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Reinvigorating the "In Their Shirtsleeves" Industrial Exhibit at the Worcester Historical Museum

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A Modern Industrial Exhibit

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Abstract

The goal of this project was to reinvigorate the “In their Shirtsleeves” exhibit to update the historical timeline, and make the experience more engaging and memorable. To meet this goal, we conducted a site assessment, investigated recent economic developments in Worcester, interviewed industrial professionals, researched “best practices” through case studies, and visited other museums to observe interactive technologies and visitor trends. Our analysis suggests that the application of interactive technology provides options for a small museum including increased visitor engagement, understanding, and interest. Based on these findings and results, we recommended strategies that the museum can use to develop an interactive and engaging exhibit that encompasses recent industrial trends.

Executive Summary

Introduction and Literature Review

Over the past century, the Worcester Historical Museum has been dedicated to gathering and displaying the history that has made the city into what it is today. Their exhibit "In their Shirtsleeves," located in the Fuller Gallery of Industrial History, tells the story of Worcester's business and manufacturing industries.

Figure 1: Exhibit entrance (Photo Credit: DellaGrotte, 2014)

The exhibit needs to be updated to include recent developments and incorporate new technology. Our goal for the Museum was to propose recommendations to reinvigorate the "In their Shirtsleeves" exhibit and make the experience more engaging and memorable for visitors of all ages.

After an initial spike in the creation of museums during the 1900s, interest in visitation has steadily been declining. Museums are challenged by new technologies, a decrease in free time for potential visitors, and the need for programs and content that are both useful and relevant.

The first step in creating a new or reinvigorated exhibit is to establish an organized and logical display of artifacts, which is achieved through exhibit design. There are two elements that an exhibit designer must take into consideration while developing an exhibit: the visual appearance and the science of natural human tendencies. It is also important to grab the visitors' initial attention towards an object, which can be accomplished through the use of interactive technology. This allows the visitor to complete the three stages of engagement: participation, narrative, and co-presence. Once these three steps occur, it is proven that the visitors' engagement with the exhibit and its artifacts is much higher, thus visitors are able to develop connections between themselves and the artifacts.

Methodology

This project had four objectives:

- Assess the museum collection to grasp the story of Worcester's industrial history
- Identify major historical events pertaining to the recent transition of Worcester's industries
- Analyze visitor perceptions to gauge their impression of the "In their Shirtsleeves" exhibit as it currently stands
- Research successful methods implemented by other museums to create interactive exhibits

Objective 1: To accomplish our first objective, we chose participatory action research to analyze the artifacts and displays of the exhibit from the perspective of a museum visitor. We compared our observations to best practices discussed in our Literature Review to examine what the exhibit currently has as well as what it was lacking.

Objective 2: In order to reach our second objective, we used a snowball sample through the use of Mr. William Wallace's connections and our own research to obtain contacts associated with

recent industries in Worcester. Interviews were conducted with these contacts to identify major Worcester industrial events from the past twenty years for the expansion of the exhibit's timeline.

Objective 3: The third objective focused on collecting information through observation of visitors' behavior. During our time at the museum, we observed approximately 75 visitors; these visitors were comprised of mostly school field trips and adults. We noted patterns such as the length of time the visitors spent in the gallery, their interaction with the exhibit, and the artifacts that seemed to be the most engaging.

Objective 4: Finally, we examined both successful and unsuccessful interactive exhibit methods by traveling to the following regional museums: the Boston Science Museum, the Waltham Museum, and the Tsongas Industrial History Center. We also met with select staff at these museums to discuss how they address the issue of visitor engagement.

Results and Discussion

Results

To assess the exhibit, we collected qualitative data through an initial site assessment, interviews of industrial professionals, an analysis of visitor behaviors, and research of "best practices" observed by other museums.

Objective 1: Assessing the museum collection

One of the first steps we took to assess the museum's collection in the exhibit itself was to actively view it on our own as visitors and make observations. We also interviewed the Director, Mr. Wallace and the Exhibit Coordinator Mrs. Bumpus to understand their perspectives on the exhibit.

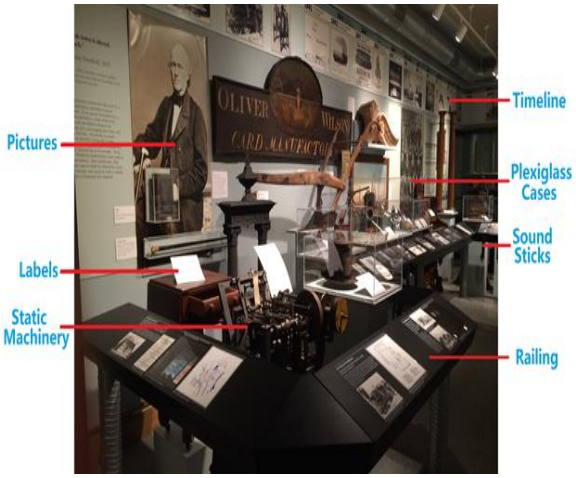

Figure 2: Diagram of exhibit components (Photo Credit: Fathima, 2014)

We observed that the gallery consists of three rooms: the main exhibit area, a mini theater to the right, and a small empty diner area in the back. The main exhibit itself is organized in a chronological order with important events described on a timeline and artifacts arranged below. Overall, the exhibit felt crowded with the amount of photographs, display cases, and artifacts scattered throughout the exhibit. A few labels were difficult to read due to the distance they were placed and several labels were too lengthy or too short which made the display unclear.

Objective 2: Identifying major historical events

The following are semi-standardized interviews that were conducted with industrial professionals to better understand recent industrial events in Worcester's history.

Mr. Jack Healy: The first interview that we conducted was with Jack Healy, the CEO of MassMEP, an agency that specializes in helping small businesses adopt current standards and technologies. When explaining the goal of our project, Mr. Healy recommended that it might be important to focus on the shift of manufacturing in Worcester from a labor-intensive factory setting into a research driven environment that deals with advanced concepts in fields such as life sciences.

Mr. James McNamara: We also conducted an interview with the director of the UMass Medical School's office of technology management, Mr. James McNamara. Since Mr. McNamara deals with the latest biotechnological patents, we chose to speak with him regarding his perception on how biotechnology has evolved in Worcester over the past twenty years and where he thinks it is heading. He suggested that it is possible that the biotech mecca would shift towards Worcester and be more economical for researchers who commute to Boston every day.

Dr. John Sullivan: Dr. John Sullivan, the former Vice Provost for research at the UMass Medical School, believed Worcester is becoming a "company start-up" center. He explained over the past twenty years, Worcester has experienced a biological research expansion.

Dr. Craig Mello: We interviewed Nobel laureate Dr. Craig Mello, who was awarded the Nobel Peace Prize in Physiology or Medicine for his discovery of RNA interference while conducting his research at the University of Massachusetts Medical School in Worcester. His discovery was significant because it allows researchers to turn off genes individually and observe the results. He believes that biotechnology will be an economic success for Worcester and that more companies and jobs will hopefully appear in the near future.

Mr. Kevin O'Sullivan: We conducted an interview with Mr. Kevin O'Sullivan, the President and CEO of Massachusetts Biomedical Initiatives, an organization dedicated to job creation to promote the growth of start-up biomedical companies. To explain his thoughts on the transition of industries in Worcester, he stated "things such as the wire industry represent Worcester's past, but technology will represent Worcester's future."

Objective 3: Analyzing visitor perceptions about "In Their Shirtsleeves"

Due to the time and sample size constraints, our team felt that surveys would not be the best way to collect quantitative data. Therefore, we decided to collect data by observing visitors and occasionally talking to them as they viewed the gallery. We found that most visitors come from school tours, which were guided and designed to help point out artifacts. By using the "continuum of attraction" as a guideline, we noted if the visitors had successfully completed the process of attraction, focus, and engagement.

Objective 4: Researching successful methods implemented by other museums

Our fourth objective was to research exhibits in other museums by both visiting them as a guest, and interviewing the museum staff. The data we gathered helped us to understand how other museums are adapting to the decrease in visitation rates and also engaging their visitors.

The Waltham Museum

Our visit to the Waltham Museum gave us an insight into the workings of a small non-profit

museum similar to the Worcester Historical Museum. The most popular exhibit was their "Waltham Hall of Fame" which consisted of nationally recognized people from Waltham, for example Big Bird from Sesame Street. Because the Hall of Fame evokes emotions of surprise and recollection, it is a simple form of interactivity as it completes the process of "continuum of attraction."

The Boston Museum of Science

We decided to visit the Boston Museum of Science knowing they had recently developed a new exhibit integrating new technology. Their newest exhibit Hall of Human Life is an example of developing museum exhibits for families and having fun while learning. For the purpose of catering to a wide range of ages and levels of comfort regarding technology, the museum found a balance of low and high technology systems through the combination of static and touchscreen displays throughout the museum.

The Tsongas Industrial History Center

We visited the Tsongas Industrial History Center because of its well-known educational learning programs for children and its museum, which is supported by the National Park services and UMass, Lowell. The purpose of each program is to amplify their learning experience through hands-on and teamwork based projects. Their museum, which is separate from the educational programs, contained many static components. Some of these components were accompanied by small-scale replicas for a hands-on experience with "how-to" instructions.

Figure 3: Loom replica from Tsongas Industrial History Center (Photo Credit: DellaGrotte, 2014)

Discussion

The industrial metamorphosis

Mr. Healy suggested a transformation in industry currently occurring in the city of Worcester from a hands-on and physical type of work into a biological research driven industry. His observations of this transition were confirmed by four other interviews that we subsequently conducted. The general consensus was that Worcester is prominently growing in the areas of life sciences as well as health care. While the life sciences and healthcare industries are a growing part of Worcester's economy, our interviews revealed that the types of industries that made the city renowned are still prevalent.

Reminisce the museum experience

Given the leisure-based competition that museums face today, there is a need for a creative approach to exhibit museum collections that appeal to the visitors. Museums address this issue by changing their museum environments to tailor to educational needs of children as well as adults, so they can provide an experience that is both educational and enjoyable for an entire family. By enhancing artifacts with methods of interactivity, the Worcester Historical Museum can instill a connection between artifacts and visitors that does not simply depend on nostalgic feelings.

Recommendations and Conclusions

Our recommendations for the reinvigoration of "In their Shirtsleeves" include:

Reorganization of artifacts

1. Change the name of the "In their Shirtsleeves" exhibit. The revamped exhibit will have a new focus on the shift in Worcester's industries from hands-on factory work to more abstract research-based industries such as biotechnology.
2. Reorganize the gallery to help the visitors understand the transition of industries in Worcester and create a more fluid exhibit. Rearranging the displays to highlight the relationship of the artifacts to the timeline will allow the visitors to better understand how the objects fit in Worcester's industrial history.
3. Convert the diner and mini theater area to optimize the space. Based on our observations, few visitors enter the diner area because it features fewer artifacts. One suggestion to resolve this issue is to remove the wall between the main exhibit room and the diner to expand the gallery and create additional room for newer displays.

Interactive models of artifacts

4. Include interactive models of current industrial artifacts in the exhibit.
Interactive models should be utilized in order to help visitors better understand and appreciate the industrial machinery in the exhibit.

5. Add interactive models for biotechnology to the exhibit. Interactive objects should be included when considering an expansion for the exhibit in the field of biotechnology.

Visual aids

6. Add short videos or animations to the exhibit. Clips could be utilized in the updated section related to the life sciences industry.

Interactive touchscreen terminals

7. Install touchscreen kiosks in the exhibit to give visitors a wider range of information. touchscreens are the most affordable and effective interactivity method for small museums and can be used to depict the theme of industrial transition.

8. Include an interactive map of the city on a touchscreen terminal. To allow for a greater level of engagement, an interactive map of can be implemented through the use of either a standard touchscreen or one in the form of a table.

9. Include interactive games and quizzes on the touchscreen terminals. Quizzes and games allow both family and group interaction as well as a more engaging display of information. Quizzes allow visitors to either collaborate or compete against one another which will provide an engaging experience.

10. Replace the flip books with tablets. Currently the flips books contain several pages of text. By replacing these flipbooks with tablets, more information like photographs, animations, and

videos could be added to provide more interesting material for visitors to examine.

Augmented reality & animatronics

11. Create a virtual online tour. Today, most museums have included an online virtual tour to give visitors at home a taste of what they may experience if they were to visit. The virtual online tour can include generalized artifacts from collections, so that visitors will still feel the need to view the exhibit in person.

12. Include interactive Plexiglass cases for displaying artifacts. Visitors seek tangibility in museum artifacts and an interactive Plexiglass would enable the visitors to harmlessly interact with the artifacts without touching them directly.

13. A hologram projection of an industrial worker can tell an interactive story. The use of virtual projections can depict a particular industrial event that can be replayed live in action in the form of an interactive story. Many projections in a remodeled room can be used to tell a story with different characters virtually interacting with each other.

14. Use 3D virtual objects to enable visitors to virtually touch artifacts. It is often difficult for visitors to understand the structure and function of a certain artifact by just reading its label and examining it from outside the glass case. Augmented reality can be used to allow visitors to touch objects virtually by superimposing the object onto the visitors' hands, thus preserving the actual artifact in question.

15. Add animatronic figures to exemplify factory workers' experiences and emotions. One suggestion to retain the stories of common workers while also holding visitor interest is through animatronics. Animatronics have the ability to emulate human beings from any time period and usually are capable of moving their limbs and producing strong facial expressions. In the exhibit, the animatronic figure could be dressed as a factory worker from any time period in Worcester's history and its dialogue could highlight a particularly important story.

Sliding digital timeline

16. Replace the current timeline with a sliding digital timeline along the wall. The system could be used to condense the information, encourage the visitor to continue learning, could be routinely updated at the sponsor's discretion, and allow the exhibit to remain in its chronological order.

Conclusion

Museums globally are challenged by decreasing visitor rates and a lack of interest which can be attributed to the development of new entertainment technologies. By implementing interactive experiences into the exhibit through the use of touchscreens and other technologies the museum will strengthen the visitor experience and begin to address the larger issue associated with visitation rates. We are confident in our recommendations and believe that they represent a wide range of options that the museum could further investigate and include in their exhibit. Additionally, many of our recommendations can be applied to other areas of the Worcester Historical Museum. By initiating this step in a larger process, the Worcester Historical Museum can solve the problems faced by small museums and continue to provide information about the

city’s past to an evolving audience.

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- Dr. Holly Izard, for guiding us through collections and participating in our group meetings
- The staff of the Worcester Historical Museum, for always making us feel welcome during our time here
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Chapter 1: Introduction

One of the most important roles of historical museums is to help visitors connect with the rich and exciting past that has shaped their society. However, staying current in an ever-changing and developing world is a challenge that many of these institutions face. Exhibits need to be updated both for content and access so as to best tell the story behind the display. It can be difficult to gather content that accurately reflects key moments in history while providing upkeep for an entire museum with both temporary and permanent exhibits. Additionally, providing meaningful digital engagement for visitors can be a complex, and often costly, process.

Over the past one hundred years, the Worcester Historical Museum has been dedicated to gathering and displaying the history that has made the city into what it is today. From the many galleries at its main location at 30 Elm Street to the only historic house museum in the city, Salisbury Mansion, the museum provides a great service to the city of Worcester. In addition, the museum's educational programs, tours, library, and publications further serve the community and promote its motto "Your city. Your history. Your future."

The museum has fallen victim to these problems in recent years, specifically in one of their most important permanent exhibits, "In their Shirtsleeves." This exhibit, located in the Fuller Gallery of Industrial History, tells the story of Worcester's business and manufacturing, which has had a large impact on shaping Worcester into the city that it is today. It has unfortunately become dated and needs a complete overhaul; accomplishing this may increase visitor satisfaction regarding both the exhibit and the museum itself. The reimagining of the gallery should be lively and current in both its design and content to engage visitors. Therefore, new interactive technologies such as touch screen terminals could be considered. However, these changes alone may not be enough to attract new visitors to the museum.

As a team, our goal for the Worcester Historical Museum was to propose recommendations to reinvigorate the Fuller Gallery's "In their Shirtsleeves" exhibit and make the experience more engaging and memorable for visitors of all ages. To accomplish this goal, we assessed the museum collection to grasp the story of Worcester's industrial history. We then identified major historical events in Worcester's recent history to focus on the transition in industries. We also observed visitors to gauge their impressions of the "In their Shirtsleeves" exhibit. In addition, we researched successful methods that museums have implemented to create

interactivity between the exhibits and visitors. Collectively, these methods helped us propose ideas to restore the installation of the “In their Shirtsleeves” exhibit to keep it relevant to the audience.

