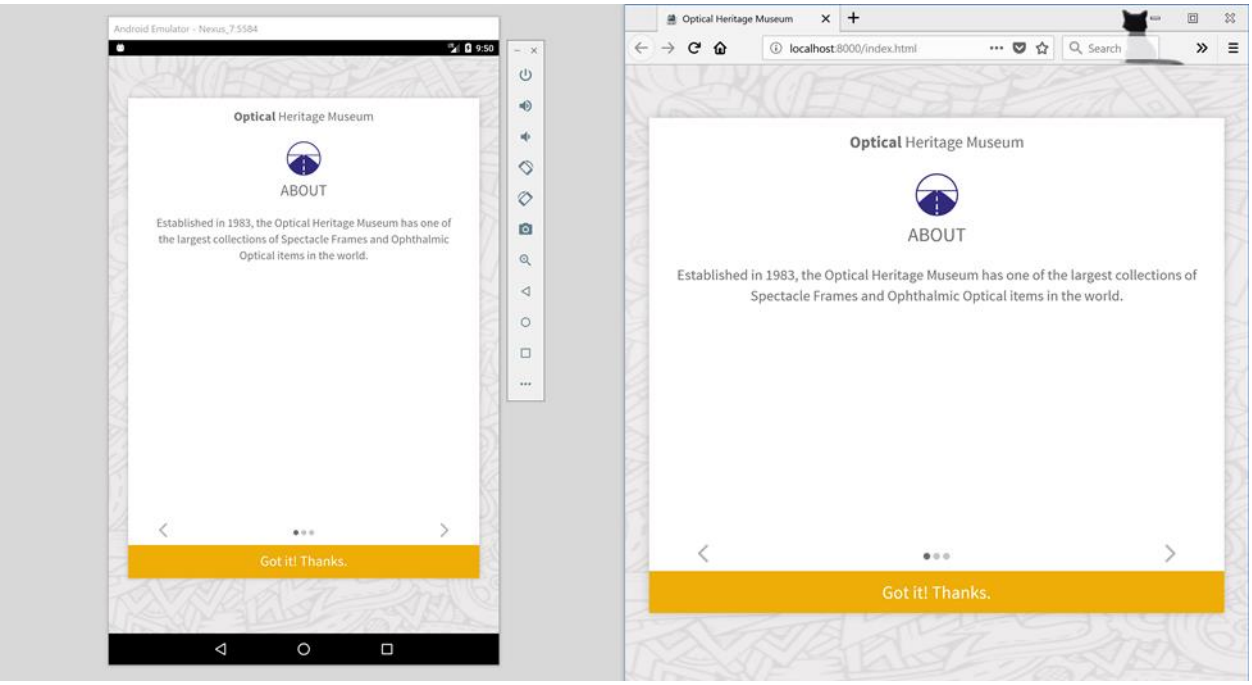
Explained within the results section, implementing use of online exhibitions for certain items and exhibits within OHM along with a few tweaks to the website would only benefit OHM and its publicity and reputation. Given that Zeiss manages OHM's publicity and website, there would seemingly be little cost to implementing these updates which are quick implementation strategies to increase the user-friendly experience all online visitors are looking for. Similarly, in order to draw in greater foot-traffic, embedding videos from Mr. Whitney's personal website would serve as a great reference and potential draw for online visitors wanting to schedule a tour or stop at the physical museum space. Finally, given the resources readily available to OHM for this recommendation along with the ease and cost-effectiveness of creating videos to be uploaded on the website, it would seem there nothing but upside to this plan. Below you will see an example of embedded videos from the Mutter Museum in Philadelphia.



Major Recommendation #4: Mobile Tour

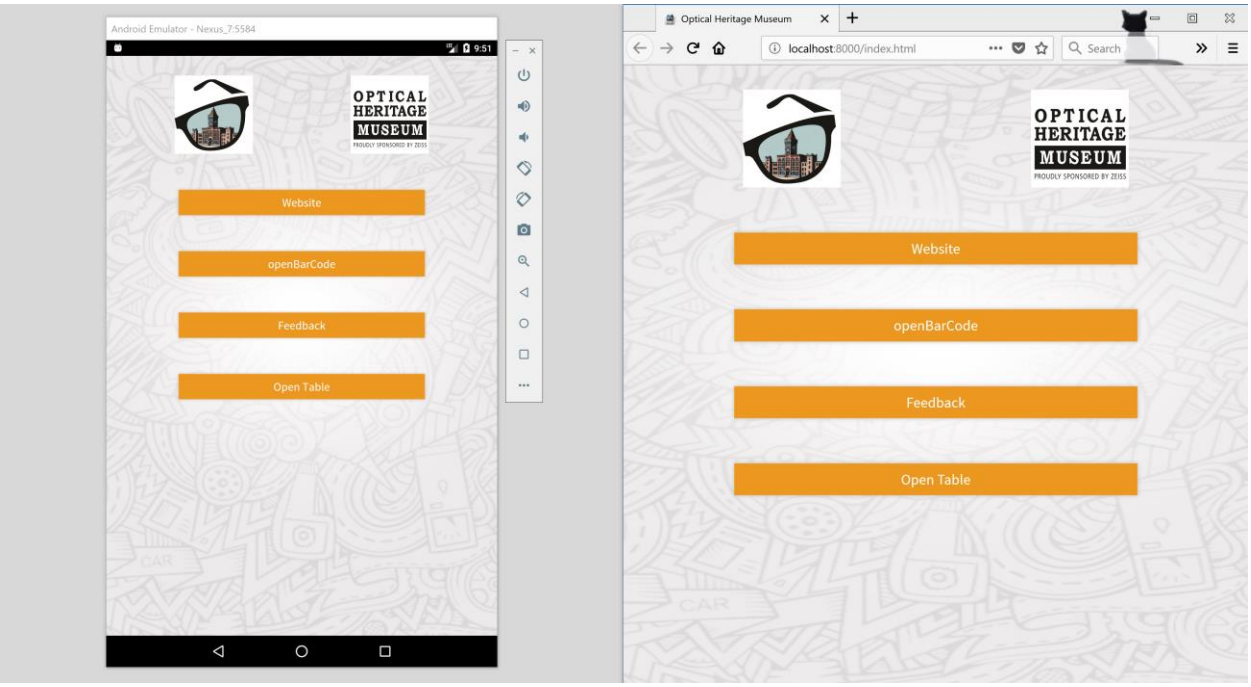
With the previous 3 recommendations being possibly short-term options, our fourth recommendation would be a long-term solution to address a few areas of concerns that both OHM and Mr. Whitney were vocal about. First, the first 3 recommendations were offered in support of a mobile tour, whether it be coupling navigational flooring with a mobile tour, accessing funding to pay for its development or link possible updated website features with the tour as well. From witnessing how regional museums incorporate such a tour successfully through cost-effective options, the option of constructing a mobile tour holds great appeal to OHM to solve a few of its challenges, including the limited self-guided nature of the museum

now without a formal tour. A mobile tour also solves the challenge of requiring staff on site to monitor visitors, it increases the interactive levels of the museum thus increasing engagement with exhibits and this option also offers the possibility of online visitors taking a demo tour to entice a physical visit to OHM.



As for the benefits of implementing a web-based mobile tour guide, there are few, which include no installation needed for a mobile app, it allows for real-time feedback, allows for easy updates and it creates a continuous connection with all online features available in the OHM website. With no installation required through a web-based mobile tour, visitors can simply scan a QR code at the beginning of the museum to prompt a link which contains the tour itself. Due to the link being connected to the website, online visitors may also experience the mobile tour before physically visiting OHM, giving them a sense of what to expect. As mentioned in museum visitation results, the Manchester Millyard Museum is using a similar tour with great success and virtually has decreased the necessity for person-guided tours. Similarly, through a web-based tour, its connectivity with the OHM website allows for continuous updates and direct

connection to any online exhibitions. Its web-based format also allows for feedback to be collected immediately and allows for functional expansion, such as partnering with the neighboring restaurant to have promotions from the Dark Horse tavern show up upon completion of the tour and show the menu of the restaurant as well.



Finally, the development of a mobile tour is feasible from several avenues, whether it is an independent contractor or a possible student intern from one of the local universities. As touched on earlier, OnCell provided the mobile tour for Manchester Millyard Museum for a $900 set-up fee with an additional monthly charge depending on the complexity of the app, thus an audio guided tour costs $99 per month, a lite tour version is $249 per month, and full mobile tour version will cost $399 per month (See Appendix B). On the other hand, our group has also established a demo version of the mobile tour and the variety of functions it can offer, which is backup with a manual of how to construct the mobile tour from scratch. The provision of this manual will allow future student interns the capability to set up a mobile tour and establish a beta version for OHM to possibly use. The drawback to keep in mind is maintenance and how would

it occur if the tour is set-up through student-driven internships. Overall, this option provides immense upside, particularly if OHM plans to expand and co-locate possibly down the road.

Major Takeaways

Beyond our major recommendations, we hope OHM is able take away a wealth of information not only on best practices used within the industry when implementing interactive products, but also what products are available and their costs, what other museums are using, where are potential capital budgeting opportunities, what are potential partnerships, and what improvements can be made according to an outsider's perspective. Ultimately, with the attached deliverables, we hope to give OHM a clear understanding of their current options and what possibilities can be explored. Along with everything presented in this document, we will also provide our client with a flash-drive of all electronic copies along with resources on such products, for example the overview of OnCell's mobile tour capabilities. Despite the amount of information, our constant communication with OHM and Mr. Whitney will serve as a guide as to what deliverables are of importance to first review and what should be given their full attention.

Group Takeaways

Needless to say, no members within our capstone team entered this project with previous experience on the museum industry. Each step taken throughout our project was new for everyone and provided the necessary enthusiasm and attention needed to complete such an in-depth project with countless hours of research, field work and deliverable development. Not only was our intellect tested but our group dynamics were forged through hard-work, long hours and multiple car rides to OHM and other museums. As a final project in the business world, our entire group must admit it was a challenging project but well worth the effort. We will never work on a similar project and will go our separate ways, but our work we accomplished

throughout this capstone experience will serve as a practical reference to how projects should be managed, how to rely on your team members positively and how to have fun doing it.

Conclusion

As a team, we addressed the multiple challenges facing Optical Heritage Museum and its staff, with a primary focus on providing resources necessary for immediate and future action to increase interactivity amongst the museum's exhibits. This report provides an overview of the challenges faced by OHM, the current literature on how interactive exhibits should be designed to achieve success, our project approach with results detailing all products found and museum notes relevant to the project, and our four major recommendations to our client. Through our web-based research and museum visitation experiences, our group created and developed several deliverables, including a comprehensive recommendations list, cost-structure chart with interactive products, funding profiles, regional museum checklist and a contact list for future resources (See Appendix G). Provided are short-term and long-term recommendations along with the necessary information to roll-out implementation such recommendations. We have high hopes the final product of this project will serve OHM and all staff well in their pursuits to expand and improve. We wish Optical Heritage Museum, its staff and all future partners the best in their endeavors.

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Appendix A: Recommendations List

(One to five-star rating, highest recommend: ★★★★★)

★= 1 star ☆= ½ star

Wayfinding floor/Navigational floor Feasibility: ★★★★★

- A more friendly and creative way of navigating visitors.
- Low cost and easy-to-implement.
- Floor graphic is flexible, and removable.
- Could be integrated with AR technology.