Chapter 2: Literature Review

Reinvigorating historical museums is a difficult challenge that requires a creative approach to leave a lasting impression on visitors. Enhancing the exhibit by incorporating interactive technologies and intriguing artifacts is one way to create memorable experiences. This chapter will begin with a brief overview of the present condition of the museum site, followed by addressing the challenges faced by contemporary museums. We will also examine artifact curation processes and discuss the effectiveness of exhibit design in small museums. In addition, we will present an analysis of an interactive and technological approach that many successful museums have incorporated. Finally, we select and examine several case studies that related to important aspects of our project, such as exhibit layout and interactive technologies. These case studies help us learn about museum solutions in a more applicable way than common research methods.

2.1 The site in the spotlight

The Worcester Historical Museum is located at 30 Elm Street, in the heart of Worcester, Massachusetts, as seen below in Figure 4 with its own motto: "Your City. Your History. Your Future."

Figure 4: The Worcester Historical Museum front entrance. (Photo Credit: DellaGrotte, 2014)

It is a small-scale local museum that celebrates the success of the local community in Worcester in a unique, distinctive and succinct manner. Of the many galleries that the museum has to offer, the Fuller Gallery of Industrial History focuses on telling the story of Worcester's rich and varied industrial history from 1779 until 1993. It houses one permanent exhibit named “In their Shirtsleeves”, as seen in Figure 5 story of Worcester” (“In their Shirtsleeves”, n.d.).

Figure 5: "In Their Shirtsleeves" exhibit (Photo Credit: DellaGrotte, 2014)

The museum is staffed by nine people, including the executive director, exhibitions coordinator and curator of collections. They also have a board of eighteen trustees, as well as several volunteers and interns. Among the parties interested in revitalizing the space is the executive director of the museum Mr. William Wallace. The exhibitions coordinator, Mrs. Vanessa Bumpus, and the curator of collections, Dr. Holly Izard, are in charge of managing the exhibits at the museum and collecting and preserving the artifacts, respectively. Mrs. Bumpus graduated from the University of the Arts in Philadelphia with a Master of Fine Arts in Museum Exhibition Planning and Design. She has also worked at the "Late Show with David Letterman" and the Metropolitan Museum of Art in the past and finds "behind-the-scenes stories" interesting and is passionate about museums of all types. Dr. Izard is a Boston University graduate with a Ph. D. in American and New England Studies. She has worked as a research historian at Old Sturbridge Village, and has a strong interest in primary document and architectural research as well as writing for public and academic resources. Other stakeholders include visitors to the museum, which range from local residents, schools both elementary and college, tourists, and historians wanting to learn more about the city's history.

To understand and discuss where the Worcester Historical Museum currently stands, we will look at the transition of museums into the modern era.

2.2 Rethinking museums in the age of technology

There are several reasons why one visits a historical museum, including the ability to experience an age that has passed, for a learning experience or cultural development, and also to see artifacts that often cannot be viewed otherwise; other reasons simply include need for entertainment and socialization. However, in today's society, "museums are challenged by new information technologies, increasingly mobile and heterogeneous communities, and the demand for contemporary programs that demonstrate usefulness and relevance" (Burton & Scott, 2003, p. 65). Therefore, museums are compelled to observe creative approaches to both attract and keep the visitors engaged.

At the peak of the Industrial Revolution in the 1900s, an "unprecedented museum boom" began to occur which put the newest technologies of the age on display. Since many had no other way to observe the latest innovations, museum visitation was extremely high. After this initial spike in museums however, interest in visitation has steadily been declining. According to the National Endowment for the Arts (1996), the recent increase in easily accessible technology directly relates to the sharp decline in museum attendance around the world (Scott *et al.*, 2003). A researcher named Oliver Pergams confirmed this theory at the University of Illinois in Chicago by observing the adverse impact of "indoor media" on the per capita attendance at US National parks (Driscoll, 2007).

Technologies, such as the Internet, can provide a wealth of information for users to learn about and connect with, which is very similar to what museums provide. In addition, the ease at which people can access this information discourages them from taking the time to visit places such as museums to discover it for themselves (Scott *et al.*, 2003; Garfindle, 1999). Anderson (1999) further explains that today's "information-based paradigm" and "virtuality of experiences" provided by the Internet and mobile devices easily allows people to stay at home to gather information rather than visiting establishments like museums. To solve this problem, museums must begin to examine methods to not only incorporate creative technology into their exhibits, but to also use entertainment technologies such as the Internet and social media to attract and engage visitors even from their homes.

Moreover, museums are beginning to examine the effect that current technologies have on museum interest to combat these decreasing visitor rates. The evolution of the leisure environment has a direct impact on museum visitation leading to a competitive environment for

museums. This competition is largely due to people's evolving choices and interests to consume history in light of increasing amount of new commoditized entertainment/leisure technologies (Burton, Louviere & Young, 2008; Jr., Bryan, 2004). It is only effective if museums were to provide the learning experience that the newer generations of learners are being nurtured with, which is more hands-on and teamwork based projects done in a cohesive environment. With the changing learning style, family-oriented museum galleries, which focuses on storytelling using interactive components, enable engagement for large groups of people to learn together. This development of social interactions and learning by example can make use of multimedia technology to achieve visitor engagement (Carson, 2008). The rest depends on marketing strategies to communicate the entertaining and engaging components of the museum to the public.

After examining the problems that currently afflict many small-scale museums, solutions that pertain to the Worcester Historical Museum will be suggested. The first step in creating a new or reinvigorated exhibit is to establish an organized and logical collection of artifacts. The following section will detail aspects of this curation process as well as effective exhibit layouts that are integral to designing an appealing exhibit.

2.3 Curation of historical artifacts in small museums

For museums to be successful in today's society, a solid foundation of curatorial work must be established. Curation often occurs "behind the scenes" at a museum and upon first inspection the importance can be overlooked. Topics such as visitor engagement and exhibit design all depend on work done by the museum curator. Modern day curators also must determine creative ways to collect and display artifacts that are either difficult or impossible to present to visitors in a traditional sense, for example objects related to microscopic elements. In addition, small museums face a set of specific challenges regarding curation that should be addressed in order to maximize the visitor experience.

Curation is defined as, "professionals working in museums and cultural heritage organizations address social, cultural, and even political issues as they seek to be responsive to changing societal needs and trends" (Seakins & Dillon, 2013, p. 415). As stated in the Second Law of Thermodynamics, there is a universal tendency for all systems to go from order to disorder. To address this inclination, curators focus their efforts on keeping a well-organized and

meticulous database of all artifacts brought into the museum. They are also responsible for researching and recognizing possible artifacts that may enhance the collection, as well as knowing when an artifact doesn't belong. Lastly, they are skilled in the techniques of preservation to keep the artifacts in good standing and value.

One organization recognized for their contributions toward the museum community is the American Alliance of Museums (formally named the American Association of Museums), which has created the Curators Committee of the American Association of Museums (CurCom, 2009). This group of devoted and specialized curators developed a document called A Code of Ethics for Curators that "describes the fundamental principles, core beliefs, and responsibilities that define curatorial work and provides guidelines for ethical conduct". In this document, they stress how important a curator is for the museum and that they provide the vital role as advocate for their institution in the public eye. According to AAM, curatorial work is guided by three values, to serve the public good, the institution, and the museum profession (CurCom, 2009). An example of this is the responsibility to take into consideration the potential accessibility needs for all visitors, which includes but is not restricted to those who fall under the standards set by the Americans with Disabilities Act (ADA) (CurCom, 2009, p. 5). Planning with these ideas in mind will eliminate any restrictions towards visitors and will help create a space conscious exhibit.

Small historical museums stimulate the visitors to reflect upon the developments and achievements of the community. However they face several unique challenges in regards to the curation of historical artifacts. These problems are mostly related to the physical size of the artifact storage area. When curating artifacts, small museums naturally have a tendency or obligation to accept almost every donation in the hope of interesting a wider range of visitors (Guthe, 1973). While larger museums have multiple storage areas either on or off-site to house donated artifacts, small museums are very limited in the area they can dedicate to storage. In addition, museum curators must follow policies specific to their institution in regards to preserving artifacts. Most museums have rules that state that once an artifact is collected, it cannot be disposed of unless the historical or research value has been fully compromised (CurCom, 2009). In combination with the lack of space that many small museums must deal with, this policy can create problems in terms of the quality of stored artifacts.

Recent scientific discoveries, such as biotechnology are more conceptual than tangible and therefore require a more creative approach to display in a museum. Museums have adopted

new methods to collect and display the latest developments in the scientific world, such as biotechnology in healthcare and life sciences. Some museums such as the Science Museum in London have figured a way around the issue of curating conceptual artifacts by focusing on "science communication studies" and "audience research" in their Wellcome wing (Boon, 2010). Furthermore, as younger patrons become less familiar with artifacts such as machines, commonplace in the 19th century, a shift in focus to digital and virtual media to exhibit conceptual artifacts is necessary.

2.4 Effective exhibit design to engage visitors

In addition to curation, exhibit design is an important element in the attraction of an exhibit to visitors. More specifically, the way that artifacts are displayed and arranged in an exhibit can often be essential to impressions and understanding of the exhibit as a whole. Without successful exhibit design, visitors can become confused as to the theme that the curator is attempting to convey through the exhibit. This confusion can even lead to eventual disinterest in the artifacts and as a result visitor engagement cannot take place. In this section we examine the keys to successful exhibit design including artifact presentation and problems that prevent visitor engagement.

Just as a grocery store is designed for maximum purchasing opportunities, a museum exhibit is designed to attract and draw in visitors. There are two elements that an exhibit designer must take into consideration while developing an exhibit, visual appeal and the science of understanding the visitor. When visually designing the fundamentals of the exhibit there are five features that must be understood: value, color, texture, balance, and line. Value is simply the different shades between black and white, which is associated with characteristics of weight. Color is essential for conveying an overall emotion and can be used in combination with value as pigments, which can change the appearance of a displays surface. This ties into the art of texture as noted to be the creation of "[toothiness] by varying the density of pigments, quality of line, and strength or weakness of values." Lines have the ability of giving direction, which is helpful in a museum setting to guide a visitor from one display to the next. Given these fundamentals, the challenge museum designer's face is finding a balance between them to guide the visitor's attention to specific information in the exhibit and create a more cohesive experience (Dean, 1996, p. 35).

One strategy that typically evokes an immediate response from visitors is the use of an interactive or engaging environment. This is employed in many successful museums because humans have the natural tendency to direct their attention to sudden changes around them. It is important to grab the visitors' initial attention towards an object, because without that first step it is impossible for them to make a memorable connection. Artifacts that easily draw visitor attention, such as ones that have unique physical attributes (large size, attractive color, unique shape) or non-physical attributes (ancient artifact, sense of nostalgia) should be presented at the forefront of the exhibit (Teixeira, 2009). In addition, the use of height is often overlooked in exhibits. Sometimes, an exhibit can be "hurt" by having artifacts below or above the "visitor's line of sight" and therefore the importance of the artifact can be accidently skipped over (Bitgood, 1996). Once the visitors' attention has been initially captured, there is a sequence of events that must occur for their engagement to stay consistent throughout their time at the exhibit.

The tri-leveled "continuum of attraction" (capture, focus, engagement) is the series of mental connections that a museum designer aims for (Bitgood, 2013). This process is sequential, so without capture, the visitor will be unable to focus and will make no efforts to further pursue or retain the information. Capture can be accomplished easily through objective actions, however the next two steps occur in the subjective mind. The visitor must focus in on the artifact and process their thoughts about it, for example questions or personal connections. The final step is engagement, and this happens when the visitor begins to connect what they have seen with the big picture of the exhibit and continues to think about what they saw not only as they continue through the exhibit, but also after they leave (Bitgood, 2013).

This theory returns back to the major problem of historical museums: the inability to capture and engage their audience to create a memorable experience. The reason why many museums struggle to entertain visitors is because exhibits often include several barriers to engagement. For example, a large amount of artifacts behind glass cases, low physical interaction, and a confusing layout with too many artifacts have all been shown to prevent visitors from becoming fully engaged in an exhibit. In addition, artifact labels are often found by visitors to be difficult to read and too technical to be worth spending time over (Teixeira, 2009). To combat these problems related to exhibit design, museums are beginning to utilize interactive technologies.

2.5 Visitor engagement through the use of technology

One of the main ways that museums have attempted to innovate and improve their exhibits is through the use of interactive technologies. Because of how dependent society is on entertainment technologies, most visitors expect similar forms of entertainment to be present in an exhibit as well. The addition of these interactive elements is generally considered to create higher levels of engagement and provide the same quality of information to visitors as more standard methods such as labels (Gammon, 2003).

When interacting with technologies that are part of an exhibit, visitors have reported three categories of enjoyment: participation, narrative, and co-presence of others. Participation is a way that information about artifacts can be made personal through the use of interactivity, for example when a visitor has direct power or influence over a specific element of the exhibit. Narrative involves interactive technology providing a method for visitors to experience the artifacts of the exhibit as part of a larger story instead of just individual pieces. Finally, the co-presence of others when interacting with technology has been shown to increase the desire to enjoy a deeper connection with the exhibit. When interactive technology allows these three things to occur, it is proven that the visitors' engagement with the exhibit and its artifacts is much higher (Haywood & Cairns, 2007).

As a comparison, interpretation techniques that do not involve interactivity do not yield similar levels of learning or engagement. According to Bitgood and Cleghorn, artifact labels are the most poorly recalled exhibit element among visitors when compared to visual information and interactive content (Bitgood & Cleghorn, 1994). If written labels are to be included with technology, they must be well written and easily understandable to all age groups.

When implementing interactive technology into an exhibit, museums have several choices to consider depending on the scale and layout of the museum and exhibit. Touchscreen modules are most widely used because they allow for a diverse range of interactivity methods and are the simplest form of interaction for visitors. In addition, because many small museums are behind their larger counterparts in terms of technology, touchscreens are often the most affordable implementation (Institute of Museum and Library Services, 2006).

The most common ways museums choose to integrate these touchscreens are to supplement a particular artifact with additional photos, videos, or interactive activities, as shown in Figure 6.

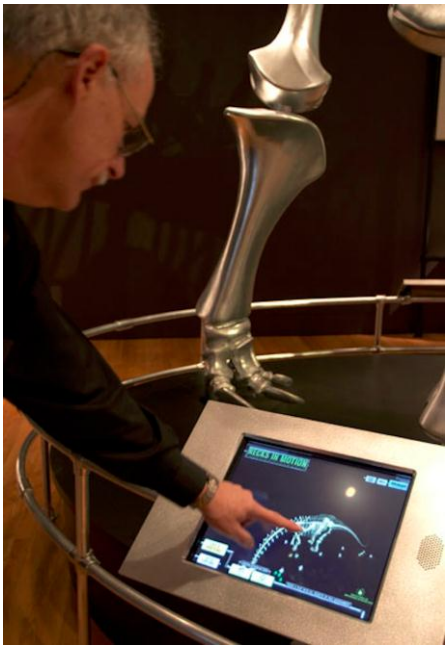

Figure 6: A visitor using a touchscreen terminal to interact with a static artifact. (Retrieved from American Museum of Natural History, http://ix.cs.uoregon.edu/~kent/paleontology/museums/AMNH/index.html)

Some even allow access to an online database with more pictures and information about all artifacts in the gallery. Instead of replacing entire modules to create new ways of interacting, the terminals can simply be programmed to update. In the case studies section we will discuss how one particular museum integrated touchscreen technology into their galleries in much greater detail.

Mobile phone applications are another way that museums can provide meaningful interactivity for their visitors. By easily allowing access to a museum's website for example, Phone applications can enhance the experience for visitors both during their visit and after having left. Browsing through photo galleries and videos are standard features that could be included but innovative features such as interactive guides which provide access to information at the user's fingertips will leave a much greater impression on the user (McAteer, 2012). Additionally, after the visitor returns home, apps can provide further access to information about the artifacts on display, as shown in Figure 7 below. Users could also share reviews about the museum, learn about new renovations, and read about special events and speakers the museum would be holding in the future (Llovio, 2009).

Figure 7: A mobile and tablet based application for information and virtual tours. (Retrieved from Memphis Brooks Museum of Art [http://www.brooksmuseum.org/apps)](http://www.brooksmuseum.org/apps)

It should also be noted that there are more creative and elaborate uses of technologies besides the above being implemented in many museums. A great example of this is the PassPort to Discovery system (Anonymous, 2010). It was introduced at the Northwest Museum of Arts and Culture in September 2010. The system gave users a card upon entering the museum that could be scanned at several terminals around the museum. When scanned, a personalized avatar would appear on a nearby screen and provided specific information about the exhibit based on the user's interests. PassPort to Discovery also allowed the users to play games unique to the exhibits and share scores (Anonymous, 2010). This is a good example of how interactive museum technology can be creatively implemented. By providing a personalized experience, the system allows each guest to feel more connected with the exhibit than simply reading a summary of the artifact. This increases the potential for visitors to leave the museum feeling like they have made an impact on the exhibit and will stimulate a larger interest in the artifacts in the gallery.

After considering what technology can bring to the museum environment, it is useful to examine some of the challenges small museums should consider. One concern they have to be aware of when considering technological additions is cost. The latest technology often can cost thousands of dollars and it is a significant investment to bring to an exhibit. Also, the newest technology may not be the most appealing to the age groups visiting the museum. It is useful to consider the full spectrum of ages that will be visiting the museum because older visitors may not find the same appeal in the "cutting edge" technology that excites children and young adults. Finally, it is also very important to keep in mind the reasons for adding the technology: to increase visitor interaction and experience. Therefore, museums should be careful that technology is not added to an exhibit simply for novelty or because it is cutting edge. Visitors should be able to "make meaningful connections to museum collections both individually and socially within the museum space" and that is exactly what interactive technology allows for (Gillette, O'Brien, Bullard, 2011).

2.6 Case Studies

In the next section, three case studies were chosen to support successful examples of museums attracting visitors in different ways. The Zeppelin museum applied the use of exhibit design to intrigue the visitor throughout the museum. Museum of Anthropology used methods of modern technology to enhance their museum through interaction. Lastly, web and mobile technologies at the Rijksmuseum Amsterdam are being developed to increase the potential visitor base.

Engagement through imagination

Lake Constance located in the town of Friedrichshafen, Germany during the 1990s was known as "Zeppelin City" as a result of the manufacturing of giant airships during WWI (de Syon, 1999). Looking back at this historical "source of civic pride" one of the ways the country wanted to dedicate this event in history was through a museum, which was opened on July 2, 1996 as the "ninety-sixth anniversary of Count Zeppelin's first airship flight" (De Syon, 1999, p. 114). In the twentieth century, the museum was a common place to visit to encourage children to learn about the past and to reminisce about the "good 'ol days". Today, the most common problem for museums is the decreasing numbers of visitors due to lack of interest. One way to keep a visitor's attention is the overall design of the exhibit from the first step they take inside

until they leave the museum. This case study examines the success of exhibit design at the Zeppelin Museum.

The design of this museum appears to be well thought out to engage the visitors with powerful visual effects. According to one report discussing the problem of engaging visitors, "the new Zeppelin Museum has taken up the challenge masterfully, first with a scale diorama of the Hindenburg dirigible over Friedrichshafen placed at the entrance, and then with a full-size replica of a section of the same airship" (de Syon, 1999, p. 115). Not only do they use dramatic visuals, but they also have unique ways of allowing the visitors to bring a little history home with them. The museum cleverly produces small scale look-a-likes of the tickets that were received boarding the Hindenburg as the admission pass for the museum. This is appealing to young children and allows them to bring it home as a souvenir. Another creative way to enhance the visitors experience was by interior designing. The walls depicted what a person boarding the Hindenburg would have actually seen.

As the room opens up, the audience comes in full view of the full size replica of the Hindenburg's interior hull. The visitor "gains a clearer sense of travel in the golden age of passenger airships" which further aids viewers experience (de Syon, 1999, p. 116). The use of adjoining rooms and second floor levels, the smaller artifacts and technical displays give the visitor more opportunities to listen and learn about the overall history of "Zeppelin City". Concluding the museum visit, families have the opportunity to purchase small sized souvenirs and trinkets to consolidate the memories they made while visiting at home. As a result, the combination of a well thought out exhibit design and the high tourism in the area proved to be effective tool in keeping their visitation rates up.

Engagement through self-direction

The focus of this study is a new technology deployed at the Museum of Anthropology (MOA) in Vancouver, British Columbia, known as the Collections Access Terminal (CAT). It has been researched and developed by the museum over the course of a decade. The goal of this technology was to allow for increased visitor interaction and engagement with the exhibits. Also important in the design of the CAT was the ability to bring visitors together through social interaction and meaningful exchanges (Gillette, O'Brien, Bullard, 2011).

Fourteen of the CAT terminals were installed at various locations around the museum

following the design process. They feature 24-inch Apple Cinema displays with touch technology screens. The terminals have a welcome screen to attract visitors to them, and when the screen is touched they transition to a portal page. From here the visitor can view a map of where they are currently located in the museum or view the collection. They can view said collection through various search options including an interactive map or by location in the gallery via a 3D rendering. The CATs also can display a page to advertise upcoming events at the museum as well (Gillette et al., 2011).

The study focuses on the design process of the CAT, and was conducted through a combination of research and interviews. The authors examined background materials, newspapers, meeting minutes and other paperwork from the design process. They also conducted interviews with six members of the museum staff who they believed had a significant impact on the CAT's development. This research was intended to delve deeper into the workings of the design process and how the design of the CAT changed and adapted during its development.

The main intent of creating the CAT system was to replace the museum's largely outdated visual storage system. The museum had hundreds of data books in their archives that detailed all the artifacts in their collection. The CAT was designed to replace these data books with a more convenient and accessible alternative. The designers based this technology on already existing concepts after examining multiple museum websites and terminals. While the designers admitted that they never had time to solely work on the CAT during its decade long development, they did agree that having a team where each member brought a different expertise helped to ensure that the final quality of the product was consistent and engaging.

Engagement through social media

This case study focuses on a new technology that is being researched at the Rijksmuseum Amsterdam. It focuses on supporting "a 'virtuous cycle' of the museum visit, which links the personalized museum experiences both online and on-site" (Wang et al., 2009). The technology consists of both a website component intended for use at home and a mobile phone component that is mainly used during the museum visit. The purpose of incorporating this technology is so that the visitor can begin their museum experience on the website and continue by visiting the museum. After the visit, they can extend the experience by once again visiting the website. Of course, this is just one possible scenario because the implementation of this technology promotes

freedom to choose when and how the visitor will continue their museum "visit".

The website based component first contains an Art Recommender where the user can browse and rate specific pieces based on the interests that the user can provide. Once the system knows the type of art that the user finds interesting, it can begin to display paintings in the collection that the user might find interesting. The user can rate these suggestions and that information will be passed on to the next tool in the system: the Tour Wizard. This wizard will generate online museum tours that contain the paintings that the user has told the Art Recommender were interesting to them. These tours can be presented both in an historical timeline and also on a layout map of the museum (Wang et al., 2009).

The last piece of this new museum technology is the Mobile Guide, which is accessible via an application on most mobile devices. It converts the online tours from the Tour Wizard into an equivalent on-site tour that will take the user to all of the paintings that had received a high rating. When the user completes the physical tour, the mobile app syncs with the user-created profile on the web and updates their behavior for use in making future recommendations.

This technology was proposed to increase the interaction with visitors both before and after they visit the exhibit in the hopes that this will increase the desire to visit the museum. While the technology has yet to be incorporated fully in the museum, initial use cases have been positive and lead to a conclusion that mobile and web based technologies are important in providing a memorable experience to museum visitors.

2.7 Summary

To reinvigorate an exhibit, extensive research must be done not only on the subject matter of the exhibit but also on the presentation itself. Therefore, we examined how curation contributes to the engagement of an exhibit and why small museums face additional difficulties when collecting artifacts. Additionally, we examined the exhibit design process including the importance of artifact presentation and arrangement. Finally, through our investigation of recent advancements in museum technology, we found that interactive technology can in fact be an important element for increasing visitor engagement.

Chapter 3. Methodology

The goal of our project was to propose recommendations to reinvigorate the Worcester Historical Museum's "In their Shirtsleeves" industrial exhibit to make it more engaging and memorable for visitors of all ages. In order to meet this goal, we formulated the following 4 objectives:

- Assess the museum collection to grasp the story of Worcester's industrial history
- Identify major historical events pertaining to the recent transition of Worcester's industries
- Analyze visitor perceptions to gauge their impression of the "In their Shirtsleeves" exhibit as it currently stands
- Research successful methods implemented by other museums to create interactive exhibits

The remainder of this chapter will discuss and elaborate on each of these objectives. We will present the methodological strategies that were used to meet each objective and explain how each one assisted us in completing our overall goal.

3.1 Assessing the museum collection

Our first objective was to assess the museum's entire collection to grasp the story of Worcester's industrial heritage. This step was significant in establishing a basic foundation for the history of Worcester as well as assessing the current state of the exhibit. In order to meet this objective, we chose participatory action research to analyze the artifacts and displays in the shoes of a museum visitor. We also interviewed the staff at the museum to get a sense of where the exhibit is currently standing.

We conducted semi-standardized interviews with the museum staff because it ensures that "interviewers are permitted to probe far beyond the answers to their prepared standardized questions" (Berg, 2007, p. 95). Due to the fact that the former exhibit coordinator, who designed the standing exhibit is no longer an employee, we interviewed the director of the Worcester Historical Museum, Mr. Wallace, and the current exhibit coordinator, Mrs. Vanessa Bumpus in

order to understand their perspectives on the exhibit.

Additionally, we spent time in the stored collections with the curator, Dr. Holly Izard, to perform archival research and learn about the exhibits' inventory of artifacts. It is important to know if the artifacts on display are the only ones available that pertain to that part of Worcester's industrial history or if there are additional artifacts in storage that are not currently in use. This allowed us to consider alternative displays and artifacts to represent the story of Worcester's industrial history.

From the information we gathered, we chose to focus on the transition from the traditional labor-intensive industrial past to the modern abstract "think tank" industrial era that has occurred in Worcester over the past twenty years. We chose to emphasize this shift in the exhibit in order to depict where Worcester's industrial focus is heading today.

3.2 Identifying major historical events

Our second objective was to identify and select major industrial events in the past 20 years of Worcester's industrial history to be able to broaden the story of Worcester's transition in industry. In order to reach this objective, we used a snowball sample through the use of Mr. Wallace's connections. We obtained contacts associated with recent industries in Worcester and conducted interviews with them to learn about the major developments in their respective fields. Discussions with professors who are knowledgeable in recent Worcester developments also allowed us to obtain further literature and information.

We chose to use an unstandardized interview when discussing with Mr. Wallace to allow him to expand upon his thoughts without restrictive formulated questions. It is written in the Qualitative Research Methods for the Social Sciences that the advantage of an unstandardized interview is, "interviewers must develop, adapt, and generate questions and (appropriate) follow-up probes" (Berg, 2007, 94).

Nobel laureate, Dr. Craig Mello, who conducted his research at UMass. Medical School, was also interviewed along with several other relevant professionals in the biotechnology industry whose names were obtained through a snowball sample. Through our own research we discovered a number of contacts with knowledge that could contribute to the recent history of Worcester for extending the timeline. These included Mr. Jack Healy, the director of operations

of the Massachusetts Manufacturing Extension Partnership, and Kevin O'Sullivan, the president and CEO of Massachusetts Biomedical Initiative.

We also consulted with Professor Dominic Golding at the Worcester Polytechnic Institute (WPI) because he has advised several student projects related to the update of exhibits in small museums. The purpose of speaking with Professor Golding was to obtain additional resources and contacts regarding this subject. In addition to providing this information, he also directed us to individuals that had knowledge pertaining to recent industrial developments in Worcester.

The contacts that were referred to our team included Professor Baller and Professor Hanlan. We conducted discussions with these professors to further obtain resources that related to the extension of the exhibit timeline.

3.3 Analyzing visitors perceptions about the "In Their Shirtsleeves" exhibit

The third objective was to obtain and analyze museum visitor feedback about what constitutes an appealing exhibit as well as the quality of "In Their Shirtsleeves" specifically. The public's opinion is very important when designing an exhibit that is capable of attracting visitors. Praise from visitors, both by word of mouth and feedback such as online reviews, can have a large impact on the popularity of the museum.

However, to accomplish this objective, we decided not to gather information through the use of surveys due to concerns about sample size and limitation due to time constraints associated with the duration of the project. In addition, we found in preliminary interviews that it was difficult for visitors to articulate their thoughts about topics such as exhibit improvements, as it seemed to be an abstract concept to them. They offered general thoughts regarding the improvements, and even criticism, but not specific suggestions.

Therefore, we collected information through observation of visitors' behavior during their visit to the museum on weekdays. We observed approximately 75 visitors during our time at the museum; these visitors were composed of mostly school field trips and adults. By watching their behaviors, we were able to gather information about their impressions of the exhibit. We noted patterns such as the length of time the visitors spent in the gallery, their interactivity with the exhibit, and the artifacts that seemed to be engaging to the visitors. These included artifacts or sections of the exhibit that were particularly intriguing and how often they picked up the sound sticks or watched the movie clip. Through our observations of

approximately 75 visitors, we were able to detail what segments of the exhibit were capturing visitors attention and which areas needed to be improved.

3.4 Researching successful methods implemented by other museums

The fourth objective was to research and observe "best practices" of interactivity implemented by other museums. To achieve this objective, participatory action research was selected to model visitor interest and engagement. Action research, coined by Kurt Lewin, is described as "a process that gives credence to the development of powers of reflective thought, discussion, decision and action by ordinary people participating in collective research" (Berg, 2009, p. 247).

To experience interactivity from the perspective of a visitor, we traveled to the following regional museums: the Boston Science Museum, the Waltham Museum, and the Tsongas Industrial History Center, in order to examine both successful and unsuccessful interactive methods used in exhibits. In addition to visiting the museums, we met with select staff to speak directly about how they tackle the issue of visitor engagement. Among the staff interviewed was Cynthia Vengroff, a Museum Education Supervisor, and Benjamin Wilson, a software developer for museum technologies. This was achieved by conducting semi-standardized interviews, which focused on how interactivity in exhibits was maximized while still providing relevant information to visitors. As previously stated, semi-standardized interviews provide structured form while also creating a relaxed environment for the interviewee.

Subsequently, our conversation with Professor Golding also led us to contacts in the field of interactive museum technologies. Professor Jeffrey Forgeng, for example, was an advisor for projects conducted at the Higgins Armory Museum, including one on the use of interactive technologies to improve visitor engagement.

3.5 Final deliverable

We presented a set of scenarios based on our findings to the Historical Museum staff. We collected and synthesized all of the information we gained from the research, site visits, and interviews to propose recommendations aimed toward reinvigorating the exhibit to make it more engaging and memorable to the visitors. These scenarios included a range of technological

options for a more engaging experience, as well as suggestions for amending or updating the exhibit's display.

Chapter 4: Results & Discussion

To assess the exhibit, we collected qualitative data through an initial site assessment, an analysis of visitor behaviors, interviews of industrial professionals, and research of "best practices" observed by other museums. This chapter consists of our key findings followed by a discussion of those findings.

Results

4.1 Objective 1: Assessing the museum collection

One of the first steps we took to assess the museum's collection in the exhibit was to actively view it on our own as visitors and make observations. We observed that the gallery consists of three rooms namely, the main exhibit area which was surrounded by a mini theater to the right and small diner area in the back. According to Teixeira and Burch (2009), partitioning a gallery into smaller rooms helps the visitors feel less burdened while looking at the exhibit (as cited in Teixeira, 2009).

We also interviewed the Director, Mr. Wallace and the Exhibit Coordinator Mrs. Bumpus to understand their perspectives on the exhibit. They both expressed their views on the exhibit as being outdated and, in many ways, inadequate in telling the most recent history of Worcester. Specifically, Mr. Wallace stressed that the exhibit lacks interaction and that it feels very static, noting that, "nothing moves in there, it's very boring" (personal communication, January 21, 2014). When we asked Mrs. Bumpus what she thought of the exhibit she stated, "It is overwhelming and intimidating. There's no life to it, even though it's a story of peoples' lives" (personal communication, January 21, 2014). Furthermore, both explained that one of the main reasons why people visit the gallery is to learn more about a past family connection to the city. For example, they have observed many visitors pick out artifacts or point out companies due to the fact their parents or grandparents worked, used, or told stories about them. Mr. Wallace concluded by stressing that those types of connections must be maintained in the updated exhibit and that technology could play a large part in enhancing that experience.