Re-evaluate 5-year plan Feasibility: ★★★★★

- Envision museum with interactive components incorporated
- Financial Information. (Donation & Sponsors)
- Expansion & Co-location

Zeiss Gift Shop Feasibility: ★★★★☆

- Already has a free space.
- Easy to get some optical models (glasses).
- T-shirts, hats, and bags with the signal of OHM.
- Use 3-D Zeiss capability to print gift shop items

Online Exhibits Publicizing Feasibility: ★★★★☆

- Publicizing exhibits.
- Added descriptions of each posted items.

Embedding Videos on Website Feasibility: ★★★★☆

- Embedding YouTube videos windows to website.
- Linking information from Mr. Whitney's personal website to OHM website.

Updating Current Exhibits with Interactive Function Feasibility: ★★★★☆

1) Drop-Ball Test
   - Already have metal ball kits
   - Easy set up
   - Zeiss may help provide glasses
2) Microscope Station
   - Set up one or to Microscopes with samples (e.g. Blood cells, vege cells)
   - Enrich Interactive activities.
3) Optical Illusion Room
   - Mirrors facing each other
   - Utilize current illusion exhibits
4) Town History Book on Display
   - Using Pedestal for display

- ❖ Allowing visitors to flip through pages

5) Eye-exam through current lensometers (20th century and 21st century models)
- ❖ set up eye exams during events
- ❖ create a self-operational lensometer with directions if possible

6) Setting up Othalmeter for use
- ❖ Similar directions as above

7) Creating WWII Eyeglass Wearing Station
- ❖ Keep Display, take a few pairs for interaction
- ❖ Tag some with descriptions
- ❖ Offer visitors chance to try on a few and take pictures

Partnering with local Educational Institutions Feasibility: ★★★★

- ❖ Partner with locale public schools.
- ❖ Partner with local QCC campus.
- ❖ Look into postings for volunteer work.
- ❖ Look into possible volunteer work postings at Universities within driving distance to contract students who wish to develop/code software.

Reforming Website Functions Feasibility: ★★★★

- ❖ Fixing broken links.
- ❖ Combining similar functions.
- ❖ Embedding google street view window on website instead of a link.
- ❖ More visible social media links.

Display cases with LED lighting Feasibility: ★★★★

- ❖ Help re-organize exhibits and give visitors a clear logic of how exhibits are organized.
- ❖ Create a better atmosphere of museum.
- ❖ LEDs are energy-efficient comparing with traditional lighting.
- ❖ Can be integrated with QR code scanning, LED screen, audio device or any other electronic devices.
- ❖ Will store less exhibits.

Laser Line Lens Reflection Feasibility: ★★★☆

- ❖ Laser can be cost-effective.
- ❖ Already introduced by Mr. Whitney's.
- ❖ Would fit in well with their interactive room initiative.

Mobile App Tour Implementation Feasibility: ★★★

- ❖ Creating mobile tour.
- ❖ Creating application for phone/website.
- ❖ Creating supplemental videos/audio files.
- ❖ Look into IBeacon technology.

A Virtual Tutorial Feasibility: ★★★

- ❖ Free to install the AR editor.
- ❖ Need Windows operating system.
- ❖ Free 3D model narrators downloads from websites.
- ❖ No high technique requirements.

VR Headset Feasibility: ★★☆

- ❖ Relatively cheap.
- ❖ Must be compatible with company or visitor's phone.
- ❖ Creating video is expensive/large up-front cost with little return.

Appendix B: Product Cost Structures

AR Virtual Tutorial COSTS	Cost ($)	VR COSTS	Cost ($)	QR COSTS	Cost ($)
Hardware and software		**Hardware and software**		**Hardware and software**	
Application device (Visitors' phones)	$0	Samsung Gear VR Headset	$60	Initial hardware and software purchases	$0
Development equipment (Windows System)	$1,000	lease costs	$0	lease costs	$0
Development Platform (ARVR Editor)	$0	Software licensing	$0	Software licensing	$0
Development Resources (3D models and audio record)	$0	Subscriptions	$0	Subscriptions	$0
Operations		Maintenance contracts	$0	Maintenance contracts	$100
Labor costs for IT operations	$0	Extended warranties	$0	Extended warranties	$0
Outside service providers	$0	Set-up fees	$0	Set-up fees	$0
Facilities costs used by IT staff	$0	Supplies	$0	Supplies	$0
Network costs	$0	Materials	$0	Materials	$0
Internet connectivity	$100	Spare parts	$0	Spare parts	$0
Administration		**Operations**		**Operations**	
Finance	$0	Labor costs for IT operations	$0	Labor costs for IT operations	$0
HR	$0	Outside service providers	$0	Outside service providers	$0
Administration	$0	Facilities costs used by IT staff	$0	Facilities costs used by IT staff	$0
Procurement costs	$0	Network costs	$0	Network costs	$0
Staff training	$0	Internet connectivity	$0	Internet connectivity	$0
		Administration		**Administration**	
		Finance	$0	Finance	$0
		HR	$0	HR	$0
		Administration	$0	Administration	$0
		Procurement costs	$0	Procurement costs	$0
		Staff training	$0	Staff training	$0
Total AR Virtual Tutorial costs	**$1,100**	**Total VR costs**	**$60**	**Total QR costs**	**$100**