The main exhibit itself is organized in a chronological order with important events described on a timeline along the wall. The artifacts are arranged below the timeline barred by a railing that featured additional information as well as embedded artifacts. Additionally, there are audio and visual devices distributed throughout the exhibit; among these were a combination of

sound sticks, pushbuttons, flipbooks and small TV screens. The following Figure 8 displays the exhibit components:

Figure 8: Components of the "In their Shirtsleeves" exhibit. (Photo credit: Fathima & Xu, 2014)

At first glance, the main exhibit felt crowded with the amount of photographs, display cases, and artifacts scattered throughout the exhibit. Galleries that contain a large amount of artifacts often create feelings of confusion and leave the visitor overwhelmed. As a result, visitors would be unsure about where to begin exploring the exhibit and consequently skip over large portions of the gallery. (Teixeira, 2009; Griffiths, 2003). We examined the artifacts on display to determine if there was any relationship between the information on the railing and the timeline along the wall. We noted that the organization of artifacts did not always pertain to the exhibit timeline nor did it relate to the information on the railings. For instance, as seen in the following Figure 9, the map on the railing does not have a direct relation to the wire setting machine on display. Dr. Teresa Teixeira (2009) states, that without clear presentation of artifacts, visitors can be easily confused about the content and its relation to the theme of the gallery.

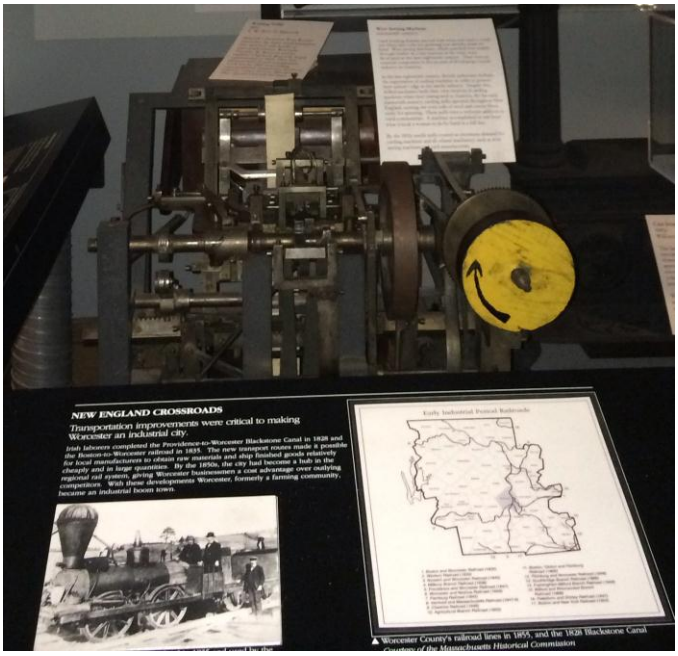

Figure 9: Relation of exhibit elements. (Photo credit: Fathima, 2014)

The use of black, white, and brown pigments in an industrial exhibit typically conveys a timeless feeling of a factory setting to the visitors, which is the kind of emotion that an exhibit of this type should express. As seen in Figure 9 above, most of the artifacts, photographs, and labels in the room featured only black, white, and brown color tones. However, as noted in our literature review, the use of bright colors, motion, or sound, can work to the museum's advantage (Bitgood, 2013). Therefore, visitors may not necessarily feel as engaged with the content of the exhibit. The exhibit does, however, feature a brightly colored plastics display in the center of the room that was meant to capture the visitors' initial attention upon entering the exhibit. This display is shown in Figure 10 below:

Figure 10: Brightly colored plastics display. (Photo credit: DellaGrotte, 2014)

"Visitors need object labels that are well written, intellectually accessible and relevant" (Teixeira, 2009, p. 16). A few labels were difficult to read due to the distance they were placed and several labels were too lengthy or too short which made the display unclear. Also, some of the labels were obscured by other artifacts in the exhibit. As observed by Monti, objects that are isolated and directly in line-of-sight are more likely to draw in visitors (as cited in Teixeira, 2009). Figure 11 shows photographs of how artifact labels are presented in the exhibit; the image on the left depicts a label that was covered by a glass display and the image on the right shows a label that does not fully convey the function of the artifact.

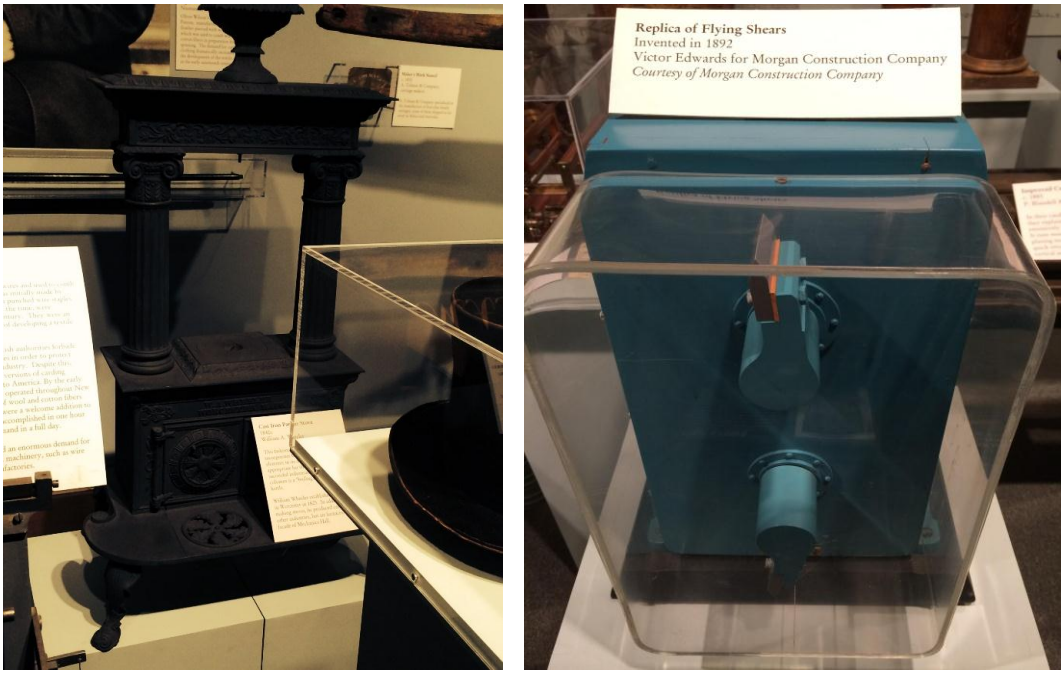

Figure 11: Examples of label usage in the exhibit. (Photo credit: Fathima & DellaGrotte, 2014)

Also, a mini theater area with seating is located in the corner of the room, which features a film of the citizens of Worcester. This mini theater can be observed in Figure 12 that displays the entire room. According to the National Endowment for the Arts (2009), visitors are more likely to view the film if seating is provided; such a space lets the visitors watch the movie in its entirety as they do not feel like they are disrupting other visitors' experiences (as cited in Falk *et. al*, 2012). However, because the video on display plays largely the same audio as from the sound sticks, visitors who have listened to them before will be much less interested in the content. At the same time, it has been shown that "if they are interested in the material being presented or fascinated by the technology, visitors will spend the time" (Falk *et. al*, 2012). According to Falk, films and media that require a large investment of visitor time will not be watched by most visitors. The video on display is nine minutes in length, which is a large time investment for visitors, given that the visitors expect to spend no longer than an hour or two in the museum (Falk *et. al*, 2012).

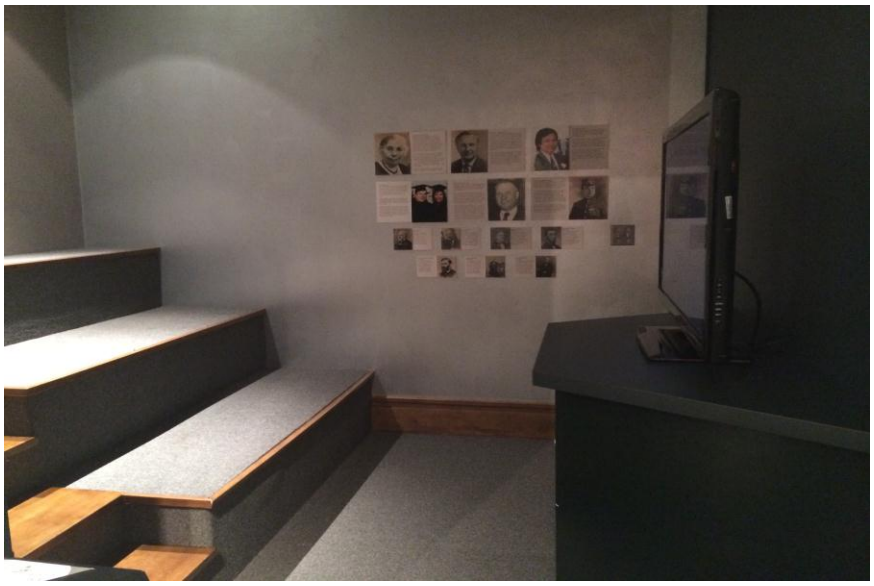

Figure 12: Mini theater including a nine minute movie (Photo credit: DellaGrotte, 2014)

In addition, there is a diner area in the back which can be observed in the following Figure 13. When asked about the purpose of the room, Mrs. Bumpus explained that the area once housed several computer stations in the past. In general, the area remained empty as compared to the rest of the exhibit with a table in one corner and pictures of diner chefs and banners on the wall.

Figure 13: The empty diner space (Photo credit: DellaGrotte, 2014)

We also looked through the stored collections with the museum curator Dr. Holly Izard. During our visit, Dr. Izard discussed the growing problem of all museums: the lack of storage space, and that most museums own separate storage units outside the museum to accommodate

those needs. This finding resonated with our background research presented in Chapter 2, that small museums are often limited by storage space for collections.

Dr. Izard guided us through the different rooms to show us the artifacts that were not presently on display. We believed that the stored collections would be a source of unique and intriguing artifacts that would further help to tell the story of Worcester's industry. However, we discovered that many of the artifacts were either duplicates or variations of objects that were already on display as shown below in Figure 14. This may confirm Guthe's (1973) conclusion that small museums have a tendency to accept many donations in hopes of interesting a wide range of visitors.

Figure 14: Several variations of rifles in stored collections. (Photo Credit: DellaGrotte, 2014)

4.2 Objective 2: Identifying major historical events

Our second objective was to identify relevant historical events that occurred in the past twenty years for the extension of the exhibit timeline. We felt that the best way to accomplish this was through snowball sampling to derive interview participants. The following are semi-standardized interviews that were conducted with industrial professionals and local professors of history.

Mr. Jack Healy

We conducted an interview with Mr. Jack Healy, the CEO of MassMEP, an agency that specializes in helping small manufacturing companies adopt current standards and technologies. Mr. Healy had insight into the types of industries that are thriving in Worcester because of the company's direct association with businesses. He explained that only the largest of companies that successfully adapt to the newest technologies can stay relevant in today's society.

We began by asking Mr. Healy about the state of industry in Massachusetts over the past twenty years. He explained that there are very few compelling incentives for companies to settle in this state. By establishing a business in a different state or even a different country, companies can avoid the price of energy and manufacturing costs that are generally high in Massachusetts.

We noted that our goal was to tell the story of the workers in this new industrial setting. In response, Mr. Healy recommended that it might be important to focus on the shift of the manufacturing industry from a labor-intensive factory setting into a research driven environment that deals with advanced concepts in fields such as life sciences. Newer industries require much fewer workers that have a higher and more focused skill set unlike the factory workers from the last century. He explained how industrial jobs in fields such as biotechnology require a much higher level of education because metalworking using large machines is such a fairly automated process today.

We asked Mr. Healy's opinion on the industries that are making the biggest impact in Worcester today. His first recommendation was to examine the Worcester Business Journal during the years of 1993 to 2014. We could easily discover specific companies that existed during that time period, and speak with their personnel to obtain more information and artifacts. In addition, he confirmed that the biotechnology industry has been a large part of Worcester's manufacturing industry and pointed us to the Biotechnology Park, which is located in the city. More specifically, Mr. Healy said that the biotechnology company AbbVie would be the representative of the kind of companies affiliated with the rise of this industry in Worcester. The company has been around since the creation of the Biotechnology Park and was one of the first to establish both research and development and production centers in the city.

Mr. James McNamara

We also conducted an interview with the director of the UMass Medical School office of technology management, Mr. James McNamara on February 10, 2014. The office of technology management specializes in patenting and licensing research applications from the Medical

School. Since Mr. McNamara deals with the latest biotechnological patents, we chose to speak with him regarding his perception on how biotechnology has evolved in Worcester over the past twenty years and where he thinks it is heading.

When asked where the biotechnological "hub" of Massachusetts was located he replied "Cambridge, but if there was a second place, it would be Worcester" (personal communication, February 10, 2014). He believed that if Worcester continues to progress in the field of biotechnology, it is possible that the hub could shift towards Worcester and become a more economical option for researchers who commute to Boston every day. Mr. McNamara also referred us to Dr. Craig Mello, a researcher from the Umass Medical School whose research in the area of RNA interference (RNAi) won a Nobel Peace Prize in 2006. His justification for referring us to Dr. Mello was that his research of RNAi is leading to developments in RNA therapeutics, an area of medical treatment that has applications to a large portion of the population.

Dr. John Sullivan

Dr. John Sullivan, the former Vice Provost for research at UMass described the industrial changes over the last 20 years for the advancement of research. Similar to other interviews, he sees Worcester as a "company start-up" center. He explained how approximately 20 years ago the research enterprise at UMass was valued under $50 million and since then, several major buildings have been built for the sole purpose of research. He noted, in 2001 the Aaron Lazare Medical Research building was built and just 10 years later, the Albert Sherman Center was built and houses the University of Massachusetts Advance Therapeutics Cluster. He stated that there are two methods of research, firstly, recruiting what he calls "the best athletes," and secondly focusing on specific areas. Most notably, they recruited Dr. Craig Mello in 1994 for molecular medicine, and within 12 years, his discovery of RNAi produced a Nobel Peace Prize.

Mr. Kevin O'Sullivan

We conducted an interview with Mr. Kevin O'Sullivan, who is the President and CEO of Massachusetts Biomedical Initiatives (MBI) on February 11, 2014. MBI is an organization dedicated to job creation and innovative healthcare throughout Massachusetts. The company acts as a "technological incubator" to promote the growth of start-up biomedical companies. We chose to interview Mr. O'Sullivan due to the impact of MBI on the development of the

biotechnology industry in Worcester and the number of entrepreneurial companies that are emerging in the city.

We learned that MBI helps companies, such as Blue Sky Biotech, Inc. to mature by providing them the laboratory space, scientific equipment and other cost-effective support services until they are stable enough to become independent firms. Mr. O'Sullivan told us that he was very proud of the fifty companies that MBI supported to become successful in the last ten years.

Mr. O'Sullivan also suggested that the transition from hands-on industry to modern brain powered industry is an important aspect to include in the new exhibit. He stated "things such as the wire industry represent Worcester's past, but technology will represent Worcester's future" (personal communication, February 11, 2014).

Dr. Craig Mello

After many suggestions referring to the Nobel Laureate, Dr. Craig Mello, we were able to fit a personal meeting with him on February 11, 2014 and discuss his important discovery. In 2006, he was awarded the Nobel Peace Prize in Physiology or Medicine for his discovery of RNA interference by use of the nematode C. elegans. He conducted his research at the University of Massachusetts Medical School in Worcester with his colleague Dr. Andrew Fire of Stanford University. In the one hour of his time, he was able to describe his discovery in a way to allow us to understand by using analogies that a common person could relate to. The general idea was that he found a "search engine" in the nematode C. elegans which is found in all organisms. He explained that just like when we receive unknown emails: we do not open them right away, but instead we check to make sure it is not a virus. Similarly, every cell goes through this process of checking when it contacts RNA by dicing it into pieces and rapidly comparing it to its "database" while it checks for any codes for virus. Dr. Mello used this extremely accurate search engine to program the system by entering a query to find a specific piece of RNA and silence it. As a consequence, if there is no RNA, there is no material to make up a gene. This discovery was significant because it allows researchers to turn off genes, one-by-one and observe the results. For example, this process can be applied to cancer cells by "turning off" targeted genes and figuring out which genes are causing the cell to be cancerous. He compared the accuracy of this search engine to Google and how you don't need to type in the 500,000 words of War and Peace to get results, you can just type "everything I know, I know because of love."