Website COSTS	Cost ($)	Native Mobile App (OnCell)	Cost ($)	Wayfinding floor COSTS	Cost ($)
Hardware and software		**Set-up Fee**	$900	**Hardware and software**	
Initial hardware and sofware purchases	$3,200	**Maintenance (Monthly)**	$99-399	Planning/Design	$200 or included
lease costs	$0	Audio Level	$99	Materials	$200-300 (for a 3,000-3,500 sq. ft space)
Software licensing	$30	Lite Level	$249	Set-up fees	$200-300 (for a 3,000-3,500 sq. ft space)
Subscriptions	$0	Pro Level	$399	**Operations**	
Maintenance contracts	$0	**Administration**	$0	Maintenance (within 10 years)	-
Extended warranties	$0			Maintenance (More than 10 years)	$600
Set-up fees	$0			**Administration**	
Supplies	$0				
Materials	$0			**Products & Businesses**	
Spare parts	$0			1. G-Floor and AlumiGraphic by MX Display	
Operations				2. FloorTac, Protac and Interlam Pro Emerytex - DRYTAC	
Labor costs for IT operations	$320			3. Corporate & Environmental Graphics - DGI, Boston MA	
Outside service providers	$0			4. Museum Graphics - ICL IMAGING, FRAMINGHAM, MA	
Facilities costs used by IT staff	$0			5. Signage system - Absolute Museum & Gallery Products	
Network costs	$0			6. C & G Partners	
Internet connectivity	$0				
Administration					
Finance	$0				
HR	$0				
Administration	$0				
Procurement costs	$0				
Staff traning	$0				
Total Website costs	**$3,550**	**Native Mobile App costs (OnCell)**	**$1000-$1300**	**Total costs**	**$600 - $800**

Display Cases with LEDs COSTS	Cost ($)
Hardware and software	
Planning/Design	-
Materials (big case 40" - 50" Wide x 70" - 80" High)	$1,000 - $2,000/unit
Materials (small case)	$500 - $1,000/unit
Materials (LED bulb)	$5 - $10/1W-5W bulb
Operations	
Electricity cost	$5/year/1W-5W bulb
Administration	
-	
Products & Businesses	
1. SmallCorp, Greenfield, MA	
2. PACIFIC STUDIO	
3. Helmut Guenschel, Inc.	
4. UNIVERSITYPRODUCTS	
5. Display Cases - Display2go	
6. Gaylord	
7. LED signage - Mandex	
Total costs	**$1,500 - $ 2,000**

Appendix C: Capital Budgeting Profiles

The George I. Alden Trust

A. **Which online database/directory you used:** Foundation Directory

B. **Name and location of funder:** The George I. Alden Trust, Worcester, MA

C. **Website, url:** http://www.aldentrust.org/

D. **Types of programs they fund:**
   i. Community improvement
   ii. Diseases and conditions
   iii. Education
   iv. Education services
   v. Elementary and secondary education
   vi. Higher education
   vii. Human services
   viii. Interfaith
   ix. Museums
   x. Performing arts
   xi. Special population support
   xii. Undergraduate education
   xiii. University education
   xiv. Vocational education

E. **Types of support they provide:**
   i. Capital and infrastructure
   ii. Capital campaigns
   iii. Continuing support
   iv. Endowments
   v. Equipment
   vi. General support

F. **Grant application requirements:** Applicants are encouraged to contact the trust by telephone, email, or make a visit, prior to submitting an application. Application form not required.

G. **Applicants should submit the following:**
   i. **Initial approach:** Proposal with cover letter

ii. Copy of IRS Determination Letter
iii. Timetable for implementation and evaluation of project
iv. Listing of additional sources and amount of support
v. Listing of board of directors, trustees, officers and other key people and their affiliations
vi. Contact person
vii. Brief history of organization and description of its mission
viii. Detailed description of project and amount of funding requested
ix. Copy of current year's organizational budget and/or project budget

H. **Grant application deadlines:** Feb. 15, May 15, Aug. 15, and Nov. 15

I. **What other organizations they have funded in the last few years:**

i.	Abby's House, Worcester, MA	15,000
ii.	American Cancer Society, Framingham, MA	15,000
iii.	ArtsWorcester, Worcester, MA	15,000
iv.	CASA Project, Inc., Worcester, MA	15,000
v.	Children's Friend, Inc., Worcester, MA	15,000
vi.	Community Harvest Project, Inc., North Grafton, MA	15,000
vii.	Dismas House, Worcester, MA	15,000
viii.	Family Services of Central Massachusetts, Worcester, MA	15,000
ix.	Genesis Club, Inc., Worcester, MA	15,000
x.	Greater Worcester Land Trust, Worcester, MA	15,000
xi.	Horace Mann Educational Associates, Worcester, MA	15,000
xii.	Jeremiah's Inn, Worcester, MA	15,000
xiii.	Lutheran Social Services of New England, Worcester, MA	15,000
xiv.	Main South Community Development Corporation	15,000
xv.	Mass Humanities, Northampton, MA	15,000
xvi.	Music Worcester, Worcester, MA	15,000
xvii.	NEADS, West Boylston, MA	15,000
xviii.	Rachel's Table, Worcester, MA	15,000
xix.	Regional Environmental Council, Inc., Worcester, MA	15,000
xx.	Salvation Army, Worcester, MA	15,000
xxi.	Stone Soup Artists and Activists Collective, Worcester, MA	15,000
xxii.	Tenacity, Inc., Shrewsbury, MA	15,000
xxiii.	Veterans, Inc., Worcester, MA	15,000
xxiv.	Wachusett Greenways, Holden, MA	15,000
xxv.	Worcester Animal Rescue League, Worcester, MA	15,000
xxvi.	Worcester Children's Chorus, Worcester, MA	15,000

xxvii.	Worcester Community Housing Resources, Inc., Worcester, MA	15,000
xxviii.	Worcester County Food Bank, Shrewsbury, MA	15,000
xxix.	Worcester Youth Center, Worcester, MA	15,000
xxx.	YouthNet Worcester, Worcester, MA	15,000

J. Grant Range: For a community non-profit organization, on average $15,000.

(Smiley et al. 2017)

The Stoddard Charitable Trust

A. Which online database/directory you used: Foundation Directory

B. Name and location of funder: The Stoddard Charitable Trust, Worcester, MA

C. If they have a website, url: None

D. Types of programs they fund:

a. Subjects:

i. Art museums
ii. Arts and culture
iii. Basic and emergency aid
iv. Botanical gardens
v. Child welfare
vi. Community and economic development
vii. Community improvement
viii. Diseases and conditions
ix. Education
x. Elementary and secondary education
xi. Environment
xii. Higher education
xiii. Housing development
xiv. Human services
xv. Mental health care
xvi. Museums
xvii. Natural resources
xviii. Performing arts
xix. Shelter and residential care
xx. Youth development

b. Population groups:

i. Children and youth
ii. Economically disadvantaged people
iii. Low-income and poor people

E. Types of support they provide:

i. Annual campaigns
ii. Capital and infrastructure
iii. Capital campaigns
iv. Continuing support

v. Emergency funds
vi. Equipment
vii. General support
viii. Land acquisitions
ix. Program development
x. Seed money

F. Grant application requirements: Initial approach by telephone is recommended for potential new grant recipients or letter to the trust. Application form not required.

a. Applicants should submit the following:
i. Copy of IRS Determination Letter
ii. Detailed description of project and amount of funding requested
iii. Brief history of organization and description of its mission
iv. Copy of most recent annual report/audited financial statement/990
v. Copies of proposal: 5

G. Grant application deadlines: Mar. 1, June 1, Sept. 1, and Dec. 1

H. What other organizations they have funded in the last few years:
i. CASA
ii. Quinsigamond Community College
iii. Genesis Club
iv. Worcester Youth Center
v. Worcester State University

I. Grant Range: $10,000 (from information found in grantees annual reports)

(Smiley et al. 2017)

The George F. and Sybil H. Fuller Foundation

A. Which online database/directory you used: Foundation Directory

B. Name and location of funder: The George F. and Sybil H. Fuller Foundation, Worcester, MA

C. If they have a website, url: http://www.gsfullerfoundation.org/

D. Types of programs they fund:

a. Subjects:

i. Arts and culture
ii. Christianity
iii. Diseases and conditions
iv. Education
v. Elementary and secondary education
vi. Graduate and professional education
vii. Health
viii. Higher education
ix. Historic preservation
x. Historical activities
xi. Human services
xii. Museums
xiii. Performing arts
xiv. Rehabilitation
xv. Shelter and residential care
xvi. Special population support
xvii. Undergraduate education
xviii. University education
xix. Youth development

b. Population Groups:

i. Academics
ii. Children and youth
iii. Economically disadvantaged people
iv. Low-income and poor people
v. Students

E. Types of support they provide:

i. Annual campaigns
ii. Capital and infrastructure

iii. Capital campaigns
iv. Continuing support
v. Emergency funds
vi. Equipment
vii. Individual development
viii. Land acquisitions
ix. Program development
x. Research
xi. Scholarships
xii. Seed money

F. Grant application requirements: Application form not required.

a. Applicants should submit the following:
   i. Initial approach: Letter of inquiry or telephone inquiry
   ii. Copy of IRS Determination Letter
   iii. Copy of most recent annual report/audited financial statement/990
   iv. Signature and title of chief executive officer
   v. Listing of board of directors, trustees, officers and other key people and their affiliations
   vi. Copy of current year's organizational budget and/or project budget
   vii. Copies of proposal: 1

G. Grant application deadlines: None

a. Board meeting date(s): Feb., Apr., June, Aug., Oct., and Dec.

H. What other organizations they have funded in the last few years:

a. Capital Grants:

i.	American Antiquarian Society	$50,000
ii.	Bancroft School	$75,000
iii.	Be Like Brit	$2,500
iv.	Be-Like-Brit	$19,000
v.	Berlin Memorial School PTO	$1,000
vi.	Boylston Public Library	$100,000
vii.	CASA Project	$5,000
viii.	Central Mass Chabad	$5,000
ix.	Clark University	$150,000
x.	Easter Seals	$10,000
xi.	EcoTarium	$100,000
xii.	Edward M. Kennedy Health Center	$25,000
xiii.	Family Services of Worcester	$10,000

xiv.	First Congregational Church, Boylston	$40,000
xv.	First Congregational Church, Boylston	$10,000
xvi.	Hillside Restoration Project	$1,000
xvii.	Mass Symphony Orchestra	$15,000
xviii.	Mechanics Hall	$25,000
xix.	Old Sturbridge Village	$50,000
xx.	Quinsigamond Community College	$150,000
xxi.	Rainbow Child Development	$10,000
xxii.	Reliant Group Foundation	$50,000
xxiii.	St. John's High School	$50,000
xxiv.	Stoneleigh-Burnham School	$7,000
xxv.	Temple Emanuel Sinai	$50,000
xxvi.	The Hanover Theater	$100,000
xxvii.	Tower Hill Botanical Garden	$25,000
xxviii.	United Way of Central MA	$55,000
xxix.	WBDC (New Garden Park)	$100,000
xxx.	Worcester Education Development Foundation	$5,000
xxxi.	Worcester Education Development Foundation	$15,000
xxxii.	Why Me & Sherry's House	$5,000
xxxiii.	Worcester Art Museum	$250,000
xxxiv.	Worcester Historical Museum	$150,000
xxxv.	Worcester State University	$100,000
xxxvi.	WPI	$200,000
xxxvii.	YMCA of Central MA	$250,000

l. **Grant Range:** $2,500 to $250,000

(Smiley et al. 2017)

Wyman-Gordon Foundation

A. Which online database/directory you used: Foundation Directory

B. Name and location of funder: Wyman-Gordon Foundation, Worcester, MA

C. If they have a website, url: None

D. Types of programs they funds:

a. Subjects:

i. Arts and culture
ii. Basic and emergency aid
iii. Biodiversity
iv. Community and economic development
v. Community improvement
vi. Diseases and conditions
vii. Economic development
viii. Education
ix. Higher education
x. Hospital care
xi. Housing development
xii. Human services
xiii. Museums
xiv. Nonprofits
xv. Performing arts
xvi. Public policy
xvii. Shelter and residential care
xviii. Special population support
xix. Youth development

b. Population Groups:

i. Children and youth
ii. Economically disadvantaged people
iii. Low-income and poor people

E. Types of support they provide:

i. Capital and infrastructure
ii. Capital campaigns
iii. Continuing support
iv. Equipment

v. Regranting

F. Grant application requirements:

i. **Initial approach:** Proposal
ii. Application form required.
iii. Applicants should submit the following:
iv. Detailed description of project and amount of funding requested
v. Copies of proposal: 3

G. Grant application deadlines: None

H. What other organizations they have funded in the last few years:

i. Although the Foundations directory shows that the Wyman-Gordon Foundation has funded many nonprofits over the last few years the only organization the HILC Employee team could find information on is the The Hanover Theater

I. Grant Range: $5,000-$100,000

(Smiley et al. 2017)

The Fred Harris Daniels Foundation, Inc.