When asked how biotechnology is changing prospect of Worcester as a city, he replied that it has brought a frontier to the city, especially in medicine and that biomedical research is at the forefront. He noted, "It is a really exciting time for the field, and the world in general" (personal communication, February 11, 2014). He believes that biotechnology will be an economic success for Worcester and that more companies and jobs will hopefully appear in the near future.

WPI Historians

We spoke with two historians at WPI, Professor William Baller and Professor James Hanlan, who each elaborated on recent industrial events that have shaped the city. We based our questioning around the responses from our previous interviews, such as how Worcester has transitioned towards biotechnology and healthcare industries. Both agreed, however they also mentioned several other industries that they believed have become prominent in the past twenty years. Professor Baller noted that the entertainment industry in particular has seen a rise in recent years, due in part to establishments such as the Hanover Theater. In addition, he believed that the re-opening of the Blackstone Canal will create an entertainment/tourism district similar to what exists in cities such as Providence. On the other hand, Professor Hanlan mentioned that the industries of the past, such as Norton Company, are still around today but now produce different products. They do not have as large an impact mainly because the companies do not hire nearly as many workers. The interviews with these professors were able to give us a different perspective on modern Worcester industry than the ones received from biotechnology experts.

4.3 Objective 3: Analyzing visitor perceptions about "In their Shirtsleeves"

As noted earlier, our team felt that surveys would not be the best way to collect quantitative data, due to the time and sample size constraints. Thus, we decided to collect data by observing visitors and occasionally talking to them as they viewed the gallery. We noticed the areas they focused on and the length of time they spent with each display. We found that the majority of visitors come from school tours which are guided and designed to help point out artifacts that will best resonate with the children, who were aged between 5 and 10. Based on our brief conversations with visitors, we learned that both inexperienced (have never attended) and experienced (frequent) visitors, whose ages ranged from 50 to 80, spend time in the exhibit. These groups and individuals were made up of an equal number of both males and females.

By using the “continuum of attraction” as a guideline, we noted if the visitors had successfully completed the process of attraction, focus, and engagement. If the visitors asked questions about the artifacts, the theory states that they have successfully completed the “continuum of attraction” by connecting what they have observed with the intended theme of the exhibit (Bitgood, 2013). In addition, we focused on the visitors' reactions to "attractive versus silent objects," in the exhibit which are attributes described by Monti and Keene. They state that artifacts fall into two categories, which attract the visitors' attention. The first group is based on their material qualities, such as color and shape, as well as their non-physical attributes, such as iconicity and age. The second category are artifacts that hold a deeper meaning within their appearance (Monti & Keene, 2013).

When observing organized groups of visitors, we noted that they were mostly guided by one of the museum staff, allowing their visit to be more directional. According to Falk and Dierking, guided tours for organized groups usually consists of two phases: guided intensive viewing followed by free time of museum cruising (Falk & Dierking, 2012). The same technique was used by the museum staff while giving guided tours to groups of visitors. When interviewed, Mrs. Bumpus mentioned that the tour guides adapted their discussions during the tours based on the age and interests of the audience.

Visitors were initially led through the exhibit while the guide directed their attention to specific artifacts that were chosen because of their appeal to a large range of interests. Following this, the guide allowed the group free time to browse the gallery themselves and examine artifacts that were personally interesting. We observed that on these guided tours, visitors had a much greater interest in the information that the exhibit was presenting. This could be because the guides provided additional knowledge and stories about industrial history in Worcester, such as the invention of the steam calliope and the history of the city's diners, which cannot be obtained by viewing the exhibit alone. Once the tour guide allowed the visitors to examine the exhibit by themselves, they were much more engaged and willing to learn about the stories that were presented.

Guided groups of visitors largely consisted of children that were visiting the museum for school field trips. During these tours, we focused our observations on how the children interacted with both relatable and non-relatable artifacts. We observed approximately three to four school groups each week and found that children are typically excited by objects that they have seen in

their lives, like the space suit, the Valentine's Day card, and the monkey wrench. One of the most frequently asked questions was, “can we touch it?” to which the answer was “no”, 95% of the time. Almost every child picked up the sound sticks for the sake of being able to push the button and lift the receiver to their ears, however none stayed long enough to listen to the entire story. We also observed that children in these tour groups often focused solely on artifacts they recognized. The tour guides used this as an advantage and highlighted the Full Pressure High Altitude Flying Outfit made by the David Clark Company shown in Figure 15, Robert Goddard and his liquid fuel rocket, and the steam calliope because of its relation to a carousel. Besides those specific artifacts, children did not actively try and learn by reading other material presented in the exhibit, such as the labels or flipbooks.

Figure 15: Full Pressure High Altitude Flying Outfit made by the David Clark Company (Photo Credit: DellaGrotte, 2014)

In addition to guided tours of organized groups, we also observed inexperienced visitors who had never been to the Worcester Historical Museum and were either alone or with company. According to Falk and Dierking (2012), the inexperienced visitors usually undergo four phases

on their first visit through the museum, which begins with orientation, followed by intensive viewing of artifacts, then exhibit exploration, and finally concludes with departure from the exhibit (Falk *et al., 2012).* This seemed to be the case for the inexperienced adult visitors to the museum as well. We observed, however, that in contrast to guided tour groups, individual visitors tended to spend much less time observing the content of the exhibit.

"Melton was the first to suggest the tendency of visitors to turn to the right upon entering a gallery; according to him on average 75 percent followed this pattern" (Falk *et. al*, 2012). We observed the same pattern in the adult visitors and noted that they casually walked through the exhibit entering to the right and moving to the left while glancing over each display. This contradicts the way the exhibit is currently organized with the exhibit timeline originating on the leftmost wall and ending on the opposite side of the room. When first entering the exhibit, visitors gravitated towards artifacts that seemed to generate personal interest. After spending the majority of their time examining these artifacts, visitors dedicated brief amounts of time to browse the remaining objects in the gallery. Due to the fact that fewer artifacts were featured in the diner area in the back of the exhibit, visitors only glanced inside. Following this, visitors exited the gallery to visit additional galleries in the museum.

4.4 Objective 4: Researching successful methods implemented by other museums

Our fourth objective was to research methods of interactivity implemented in other museums by both visiting them as a guest, and interviewing the museum staff. The data we gathered helped us to understand how other museums are adapting to the decrease in visitation rates and also engaging their visitors.

The Waltham Museum

Our visit to the Waltham Museum gave us an insight into the workings of a small non-profit museum similar to the Worcester Historical Museum. The Waltham Museum, located at the intersection of Moody Street and Charles River, contained collections of artifacts varying from its Native American heritage to its industrial history. We were led by a tour guide who explained each display in detail and answered any questions we had.

The museum was mostly absent of railings or barriers so it was possible to lean over the glass displays and look down at the artifacts. Most displays were accompanied by several illustrations, photographs and labels, explaining the history in more depth. An example can be found below in Figure 16, which shows the well-known watches of Waltham.

Figure 16: Watches of Waltham (Photo credit: DellaGrotte, 2014)

Instead of arranging items in a timeline, the museum focused on individual industries and their products that were distributed in rooms with artifacts dedicated to the respective industries. Stated by their museum staff, the most popular exhibit was their "Waltham Hall of Fame" which consisted of nationally recognized people from Waltham, for example Big Bird from Sesame Street shown in Figure 17.

Figure 17: Hall of Fame: Big Bird (Photo credit: DellaGrotte, 2014)

Out of all the photos it was easy to pick out someone recognizable in history. Because the Hall of Fame evokes emotions of surprise and recollection, it is a simple form of interactivity as it completes the process of "continuum of attraction" mentioned in Chapter 2.

The Boston Museum of Science

We decided to visit the Boston Museum of Science knowing they had recently developed a new exhibit with significant levels of technology. Mr. Wilson from the technology department at the Boston Museum of Science stated, "You need to gear the exhibit to your audience" (personal communication, February 19, 2014). Their newest exhibit Hall of Human Life is an example of developing museum exhibits for families and having fun while learning. It contains over seventy new interactive components to allow the visitor to become a part of the exhibit ("Hall of Human Life," 2013). The highlight of the exhibit was the use of wristbands that stored one's personalized data obtained from completing interactive modules. Figure 18 below, shows the wristband dispensing machine and wristband.

Figure 18: Wristband dispenser and wristband. (Photo credit: DellaGrotte, 2014)

Approximately 25% of the interactive stations contained bar scanners for those who chose to receive wristbands. The wristbands gave an incentive to complete all the stations, which had an educational purpose. Every scan initiated a learning session and when the five-minute program was complete the data was saved to the visitor's wristband and the database program would store and remember their statistics for future use. Many of these stations required the visitor to directly interact with the machine. An example was scanning the wristband at a terminal and then walking a distance of fifteen feet while sensors recorded the visitor's pace. The end result was a visual replay of the walk on a screen as well as how many calories a mile are burned while walking at that pace. Figure 19 shows how the data is represented.

Figure 19: Evaluation of your walk (http://www.patriotledger.com/x1372982949/Quincy-scientist-directs-groundbreaking-exhibit-at-the-Museum-of-Science)

Additionally, it converted one's calories per mile into grapes per mile; how many grapes one could burn per mile. For more information, one could scan their wristband in a computer nearby for it to statistically show where one compares with 200 previous visitors. If one decided to continue completing these stations, the data was saved and they had the choice of reviewing their results at a later time. There was also a digital kiosk that let the visitors send a postcard via email depicting an activity of their choice that they may have participated in while in the gallery. A picture of the same can be seen in Figure 20.

Figure 20: Sending personalized postcards home via email. (Photo credit: Fathima, 2014)

This way, one can reminisce about their experiences at the Museum of Science and cherish the same with a souvenir to remind them of the time spent at the Museum.

Moreover, since biotechnology at the molecular level is difficult to convey in a typical museum setting, the museum addressed this issue by developing short videos, which explained the mechanism at a molecular level using animations. Each console focused on a specific issue related to DNA such as how genes can reveal many details about a person. Every station is set up similarly with pictures and text on the right and a video playing on a loop on the left. The video was colorful and was designed to show the molecular interactions in an understandable way. Figure 21 includes a few of the many displays about DNA and how it relates to the visitor.

Figure 21: DNA video display. (Photo credit: DellaGrotte, 2014)

For the purpose of catering to a wide range of ages and levels of comfort regarding technology, museums ideally find a balance of low and high technology systems. This was shown by the combination of static and touchscreen displays throughout the museum. One of the

static displays was of a full sized horizontal mill steam engine with labeled numbers and a sign that corresponded to these numbers. The explanations were brief but to the point and the labeled numbers were easy to see from a far distance.

Figure 22: Full size horizontal mill steam engine. (Photo credit: DellaGrotte, 2014)

LED lights were used in several displays. One particular exhibit allowed visitors to select a body part such as a general area or a specific bone or gland, and see where on the human body it was located. It allowed visitors to understand where in their own bodies the part was located in comparison to the LED dummy that was on display.

The Tsongas Industrial History Center

We visited the Tsongas Industrial History Center located in Lowell because of its well-known educational learning programs for children and its museum which is supported by the National Park services and UMass Lowell. We met with the Museum Education Supervisor Ms. Cynthia Vengroff, who led us through all nine educational programs that they tailor to specific curriculums that schools are teaching between grades 3-12. It should be noted that these programs are only accessible through planned school field trips. Depending on the current curriculum the students are learning, the teachers will choose three of the nine hands-on sessions which make up a four hour field trip. The purpose of each program is to amplify their learning experience through hands-on and teamwork based projects. The proof that this has been successful is in the amount of field trips they host on both a daily and yearly basis. Ms. Vengroff

noted, “We can have as many as five schools at a time, every day of the week. And several of them are returning schools. They just love what we do here” (personal communication, February 18, 2014). Figure 23 shows the nine educational programs and what school curriculums they include.

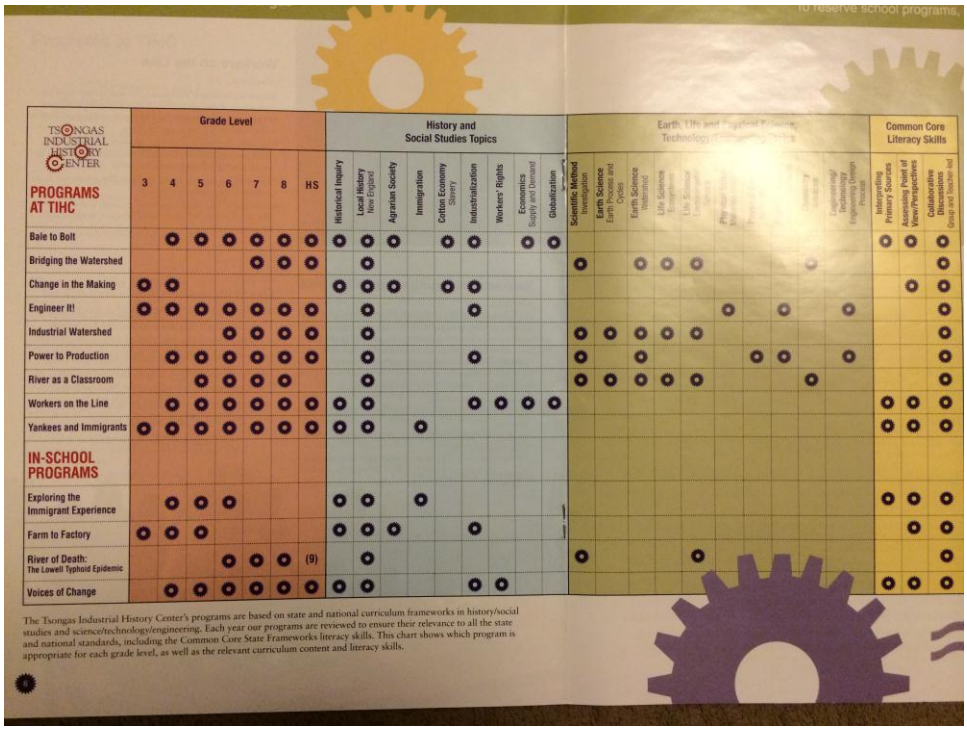

Figure 23: Educational programs pamphlet at the Tsongas Industrial History Center (Photo Credit: DellaGrotte, 2014)

Ms. Vengroff stressed the use of different learning types in each program, so that each student would be able to connect to the learning experience in their own personal way. The three major types of learning are auditory, visual, and kinesthetic. An example of applying the different learning styles was in a 3rd grade program called “change in the making” which teaches the students how the land and environment changes. For visual learners, they have three pictures showing the same landscape however in each frame they introduce a change; in this case, a developing city. For auditory learners a CD is played which sounds like a peaceful forest and then slowly turns into a busy city, and for kinesthetic learners they have a large rug in the shape of the same landscape and they are asked to place figurines on it according to what stage of development the city is in. For example, the students would place the Native Americans and wild animals on the green grass in the beginning of the program and would slowly have to replace them with houses and factory buildings at the end. She stated, “After the No Child Left Behind

Act ©, many schools have raised the bar on educational requirements as they pertain to field trips. If they do not believe the educational value is great enough, they cannot receive permission from the school board" (personal communication, February 18, 2014).

The museum was organized by subject and not every artifact was aided by a label. Most of the artifacts without labels were items that were obvious to understand and perceive what their function was. Figure 24 shows a display on cotton.

Figure 24: Cotton display from seeds to cloth. (Photo credit: DellaGrotte, 2014)

Many components of the exhibit were static however some were accompanied by small scale replicas for a hands-on experience with "how-to" instructions. Below is Figure 25 which shows the full size immobile loom and beside it a hands-on replica; Figure 26 shows a close-up view of the replica of the loom.