A. Which online database/directory you used: Foundation Directory

B. Name and location of funder: The Fred Harris Daniels Foundation, Inc. Worcester, MA

C. If they have a website, url: http://danielsfoundation.org/

D. Types of programs they fund:

a. Subjects
   i. Abuse prevention
   ii. Arts and culture
   iii. Basic and emergency aid
   iv. Botanical gardens
   v. Diseases and conditions
   vi. Education
   vii. Education services
   viii. Elementary and secondary education
   ix. Employment
   x. Environment
   xi. Food aid
   xii. Historic preservation
   xiii. Housing development
   xiv. Human services
   xv. Medical support services
   xvi. Mental health care
   xvii. Museums
   xviii. Natural resources
   xix. Nonprofits
   xx. Performing arts
   xxi. Rehabilitation of offenders
   xxii. Shelter and residential care
   xxiii. Special population support
   xxiv. Sports and recreation
   xxv. Youth development
   xxvi. Youth organizing

b. Population Groups:
   i. Academics
   ii. Children and youth

iii. Economically disadvantaged people
iv. Low-income and poor people
v. Students

E. Types of support they provide:

i. Annual campaigns
ii. Capital and infrastructure
iii. Capital campaigns
iv. Continuing support
v. Emergency funds
vi. Equipment
vii. General support
viii. Land acquisitions
ix. Program development
x. Scholarships

F. Grant application requirements: Online Application form required.

i. **Initial approach:** Online application

G. Grant application deadlines: None

a. Board meeting date(s): Mar., June, Sept., and Dec.

H. What other organizations they have funded in the last few year:

i.	ACE Family Education & Outreach Program	5,000
ii.	American Antiquarian Society	145,000
iii.	American Red Cross of Central MA	10,000
iv.	Appalachian Mountain Club	2,500
v.	Barton Center for Diabetes Education Inc.	5,000
vi.	Big Brothers Big Sisters Central Mass/Metrowest, Inc.	10,000
vii.	Bottom Line, Inc.	4,000
viii.	Community Harvest Project	20,000
ix.	Community Servings, Inc.	10,000
x.	Discovery Museums, Inc.	3,000
xi.	Dismas House of Massachusetts, Inc.	10,000
xii.	Easter Seals Massachusetts, Inc.	5,000
xiii.	First Night Worcester Inc.	3,000
xiv.	Genesis Clubhouse, Inc.	7,500
xv.	Girl Scouts of Central and Western Massachusetts, Inc	3,000
xvi.	Greater Worcester Land Trust, Inc.	2,500
xvii.	Horizons for Homeless Children, Inc.	5,000
xviii.	Jeremiah's Inn	7,500
xix.	Joy of Music Program, Inc.	6,000

xx.	Literacy Volunteers of Greater Worcester	5,000
xxi.	Massachusetts Audubon Society Inc.	11,000
xxii.	Massachusetts Symphony Orchestra Inc.	5,000
xxiii.	Music Worcester Inc.	5,000
xxiv.	National Education for Assistance Dog Services, Inc.	10,000
xxv.	Nativity School of Worcester, Inc.	10,000
xxvi.	Network for Teaching Entrepreneurship	7,500
xxvii.	Nichols College	200,000
xxviii.	Old Sturbridge, Inc.	10,000
xxix.	Pakachoag Music School of Greater Worcester	3,000
xxx.	Parents Helping Parents, the Roundtable of Support Inc.	3,000
xxxi.	Pathways for Change, Inc.	7,500
xxxii.	Princeton Land Trust	10,000
xxxiii.	Quinsigamond Community College Foundation, Inc.	60,000
xxxiv.	Rachel's Table (FS)	10,000
xxxv.	Rainbow Child Development Center	4,000
xxxvi.	Regional Environmental Council, Inc.	15,000
xxxvii.	Salisbury Singers, Inc.	1,000
xxxviii.	Seven Hills Foundation	5,000
xxxix.	Straight Ahead Ministries, Inc.	7,500
xl.	The CASA Project, Inc.	7,500
xli.	The Community Builders, Inc.	3,000
xlii.	The Health Foundation Fund	75,000
xliii.	VNA Care Network, Inc	10,000
xliv.	Why Me, Inc.	7,500
xlv.	Worcester Chamber Music Society	3,500
xlvi.	Worcester Children's Chorus	2,000
xlvii.	Worcester County Horticultural Society	5,000
xlviii.	Worcester Interfaith	7,500
xlix.	Worcester Natural History Society dba EcoTarium	5,000

l. **Grant Range:** $1,000-$150,000

(Smiley et al. 2017)

Appendix D: Museum Visitation Checklist

Museum Visitation Checklist	Navigational Directioning	Audio Aids	VR/AR	LED Displays	Mobile Tour	Co-Location Partnerships	Events/ Exhibitions	Hands-On Exhibits
Manchester Historical Museum	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Boston Museum of Science	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Worcester Art Museum	No	No	No	Yes	Yes	Yes	Yes	Yes
Worcester Historical Museum	Yes	Yes	No	Yes	No	Yes	Yes	Yes
Harvard Fogg Museum	Yes	No	No	Yes	No	Yes	Yes	Yes
JFK Presidential Museum	No	Yes	No	Yes	no	Yes	Yes	Yes

Appendix E: Museum Visitations Notes

Boston Museum of Science

1. Display/Organization of Exhibits (i.e. Navigational flooring, Audio

Cartoon map sign on the wall with audio at the entry to introduce the background of the museum..
Each hall has a signage to main dispaly area.
Every exhibit has audio descriptions.
The entire museum is divided into three modules: Green Wing, Blue Wing, and Red Wing.
Tall glass and wood display cases to put items.(Space saving, easy managing.)
Each dispaly has one or more interavtive games for visitor.