Figure 25: Loom on the left and hands-on replica on the right. (Photo credit: DellaGrotte, 2014)

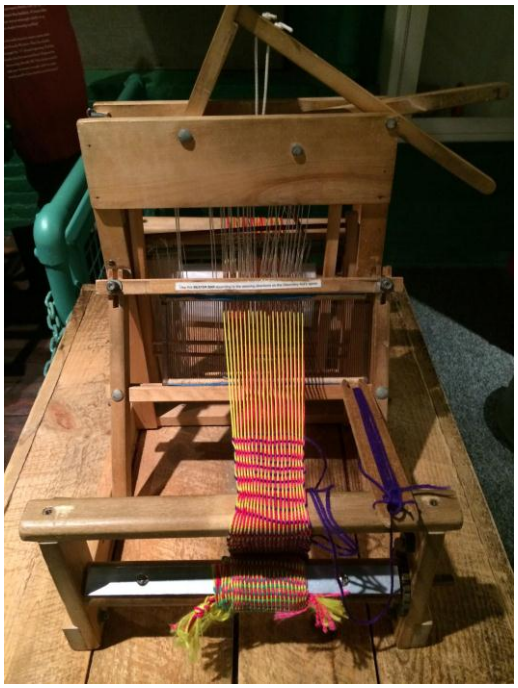

Figure 26: Close up of hands-on replica loom. (Photo credit: DellaGrotte, 2014)

One station that caught our eyes was a small tri-screen "debate" which explained the struggles of equal labor rights by having four actors discuss their views on the topic with exaggerated emotions. The entirety of the "debate" was approximately five minutes and was able to capture our attention for the whole time. Figure 27 is a photograph of the debate in action.

Figure 27: Tri-monitor "debate". (Photo credit: DellaGrotte, 2014)

Lastly, we watched antique looms produce cloth as they would from 100 years ago. The closest one can approach a working loom is about two feet, therefore it is easy to focus on how it works and moves. The finished products are sold in the museum gift shop and are a popular item.

Discussion

The key findings of our project led to two major themes that stood out as we assessed our data from the weeks of research and observations. These themes largely pertained to the extension of the exhibit timeline to include recent events from the past twenty years and making the visitor experience interesting and engaging. Subsequently, we deduced two models to support our findings namely an industrial metamorphosis and reminiscing museum experience.

The industrial metamorphosis

Through our interview with Mr. Healy we were informed of a transformation in industry currently occurring in the city of Worcester from a hands-on and physical type of work into a biological research driven industry. His observations of this transition were confirmed by four other interviews that we subsequently conducted.

The general consensus was that Worcester is prominently growing in the areas of life sciences as well as health care. At the UMass Medical School, Nobel laureate Dr. Craig Mello

was able to conduct his research and discover the process of RNA interference that has triggered other researchers to develop RNA therapies. MBI, headed by Kevin O'Sullivan, with its biotechnology incubator services has also helped many start-up companies, such as Blue Sky Biotech Inc. to focus on their research work rather than worry about business deals and equipment. The development of the health care industry in Worcester has led to innovate techniques being implemented in hospitals such as Saint Vincent Hospital and the UMass Memorial Hospital. These techniques involve incorporating lean manufacturing processes (typically utilized in factories and other manufacturing industries) to improve work flow in a time sensitive environment.

While the life sciences and health care industries are a growing part of Worcester's economy, our interviews revealed that the types of industries that made the city renowned are still prevalent. Manufacturing of machinery and parts has largely moved overseas to countries where workers can be hired to do the same type of services for a much lower price. According to Mr. Healy, however, 16.9% of the companies in Worcester are still involved in manufacturing. Norton Company, for example, still continues to manufacture products in the city after being bought out in 1990. The main difference is that companies such as Norton have been forced to shift their manufactured products to meet modern demands. From our interviews we learned that only companies that have been able to continuously adapt to market changes will remain successful. Although these manufacturing companies are playing a smaller part in Worcester's economy, they cannot be ignored when explaining the ongoing story of industry in the city.

Reminisce the museum experience

Given the leisure-based competition that museums face today, there is a need for a creative approach to exhibit museum collections that appeal to the visitors. To address this need, museums must alter their exhibits to explain educational concepts to visitors while attempting to keep them engaged through hands-on experiences and technological aids. Keeping in mind that people choose to visit museums for an informal learning experience either alone or as part of a group, interactivity can be used as a method to achieve a connection between visitors and artifacts that will remain even after the museum visit.

Figure 28: Connecting the visitors with artifacts through interactivity. (Design credit: Xu, 2014)

Our background research of museum studies and interviews with professors, including Professor Golding and Professor Forgeng, showed that many museums are developing exhibits to become more family and school oriented. By changing the museum environments to tailor educational needs to children as well as adults, they can provide an experience that is both educational and enjoyable for an entire family. When visiting the Tsongas Industrial History Center and the Boston Museum of Science we confirmed these statements by speaking with the museum staff and exhibit designers.

While the inclusion of family and school oriented exhibits in these museums is a portion of their success, it should be noted that their budgets allow for more complex and interactive displays. Despite this, the development of interactive exhibits does not necessarily require the highest level of technology as proven by the Tsongas Industrial History Center. They achieve successful engagement by featuring varying hands-on programs which tailor to a variety of learning styles. On the other extreme, the Boston Museum of Science's success stems from featuring the cutting edge of technology. Both have developed a reputation over the years for creating an exciting learning environment through hands-on experiences.

Based on the observations at both the Worcester Historical Museum and other museums we visited, specific visitor trends regarding the exhibits were discovered. The "general value principle" stated by Bitgood argues that visitors unconsciously weigh cost and benefits of their museum experience. He notes, "We attend to things in which are perceived as beneficial (such as satisfying curiosity, enjoyment) only if the costs are perceived as low in relation to its benefits" (Bitgood, 2013). As explained in our findings, visitors who were not on a guided tour spent little time examining artifacts individually and instead generally browsed the gallery. However, visitors who examined an artifact that had been owned by their parents or grandparents were much more likely to spend additional time observing and discussing the object. Recognizing that

most of the visitors interacted with artifacts they expressed were significant to them (usually because of nostalgic reasons) confirms Bitgood's argument stated above. This further supports the trend that children as well as adults focus primarily on the artifacts that they directly relate with or have prior knowledge about. However, if the artifacts are eye catching (such as the full pressure high altitude flying outfit) or feature interactive elements, visitors will attempt to study and learn about them regardless of whether the artifact has personal significance or not.

Our interviews with life sciences experts, such as Dr. Mello, and museum professionals, such as Mr. Benjamin Wilson, revealed that presenting information about Worcester's latest biotechnology industries could benefit from the aid of technology because the developments of these industries are not easily shown through the use of traditional artifacts. As mentioned in our literature review, the display of biotechnological research can be difficult because it often involves details on the molecular level. Therefore, the use of traditional artifacts would not provide the appropriate context or level of information for visitors. This idea was confirmed when we visited the Boston Museum of Science with their new exhibit Hall of Human Life. The museum developed the design of the exhibit over a span of ten years and included approximately seventy interactive stations. However, unlike the Worcester Historical Museum, which is non-profit, both of the museums we visited are either funded regularly by large corporations or receive profit.

By enhancing artifacts with methods of interactivity, the Worcester Historical Museum can instill a connection between artifacts and visitors that does not simply depend on nostalgic feelings. From our observations of both the exhibit and its visitors, we confirmed that interactivity allows visitors to create connections with artifacts that would not normally be of interest. Utilizing technology has proven to be an effective method of creating additional interactivity in an exhibit. We recognized that interactive technologies can help serve the ultimate purpose of museums to create a memorable experience for visitors; technology can thus aid in both displaying the recent scientific research as well as help the visitors relive the past. By adding interactive elements to an exhibit, museums can balance between providing educational content and engaging presentation. This will also lead to an environment that is more entertaining for a wider range of visitor types and help visitors reminisce their time spent at the Worcester Historical Museum.

In summary, many of our observations were corroborated by “best practices” discussed in the literature review and interview results from professionals. These resources helped us find standards for gauging visitor interest which we expanded upon by assessing the museum collections and observing visitors at the Worcester Historical Museum. Our observations combined with the "best practices" used in museums we visited led us to a better understanding of visitor experiences and the role that interactivity plays in exhibits. In addition to our findings related to improving museum experiences, our interviews with life sciences professionals highlighted the industrial metamorphosis in Worcester as a potential addition to the exhibit timeline. These events related to the biotechnological developments in the form of healthcare and life sciences industries in Worcester.

Chapter 5: Recommendations and Conclusions

In this chapter we will present our recommendations for the reinvigoration of "In their Shirtsleeves" industrial exhibit followed by sample scenarios that would detail the implementation of the recommendations in Appendix A. In order to classify the list of recommendations presented, we have arranged them in order of the level of technology that each recommendation entails. Our recommendations will begin with ideas that do not require technology to implement and continue through increasingly elaborate interactive technologies. In addition to our recommendations, we have included tables that detail examples of the companies/retailers who can be contracted to implement the recommendations.

The purpose of arranging the ideas this way is to provide the Worcester Historical Museum with a simple layout to examine and select recommendations based on their requirements. Ultimately, we hope that these recommendations will help WHM to implement their selected ideas as they please.

List of Recommendations based on Level of Technology:

Reorganization of artifacts

1. Change the name of the "In their Shirtsleeves" exhibit. Given our discussion about the recent industrial metamorphosis in Worcester, the revamped exhibit will have a new focus on the shift in Worcester's industries from hands-on factory work to a more abstract research-based industries such as biotechnology. Based on our background research mentioned in Chapter 2, labels must balance their length, while providing accurate information to convey its meaning. An exhibit title is similar to a label, therefore if the exhibit is changed based on our recommendations, the title will no longer meet the requirements of an effective label. As such, we recommend that the name be modified to reflect this shift to allow visitors to have a better understanding of the theme of the exhibit.

2. Reorganize the gallery to help the visitors understand the transition of industries in Worcester and create a more fluid exhibit. The exhibit currently displays a timeline of Worcester's industrial history along the walls, however the artifacts presented below the timeline often do not relate to the specific time period as was observed in our results from site assessment.

Additionally, as discussed in Chapter 4, the transition of industries from labor-intensive factory work to biological research could be included for the reinvigoration of the exhibit.

Rearranging the displays to highlight the relationship of the artifacts to the timeline will allow the visitors to better understand how the objects fit in Worcester's industrial history. This could also involve removing artifacts from the exhibit in order to relieve the feeling of clutter and create space for the inclusion of artifacts from Worcester's recent history. Other ways to organize the gallery could be based on industry (such as wire and biotechnology) or companies that originated in Worcester (Washburn & Moen and Norton Company). This would allow the visitor to see the progress of specific types of industries or individual companies in a single location. Observations from museums such as the Tsongas Industrial History Center show that organizing artifacts in ways other than a chronological order can still result in a satisfying exhibit experience.

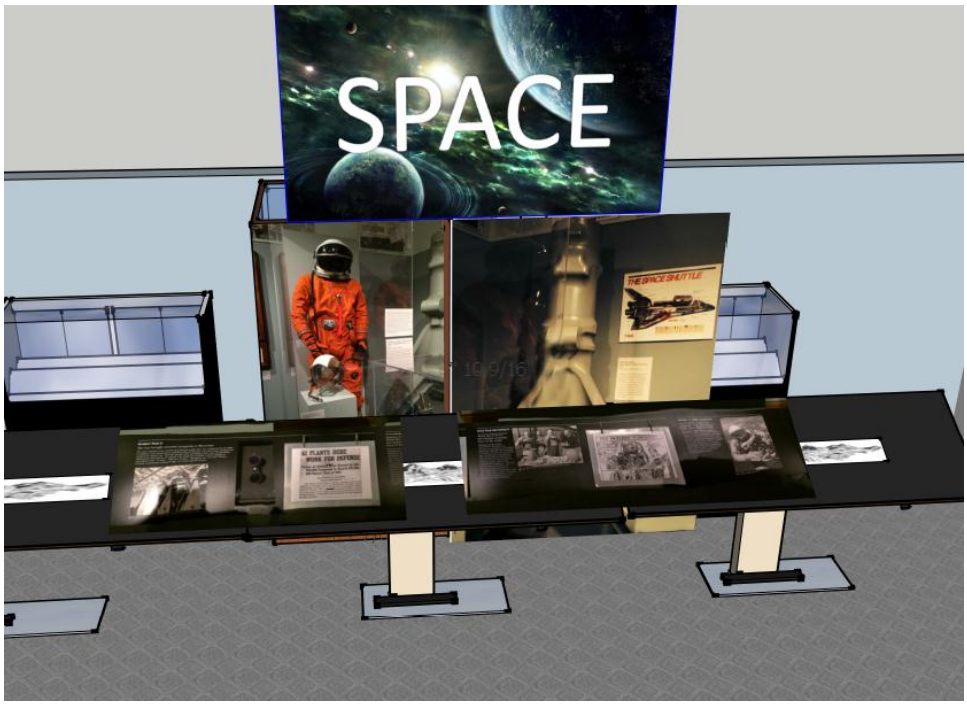

Figure 29: Exhibit concept design: Reorganization by industry - Wire and Space. (Design credit: Fathima, 2014)

3. Convert the diner and mini theater area to optimize space.

Based on our observations, few visitors enter the diner area because it currently features fewer artifacts. One suggestion to resolve this issue is to remove the wall between the main exhibit room and the diner to expand the gallery and create additional room for newer displays. Another idea to optimize the space is to develop an area for dress up with a background of a factory scene from Worcester's history. We learned through both research and museum visits that being able to take a souvenir home will strengthen the visitor experience. The clothes could represent styles from different points of Worcester's industrial past and a photo could be taken and sent via email as a souvenir.

Other ideas to optimize the space include the creation of an area detailing the three decker houses of Worcester as well as a small gallery focusing on personal stories from the citizens of the city. Worcester is well known for their unique three-deckers, as they created a residence for an entire extended family to comfortably live together. Today many of the three-deckers have been converted to college apartments, which prevents people from understanding their initial purpose. To convey to visitors the experience of living in a three decker, the diner area could be remodeled to emulate a room in one of these buildings from the 1900s.

The mini theater area is also not effectively used by the visitors as was observed in the results and so this space can also be optimized. The mini theater can be moved to the left toward the entrance so that all visitors necessarily receive a debriefing before entering the exhibit, thus making it directional for them to enter from the left as the exhibit timeline begins from the left and then moving toward the right of the exhibit. This shift of the theater would also ensure that there is enough space for the timeline to be extended to include the recent biotechnological developments.

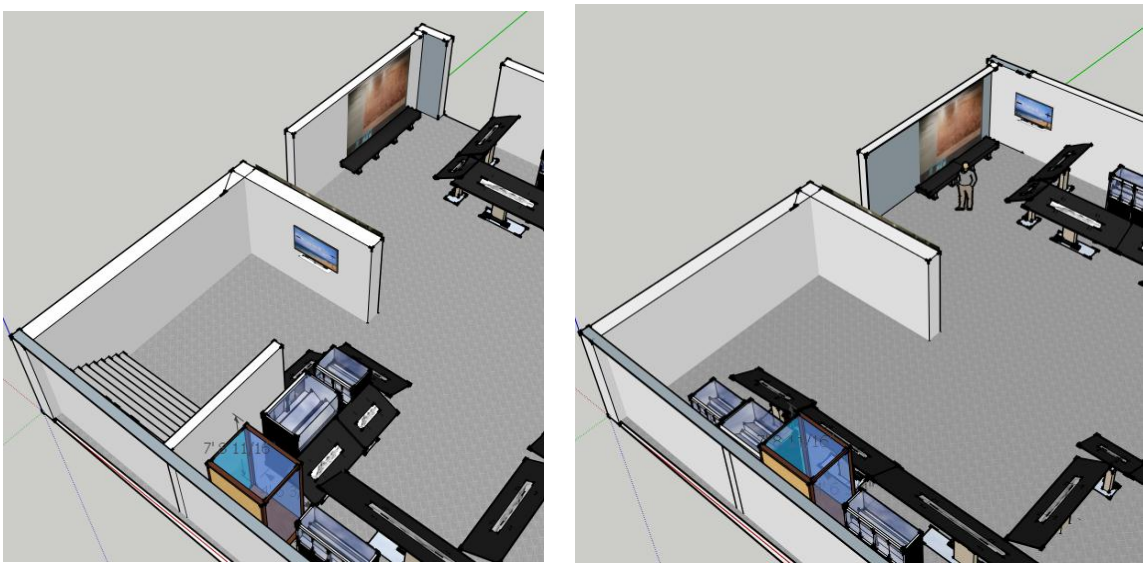

Figure 30: Exhibit concept design: Before and after optimizing mini theater space. (Design credit: Fathima, 2014)

Interactive models of artifacts

4. Include interactive models of current industrial artifacts in the exhibit.

Based on our observations during visits to other museums, we have determined that including interactivity with artifacts on display is one of the best ways to increase visitor engagement. Therefore, interactive models should be utilized in order to help visitors better understand and appreciate the industrial machinery in the exhibit. Specifically, artifacts such as the grinding machine and the wire setting machine could be enhanced with a smaller scale model. If these machines are still too dangerous to be interactive on a smaller scale, other machinery from the time period could be considered as well. Figure 31 shows an example of small-scale hands-on replicas that were used at the Tsongas Industrial History Center.