2. Technology being used (i.e. app guiding tour, VR helmet)

Every Exhibition has a audio guide(Pick up a phone and hit the button)
It has 4-D Theater.
VR machine for some diplay cases: View pictures of the display case and each item on picture can be selected by touch the screen to get the info.

3. Interactive function (what is interactive and what is its purpose)

Visitors can experience scientific principles and build dynamic models by themselves (e.g. Engineer a bridge support, Yawkey Gallery on the Charles River)
It has a Particle Mirror exhibit. Viewers can make physically interact with the simulations they creats.
Card games(e.g.Find the difference,Matching items, Sorting samples)
Visiual arts: (e.g.llusion pictures, projection of llusion items, Shadows, laser)

4. Why this specific exhibit?

Each exhibition hall is very attractive, each theme has models and games for visitors to experience
For the VR machines because the room or case include a lot items, the space is not enough for all information of items on display.This a space saving measure.
Interactive games or machines: The intention of this museum is for visitor to learn scientific knowledge, therefore they provide interactive function for them to put the theory into practice.
audio tour: Vivider than text only, friendly for reading disorders.

5. Institutional Partnerships

MathWorks
Media paetner: WCVB
MIT

6. Exhibit Layouts

Many floor-standing glasses showcases make exhibits look very tidy. The placement of exhibits on different themes is very concentrated. Visitors will not be easy to feel confused.

7. Events/Marketing

It has different live presentations through Monday to Friday, weekends, school vacation week, and holidays.
When purchasing the tickets, machines ask for the donation.
Cooperated with Boston Marathon.

8. Anything Else?

The museum's location is very good. It is next to the Charles River. Boston Duck Tours as a Boston tourism project can attract more visitors to this museum.

Harvard Fogg Museum

1. Display/Organization of Exhibits (i.e. Navigational flooring, Audio

Handheld map to be used for directions
No hard and fast rule to walk around
Different sections dedicated for different genres of exhibits

2. Technology being used (i.e. app guiding tour, VR helmet)

No publicly available usage of technology
Only use of technology was with XO game at top floor

3. Interactive function (what is interactive and what is its purpose)

There was no interactive item except the XO game at the top floor

4. Why this specific exhibit?

It had different sections in which they had simulated different kinds
Of persons playing the game such as CPU vs CPU, CPU vs kid,
CPU vs real person

5. Institutional Partnerships

They have partnership with Harvard university by which the students
Get OFF on the admission fees

6. Exhibit Layouts

The layouts were enough spaced
The on-wall printing was very well written

7. Events/Marketing

Different events can be arranged for arts students.
There were special rooms where the students could be taught about
The different colors

8. Anything Else?

They lacked directional flow and too many employees were needed to guard , almost each room had dedicated person

Manchester Historical Association

1. Display/Organization of Exhibits (i.e. Navigational flooring, Audio)

No formal navigational flooring, but exhibits set up in chronological order and wrapped around museum
Several audio-speakers started by button on exhibits
Waterpower exhibit which demonstrated water flow through moving light-up mechanism

2. Technology being used (i.e. app guiding tour, VR helmet)

Mobile audio tour via QR scan covering all exhibits (https://millyard.oncell.com/en/index.html)
Several TV's with reels playing on loops (included live accounts, historical overview of some exhibits, live-action clips)
Waterpower exhibit using live-motion screen of how water flowed
Wall-of-fame included several mystery spots, light up character and get audio with push of button

3. Interactive function (what is interactive and what is its purpose)

Mobile app with pictures, descriptions, and audio
Buttons with exhibits and audio
Hands-on activities (i.e. brick building, matching game)
Wall of fame which included audio recordings of certain figures along with light up image of characters throughout history

4. Why this specific exhibit?

Exhibit for waterpower visual mechanism was implemented because its visual demonstration was necessary to showcase the effect waterpower generators had on the Merrimack river
Two building exhibits were implemented to give children some opportunities
Wall of Fame implemented light up screen and audio recordings to serve as a last point of reference as you walk in and walk out

5. Institutional Partnerships

Manchester Historical Association
City of Manchester

6. Exhibit Layouts

Designed to create a horseshoe flow in chronological order
Mobile app labeled all exhibits in chronological order
Prominent figures were kept to one side of the hallway and the descriptive exhibits off to the other
Last bit of museum layout was confusing about where to go/where the end was

7. Events/Marketing

None looked into

8. Anything Else?

Mobile app is a marquee feature of the museum which is set up with QR and business card for visitors
Museum is co-located with other museums/organizations in the factory buildings of Manchester
Central intake office as soon as you walk in where the gift shop is located
Tours offered but not popular, mostly shifted towards mobile app which also has headphones offered by the

JFK Presidential Museum

1. Display/Organization of Exhibits (i.e. Navigational flooring, Audio

All exhibits are organized in a chronological order, and are placed in independent exhibition areas to show the major events and important life stage of J.F. Kennedy (e.g., his life in Harvard, the presidential election, time in White house) **see appendix 1-1**

Exhibits include historical images, video and audio records, copy of documents, duplicates of things his used (e.g., pen, cloths, gifts received). **See appendix 1-2 1-3 1-4**

2. Technology being used (i.e. app guiding tour, VR helmet)

LED Screen (to show video records of some historical events)

Vocal devices (look like a telephone receiver) which could play the record of Kennedy's public speaking. **See appendix 2-1**

A theater for viewing a 20-minute introductory film about JFK. **Appendix 2-2**

Digital signage and educational programs (require sign-up)

A list of web-based interactives: https://www.jfklibrary.org/Exhibits/Interactives.aspx

No smartphone app guiding

No VR-, AR- or QR code-based technology

3. Interactive function (what is interactive and what is its purpose)

Every exhibition room has a touch screen panel for visitors to know more relevant information. **Appendix 3-1**

Telephone receiver-like vocal device designed to make visitors feel like J.F.Kennedy is really talking to them on the other side of the telephone.**Appendix 3-2**

Brought back of some famous historical scenes (e.g., the television debate between JFK and Nixon, the Oval Office during Kennedy's presidency) **Appendix 3-3**

4. Why this specific exhibit?

The display of exhibits is well-organized and well-designed, and many visual information (images, video records) are used for a better understanding. Visitors would have a clear logic of what is displayed and why it is displayed. They won't feel overwhelmed or be distracted.

The interior decoration of the museum is accordance with Kennedy's time (60s, 70s American style), giving visitors a strong feeling of flashback. See **appendix 4-1**

5. Institutional Partnerships

JFK Library Foundation, a non-profit organization that provides financial support, staffing, and creative resources for the John F. Kennedy Presidential Library and Museum.

Edward M. Kennedy Institute

EBT Card to Culture https://www.mass.gov/ebt-card-to-culture

Members of J.F.Kennedy Presidential Museum enjoy free admission to all reciprocal Presidential Libraries

6. Exhibit Layouts

A one-way layout with no many wayfinding signs on the wall or floor. Visitors sometimes might be coufused about where they are heading.

See **appendix 5-1, 5-2** for a map of J.F.K Presidential Museum

7. Events/Marketing

Kennedy Library Forums https://www.jfklibrary.org/Events-and-Awards/Forums.aspx

Celebrate! Events https://www.jfklibrary.org/Events-and-Awards/Celebrate.aspx

John F. Kennedy New Frontier Awards® https://www.jfklibrary.org/Events-and-Awards/New-Frontier-Award.aspx

List of social media & Apps https://www.jfklibrary.org/About-Us/Social-Media.aspx

8. Anything Else?

The Museum locates inside the campus of UMass. College and University students in MA enjoy a discounted admission fee.There is a pavilion on the ground floor which has a good open view of Boston seaside. Many visitors come here to take pictures.

Appendix F: Mobile Tour Guide Manual

Manual

Installing Cordova

Cordova command-line works on Node.js and is available on NPM. Follow platform specific guides to install additional platform dependencies. Open Terminal and type

npm install -g cordova.

Example: $ npm install -g cordova

Create a project

Create a blank Cordova project using the command-line tool.

For a comprehensive set of options, type Cordova help create.

Example: $ cordova create OHM_Project

Add a platform

After building a Cordova project, navigate to the project directory. From the project directory, you require adding a platform for which you want to build your app.

To add a platform, type cordova platform add <platform name>.

For a complete list of platforms, you can add, run Cordova platform.

Example: $ cd OHM_Project

$ cordova platform add browser

Run your app

From CMD, run Cordova run <platform name>.

Example: $ cordova run browser

The core of Apache Cordova applications uses HTML5 and CSS3 for their rendering and JavaScript for their logic. HTML5 provides an introduction to underlying hardware such as the accelerometer, camera, and GPS. Though, browsers' support for HTML5-based device access is not compatible across mobile browsers, particularly older versions of Android. To overcome these constraints, Apache Cordova inserts the HTML5 code inside a native WebView on the device, utilizing a foreign function interface to access the native resources of it.

Apache Cordova can be extended with native plug-ins, allowing developers to add more functionalities that can be called from JavaScript, making it communicate directly between the native layer and the HTML5 page. These plugins allow access to the device's accelerometer, camera, compass, file system, microphone, and more.

https://cordova.apache.org/docs/en/latest/guide/cli/

Appendix G: Contact List

Educational Institutions	Dept.	Name	Phone	Email
Clark University	School of Professional Studies	Rich Aroian	508-793-7110	raroian@clarku.edu
Quinsigamond Community College				http://www.qcc.edu/services/recruiting/posting-position
Worcester Polytechnic Institute	Career Development Center		508-831-5260	cdc@wpi.edu
Worcester State University	Computer Science		508-929-8832	
Becker College	Center for Career Education/Advising		774-354-0448	ccea@becker.edu
Assumption College	Career Services		508-767-7409	
Southbridge High	School Counseling			
Museums	**Dept.**	**Name**	**Phone**	**Email**
Worcester Historical	General		508-753-8278	info@worcesterhistory.net
Worcester Art	Public Relations		508-793-4373	information@worcesterart.org
Vendors	**Area**	**Name**	**Phone**	**Email**
OnCell	Mobile Tour Apps		585-419-9844	info@oncell.com
DryTac	Wayfinding Flooring	Jerry Hill	804-986-3094	jerryhill@drytac.com
DGI Communications	Wayfinding Flooring		1-800-344-0432	
ICL Imaging	Wayfinding Flooring		800-660-3280	info@iclimaging@com
C & G Partners	Wayfinding Flooring		212-532-4460	newbusiness@cgpartnersllc.com
Small Corp	Display		800-392-9500	info@smallcorp.com
Pacific Studio	Display		206-783-5226	info@pacificstudio.com
Displays2Go	Display		800-572-2194	info@displays2go.com
Gaylord	Display		1-800-448-6160	customerservice@gaylord.com

Appendix H: Presentation Slides