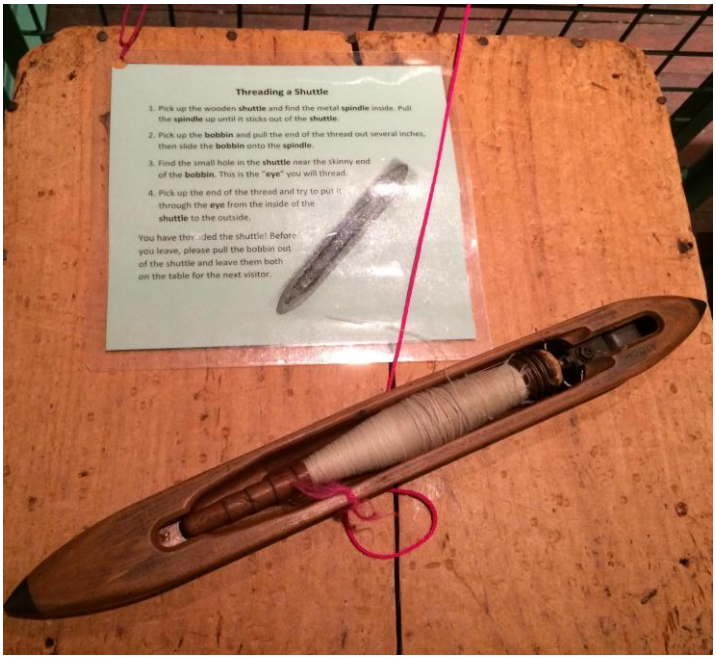

Figure 31: Hands-on how to thread a shuttle taken at the Tsongas Industrial History Center. (Photo credit: DellaGrotte, 2014)

Another idea to consider is adding LED lights to the replicas (full size or small scaled) to highlight the various aspects of the machine. By adding these LEDs, the visitor can press a button to see where specific parts of the machine are located. This would be a simple and cost effective method to help visitors understand the smaller concepts of a machine and how they connect to its overall function.

Name and company	Table loom by Schacht Spindle Company, Inc.
Cost	$800
Size	15" weaving width- 8 shaft
Contact	(303)-442-3212 or info@schachtspindle.com

Table 1: Schacht Spindle Co. Inc loom information

5. Add interactive models for biotechnology to the exhibit. In addition to models of industrial machinery, interactive objects should be included when considering an expansion for the exhibit. For example, the field of biotechnology has been extremely important in the last twenty years of Worcester's history. However, finding physical artifacts that successfully tell the story of the city's biotechnology industry is difficult. To work around this in the exhibit, interactive objects such as microscopes or hands-on atomic models as shown in Figure 32. These would allow the

visitors to examine slides that could explain the recent biotechnological developments such as RNA interference in a simple manner. In combination with animations and artifacts, an entirely new and interactive portion of the exhibit could be added.

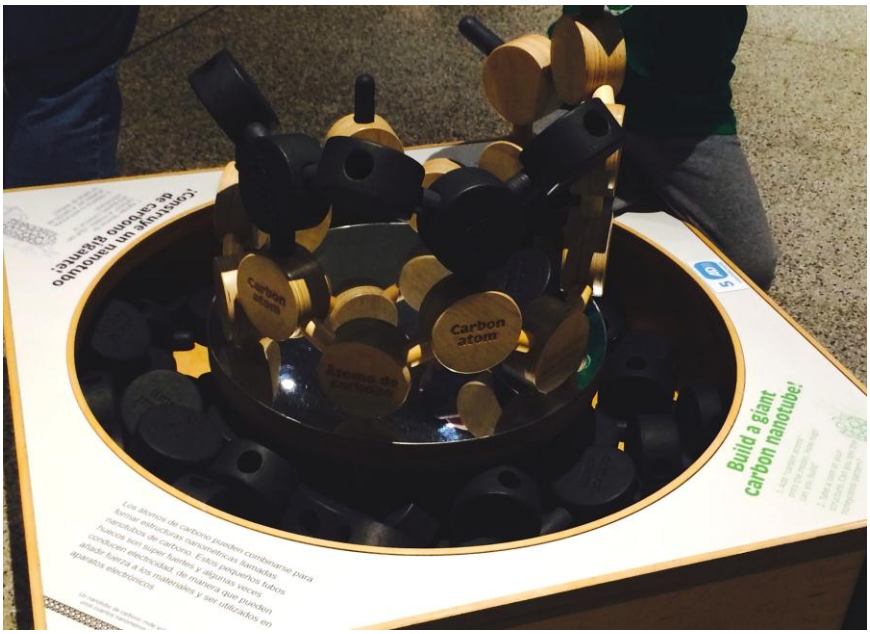

Figure 32: Hands-on atomic model from the Boston Museum of Science (Photo credit: DellaGrotte, 2014)

Visual aids

6. Add short videos or animations to the exhibit. Topics about industrial machinery and more recent developments such as biotechnology can often be difficult for visitors to understand because of the subject matter. For example, machinery from a factory in the 1800s would not create an immediate connection with a visitor because they have a limited understanding of how the artifact works, moves, and sounds. Instead of including only labels in the exhibit we recommend that adding other visual aids will leave visitors with an increased understanding.

Many people we interviewed suggested having Dr. Craig Mello's research represented through clips from his seminars. They believe he would be best able to articulate his thought processes and findings in an easy and understandable way. We recommend these clips be utilized in the updated section related to the life sciences industry. Another suggestion was to use colorful animation focused on one specific mechanism of his research. This idea stems from the examples of DNA stations at the Boston Museum of Science shown earlier in Figure 21.

Interactive touchscreen terminals

7. Install touchscreen kiosks in the exhibit to give visitors a wider range of information. This type of engagement can be used to better depict the theme of industrial transition in the exhibit. In addition, through interviews with museum professionals and visits to other museums, we determined that touchscreens are the most affordable and effective interactivity method for small galleries. Many diverse applications for touchscreen terminals can be applied to the exhibit such as an interactive map of Worcester, quizzes and games based on Worcester's industrial history, an online database of artifacts, pictures and videos of artifacts both in stored collections and on display in the exhibit, and historical information about citizens of the city in the form of a look-up database. The terminals could also be used to collect demographical information about the museum's visitors to better examine visitor trends as well as contact information to send advertisements of upcoming events. These applications could provide visitors with a fun and interactive alternative for learning about the content of the exhibit to supplement the collection of artifacts.

We believe that the most effective implementation for these terminals would be placing two or three in the center of the gallery where the plastics display is currently located. This location was chosen because it would both provide an effective entry point to the exhibit. In addition, visitors interacting with the terminals would not be distracting to visitors that chose to examine artifacts. However, terminals could also be installed alongside specific artifacts of interest to visitors, such as the full pressure high altitude flying outfit or the rat traps. The purpose of arranging them in this manner would be to highlight the objects that visitors already find interesting to both draw visitor interest and create a greater interest in the remaining stories the exhibit is displaying.

Figure 33: Exhibit concept design: Location of touchscreen kiosks to replace plastics display. (Design credit: Fathima, 2014)

Name and company	Multitouch coffee table by Ideum
Cost	Starting at $6,950
Maintenance	"maintenance free" No installation technicians No special set-up or requirements Fully assembled Lockable access ports for security
Size	Platform 32" coffee table with 40 touch points Platform 46" coffee table with 60 touch points both 2" thick
Durability	Bezel-less Water resistant Chemically strengthened glass Chassis made out of aircrafted aluminum
Operating system	Windows 8 fully installed
Support	Phone and e-mail- GestureWorks software development
Warranty	two-year full replacement

Table 2: Ideum coffee table information

8. Include an interactive map of the city on a touchscreen terminal. Based on observations of visitors at the exhibit, we determined that the map of the city was a display that visitors spent a significant portion of their time examining. Most visitors attempted to locate their home or place of work on the map of Worcester in 1878. To allow for a greater level of engagement, an

interactive map of can be implemented through the use of either a standard touchscreen or one in the form of a table. A touchscreen in the form of a table would allow visitors to examine the map in small groups and discuss their experience, which many enjoy doing with the map in its current form. This touchscreen could feature a digital version of the current map in the exhibit with an option to shift to a modern day map of Worcester. The map could also highlight interesting attractions or landmarks in the city, and the touchscreen interface would provide visitors with easy access to that information. In addition to further reinforcing the theme of industrial change in the city, the map could provide an interactive experience that families or other groups of visitors could enjoy together.

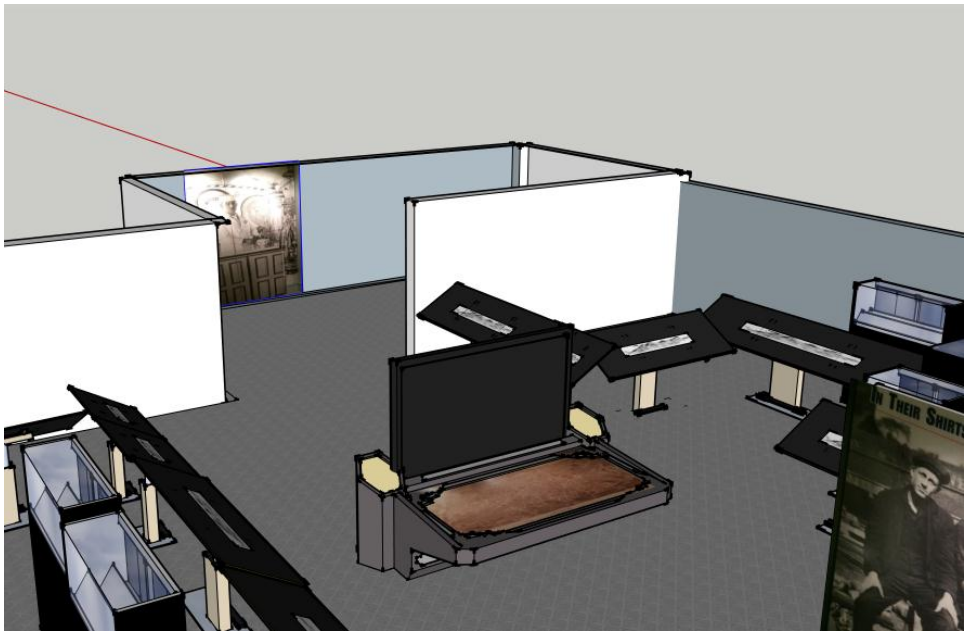

Figure 34: Exhibit concept design: Interactive map location. (Design credit: Fathima, 2014)

Name and company	The Presenter by Ideum
Cost	$11,950 (upgrades available)
Size	65" multitouch (up to 40 points) display (only 2 3/8" thin)
Operating system	Windows 7 OS
Support	Phone and e-mail- GestureWorks software development

Warranty	Two-year replacement from date of delivery
Contact	1-855-898-6824

Table 3: Ideum "The Presenter" information

Name and company	Video walls by Vislogix
Cost	Up to $250K depending on size and needs
Operating system	Will help design and engineer program
Maintenance	Offer a variety of built in maintenance including remote login, message notifications, power on/off scripts and scheduling
Installation	Vislogix installation services
Warranty	Extended option up to 5 years

Table 4: Vislogix video wall information

9. Include interactive games and quizzes on the touchscreen terminals. Our findings from interviews with museum professionals, specifically the curator of the Higgins Armory Museum, have brought forth that quizzes and games implemented on touchscreen terminals are one of the most effective ways to increase visitor interest. They allow both family and group interaction as well as a more engaging display of information. One suggestion that could be implemented is a touchscreen application that features a quick "questionnaire" about a visitor's interests and personality. Upon completion, the application would generate a result detailing the role that the visitor would have in Worcester's history (for example a shoe maker, factory worker, or seamstress). It would also provide information about that type of worker and point to artifacts in the gallery that are related.

In addition, quiz applications could be implemented to test the visitors' knowledge of the city and its industrial past. Quizzes allow visitors to either collaborate or share their knowledge or compete against one another. However, both types of interaction provide an engaging experience that visitors take part in together to learn more about the theme of the exhibit. In addition, the questions could be designed to provide answers to frequently asked questions about the exhibit. Questions could be randomly generated from a database so that each quiz provides a unique experience. In addition, questions could target certain age groups and be classified into specific

categories (such as the wire industry or the city's industrial history in the 1900s) to maximize visitor experience.

10. Replace the flip books with tablets. Currently the flips books contain several pages of text, and require a large amount of time to successfully read through them. However, the information they contain is supplementary to the artifacts and helps to convey the theme of the exhibit. By replacing these flipbooks with tablets, more information like photographs, animations, and videos could be added to provide more interesting material for visitors to examine. In addition, videos could be inserted within the text to further explain the topic. The topics could also be grouped by category and this would allow visitors the option to skim the main themes or read more deeply into the history to gain a better understanding.

Name and company	iPad Air by Apple
Cost	Wi-Fi $599 with 32 GB
Size	9.4" x 6.6" x 0.29"
Operating system	iOS 7 with AirDrop
Support	Apple genius
Warranty	One-year limited warranty

Table 5: Apple iPad Air information

Augmented reality & animatronics

11. Create a virtual online tour. Today, most museums have included an online virtual tour to give visitors at home a taste of what they may experience if they were to visit. Although there is theory about the technological paradox, which states that adding technology in hopes of attracting visitation may result in an opposite outcome due to easy accessibility from home. We feel as though online tours have become a normalcy and will be more helpful than detrimental in attracting visitors. According to (Conhaim, 2005), museums are using the internet to solve their storage problem. He states (p.31), "It's an inexpensive way to exhibit more treasures beyond limited space, a way to exhibit certain fragile items, a way to reach younger or new audiences and measure existing ones; and a way to expand the market (and revenues) from their shops." That being said, the virtual online tour can include generalized artifacts from collections, so that visitors will still feel the need to view the exhibit in person. Figure 35 is an example of the

Exploratorium's virtual online tour. They highlight the area where the exhibit is located on the map and have one or two photos sampling what the visitors will see. A short paragraph on the gallery is given and some have a short one to two minute video explaining a particular artifact. Their tour doesn't give away all the artifacts, which leaves the potential visitor wanting to see more.

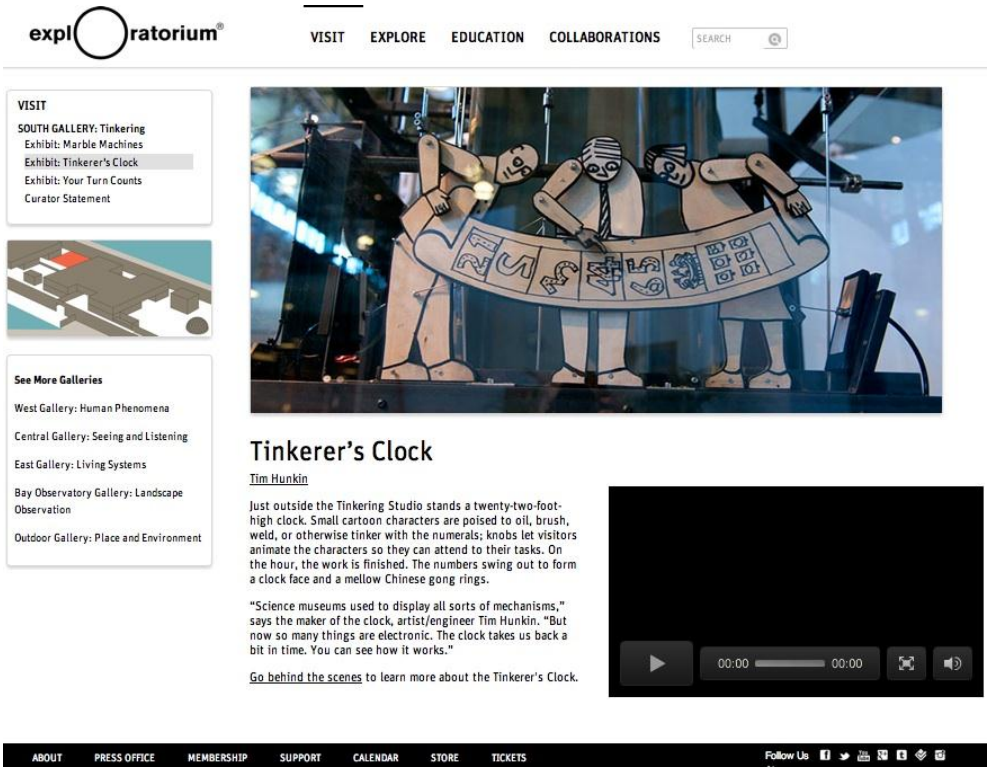

Figure 35: Snapshot of Exploratorium's online virtual tour (http://www.exploratorium.edu/visit/south-gallery/tinkerers-clock)

12. Include interactive Plexiglass cases for displaying artifacts. As we discussed in Chapter 4, visitors seek tangibility in museum artifacts and an interactive Plexiglass would enable the visitors to harmlessly interact with the artifacts without touching them directly. The interactive Plexiglass can visually display labels as well as more detailed information about the artifact thus ridding the need for physical labels; this information could include a simple as well as detailed label and description about the artifacts inside the case. Installing a transparent touchscreen based display for the artifacts inside the Plexiglass case would not only make the display more interactive but, also optimize the space used up by the railings that bar visitors from touching the Plexiglass.

Name and company	Eztouch window by Vislogix
Cost	$18-30K
Size	30"- 67" (VHF)
Maintenance	Eztouch ICS (interactive content suite)
Operating system	Works with mouse driven content Windows and Mac compatible
Durability	Direct sunlight resistant Thru-glass touch screen 98% transparent
Installation	Vislogix installation services
Contact	(800)-239-5013

Table 6: Vislogix EZTouch information

13. A hologram projection of an industrial worker can tell an interactive story. As observed in Chapter 4, visitors tend to try to personally connect to the stories of industrial professionals and the workers in Worcester that are on exhibit at WHM. However, lack of interactivity with their stories inhibits that personal connection. Reaffirmed by the literature review, the use of virtual projections can depict a particular industrial event that can be replayed live in action in the form of an interactive story. Some examples of using such a technology would be to emulate the workers union or women workers in Worcester.

These projections can be strategically placed in the current diner area or even the mini theater with the characters dressed appropriately for the age that is being depicted in Worcester's past. Many such projections in a remodeled room can be used to tell a story with different characters virtually interacting with each other.

Other examples of using this technology can be to emulate the artifacts in the exhibit and collections to visualize them while preserving the real artifacts.

Name and company	Holocube by vislogix
Cost	10" -$3,560 15" -$3,780

	19" -$7,900 32" -$9,600 40" -$11,450 70" -$36,670
Size	From 10" up to 70" can be customized
Maintenance	The unit is a self-contained No projector needed Works in all lighting conditions Integrated speaker system
Operating system	Company will provide a graphic design team to customize the program
Installation	Fully assembled 2-8 weeks depending on size and current queue
Contact	(800)-239-5013

Table 7: Vislogix Holocube information

14. Use 3D virtual objects to enable visitors to virtually touch artifacts. It is often difficult for visitors to understand the structure and function of a certain artifact by just reading its label and examining it from outside the glass case as was observed in Chapter 4. Augmented reality can be used to allow visitors to touch objects virtually by superimposing the object onto the visitors' hands, thus preserving the actual artifact in question. Visitors would be able to view and touch artifacts all around (from different angles) and thus have a better understanding of its functionality and use in different contexts. Several types of artifacts that are currently featured in the gallery could benefit from the incorporation of this technology. Tools that were important in Worcester's industrial history, such as the monkey wrench, could be virtually displayed and animated while "appearing" to be in the visitors' hands. Machinery and other large artifacts in the exhibit could also benefit from augmented reality. Miniature versions of a steam calliope or wire setting machine could fit in visitors' hands and be rotated to examine the artifact from all angles, which would be much more difficult with a physical version. In addition, artifacts that are housed in stored collections could virtually appear in the exhibit without creating more physical clutter.

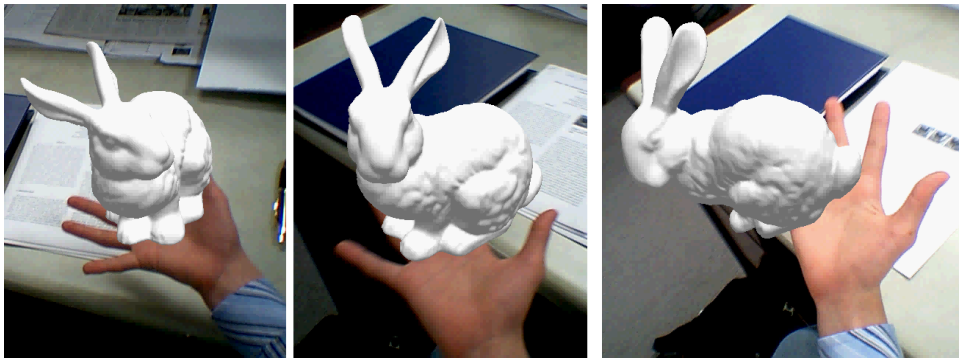

Figure 36: Creating virtual tangibility through creative use of augmented reality (retrieved from http://ilab.cs.ucsb.edu/projects/taehee/HandyAR/images/bunny.png, 2014).

15. Add animatronic figures to exemplify factory workers' experiences and emotions. The current exhibit focuses on telling the personal stories of the city's workers. However, their experiences are conveyed mainly through sound sticks, which often fail to keep visitor interest for their entire duration. One suggestion to retain the stories of common workers while also holding visitor interest is through animatronics. According to Teixeira (2009), visitors are easily drawn to objects that have unique physical attributes. Animatronics have the ability to emulate human beings from any time period and usually are capable of moving their limbs and producing strong facial expressions. Well known destinations such as Walt Disney World use animatronics to keep people entertained and focused on the information that is being presented to them as shown in Figure 37.

Figure 37: Hall of Presidents at Walt Disney Magic Kingdom (retrieved from http://photos.burnsland.com/Travel/Walt-Disney-World/Hall-of-Presidents-022111/1194151713_J9X7v-L-2.jpg)

In the exhibit, the animatronic figure could be dressed as a factory worker from any time period in Worcester's history. The worker could either use the dialogue that has already been recorded on a sound stick or new dialogue could be utilized to highlight a particularly important story.

Name and company	Full body replication by Custom Entertainment Solutions, Inc.
Cost	Basic level $10-12K Suggestion- $15K to have room to play with additional functions
Size	Full body (approx. 100 lbs)
Maintenance	Only company that makes self-contained animatronics "easier than taking care of a car" Fully programmed Fully assembled
Tech support	Over the phone diagnosis Skype Ship back to company to fix (Salt Lake City)
Warranty	One-year repair coverage (in house only)
Contact	President Josh Gray 1-801-410-4869 or e-mail solutions@customsolutions.com

Table 8: Custom Entertainment Solutions animatronics information

Sliding digital timeline

16. Replace the current timeline with a sliding digital timeline along the wall. The "In their Shirtsleeves" exhibit is currently designed around a timeline of industrial events from 1779 to 1993. This timeline decorates the upper portion of the gallery, however there is no room for including additional information. To address this issue and more directly tie the artifacts presented into the timeline of Worcester's history, the sliding digital timeline would be a best fit for several reasons. The system could be used to condense the information, encourage the visitor to continue learning, and could be routinely updated at the sponsor's discretion.

According to Griffiths (2003), museums have a tendency to over curate artifacts which results in what he calls "the death of a museum." He refers to a museum scholar George E. Hein, who states, "Collections should be distributed between exhibition and study areas" (Griffiths, 2003). By the use of the sliding timeline, the artifacts and literature can be condensed and allow the exhibit to remain in its chronological order. This will create more negative space to compensate the sensory overload that Griffiths mentions occurs in an overcrowded exhibit.
The basic mechanic of the sliding digital timeline involves a tablet that slides along a railing. With the use of position sensors, ideas and information will expand when the tablet hovers over a date or artifact. This technology allows visitors to delve into the information based on their own level of interest and also helps keep the exhibit compact and easily updatable over time. Videos, blueprints, pictures, and audio are a few suggestions that could be programmed into this device. This recommendation would be the most expensive and would require hiring IT technicians for installation. If this recommendation was considered, short and long term prototyping and trialing would be an effective way to gauge its success. Figure 38 below shows an example of how a sliding timeline has been implemented.

Figure 38: The Sliding Digital Timeline (retrieved from http://media-cache-ec0.pinimg.com/736x/93/b4/6a/93b46ac6846ed80080baf34eac3f32d4.jpg, 2014).

The sliding digital timeline is a newer product and typically is made from scratch by companies who design them to specific specs and requirements. Two sources we found to be accommodating are Ideum who are able to custom design and program touchscreen exhibits. There online custom design link is here http://ideum.com/custom-exhibits/ and can be contacted through email at info@ideum.com. The second company which appears to produce variations of the interactive digital wall is created by Onomy labs, the link is here http://www.onomy.com/blue/wall.html and can be contacted through email at info@onomy.com

Conclusion

The Worcester Historical Museum is not the only small museum currently facing the problem of an outdated exhibit strategy. Museums globally are challenged by decreasing visitor rates and a lack of interest which can be attributed to the development of entertainment technologies such as mobile phones and the World Wide Web. The recommendations that we have proposed to the museum were chosen with these concerns in mind. By implementing interactive experiences into the exhibit through the use of touchscreens and other technologies the museum will strengthen the visitor experience and begin to address the larger issue associated with visitation rates.

However, this is the first step in a larger process for the Worcester Historical Museum to upgrade their industrial exhibit in the Fuller Gallery. From our recommendations, certain strategies can be selected for the exhibit, similar to the sample plans but, based on the museum's parameters, such as budget. To successfully implement an idea, the museum could have WPI teams develop prototypes or trial runs that could be tested with museum visitors or focus groups. These projects would be inexpensive to sponsor for the Worcester Historical Museum as well as help students fulfill their graduation requirements. This could be a long term process which has the potential to generate quantitative data related to our recommendations which we were not able to compile due to the time constraints to meet our project deadline. Future project groups could analyze this data and determine if the pilot version of the recommendations is an effective tool to increase engagement levels in the visitors to the Worcester Historical Museum.

We are confident in our recommendations and believe that they represent a wide range of options that the museum could further investigate and include in their exhibit. Our ideas were organized in a manner such that the museum does not have to implement all the recommendations; the staff can select and focus on one suggestion or another and work up gradually to improve the exhibit. On the other hand, the museum could opt to select several suggestions at once and perform an entire redesign of the gallery if they would like. Additionally, many of our recommendations can be applied to other areas of the Worcester Historical Museum. By initiating this step in a larger process, the Worcester Historical Museum can solve the problems faced by small museums and continue to provide information about the city's past to an evolving audience.

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Appendix A: Sample Scenarios

We developed two sample plans detailing combinations of recommendations we offered in the previous part of Chapter 5. It should be noted, however, that these are not the only possibilities when making improvements to the exhibit. Our goal with these plans was to allow the museum staff to examine implementations that are focused on a wide range of factors, including cost, interactivity, and educational value. We believe the plans could be used to design initial exhibit layouts and prototypes for testing visitor reactions.

The two sample plans are meant to detail two scenarios that could be implemented: Plan A is an affordable implementation featuring interactivity while Plan B is more elaborate and based on cutting edge technology. For each plan we have provided a description of the recommendations that will be included, a concept design explaining the layout of the exhibit, and a table comparing elements such as interactivity and education on a numeric scale. The elements are ranked on a scale from one to five, with one representing a very low value for that element and five representing a very high value. In addition, we based our price ranking on the average value of our recommendations, however, actual implementations of these ideas could cost more or less than our estimates.

Our first sample plan represents an implementation that combines affordability with interactive elements. The first portion of the plan requires a reorganization of the exhibit to improve flow. By organizing artifacts in terms of industries instead of in a chronological order, the museum could create a separation for visitors who are interested in specific topics that the exhibit provides. The reorganization would also allow for a much simpler addition of content, for example biotechnology, when it is required. Including interactive models would be a cost effective way to enhance static artifacts that are already present in the exhibit, such as the large machinery. For the inclusion of technology in the exhibit, this sample plan will include the replacement of flipbooks with tablets and video kiosks that feature short animations. We chose these recommendations because tablets are the most inexpensive implementation of touchscreens and most visitors are already familiar with the technology. By including video kiosks or monitors featuring short animations, the exhibit will be able to explain more elaborate concepts to visitors without the use of more advanced virtual technologies.

In comparison, our second sample plan displays recommendations that are directly related to interactive technologies. As such, this scenario will be significantly more expensive than the first. A reorganization of the exhibit would also be implemented in this plan, however, it would instead be based around the incorporation of a sliding digital timeline. As mentioned in our recommendations, this technology would greatly increase the space in the exhibit for additional interactive elements as well as create a more engaging presentation. An interactive map could be featured at the center of the exhibit, so that visitors can learn about and discuss the transformation of the city in a group setting. Due to the space saving features of the sliding digital timeline, touchscreen terminals that feature games, quizzes, or additional information could be added to highlight physical artifacts remaining in the exhibit. In addition, augmented reality elements such as virtual objects can replace physical artifacts in the exhibit and work in combination with the sliding digital timeline to enhance interactivity. Finally, an animatronic figure could be placed at the entrance of the exhibit to greet visitors and provide context for the information that will be presented in the exhibit in the form of a personal story.

Plan A: Relatively inexpensive plan				
	Price level	Interactive level	Educational level	Entertaining level
Reorganization of the exhibit	2	3	3	2
Interactive Models	3	5	5	4
Gaming applications	1	5	3	5
Tablets to replace the flipbooks	3	4	4	4
Monitors with videos	3	4	4	4
Summary	12	21	19	19

Table 9: Technology Plan A based on expense

Plan B: Relatively expensive plan				
	Price level	Interactive level	Educational level	Entertaining level
Sliding digital timeline	5	4	5	3
Interactive map	4	5	5	4
Touchscreen terminals	3	4	4	4
Augmented reality	4	5	4	5
Animatronics	5	4	4	5
Summary	21	22	22	21

Table 10: Technology Plan B based on expense

After adding factors together as summary of plan in order to make comparison, we derived the following as results. According to the tables, apparently expensive plans have more high level technology involved and they certainly bring higher level of interactivity and entertainment to visitors. However, these two plans have similar educational level to visitors.

Appendix B: Specific Examples of Applications/Models

Index	Examples	Type
1	Textile loom	Machine
2	Grinding Machine	Machine
3	Flying Shears	Machine
4	Heavy Press	Machine
5	Ball valve	Machine
6	Wire coiling machine	Machine
7	Corset	Costume
8	Space suit	Costume
9	Monkey wrench	3D Replica
10	Folding chair	3D Replica
11	“Operation” game	3D Replica
12	Microscope	3D Replica

Table 11: 3D interactive model

Index	Examples	Type
	RNAi talk by Mr. Craig Mello	Informational Video/Physical Talk at the Auditorium
	Other biological processes involved in RNAi or Life Science at Worcester	Animation/Informational Video

	Life Sciences Research talk by Mr. Kevin O'Sullivan	**Informational Video/Physical Talk at the Auditorium**
	Flying Shears	**Instructional Video**
	Envelope folding machine	**Instructional Video**
		Animation
		LED Effects
	Calliope	**Informational Video**
	Animated Workers in the Historic Pictures	**Animation**
	Ball Valves	**Instructional Video**
	Recent Space Jump (space suit made in Worcester)	**Informational Video**
	Lunch Wagon for Hot Dogs	**Animation**

Table 12: Videos/Animations for the exhibit

Index	Examples	Type
	Robotic surgery	**Gaming Application**
	Dress up as an astronaut or wear a corset	**Gaming Application**
	Build your own rocket like Robert Goddard	**Gaming Application**
	Sound of a calliope, organ	**Gaming Application**
	Escape Rat trap	**Gaming Application**
	Ice skating	**Gaming Application**
	Textile loom	**Gaming Application**
	Personality Quiz to classify you as a worker in Worcester's industries	**Gaming Application**
	Interactive Worcester Map	**Spatial Map Database Program**
	Online Worker Database	**Online People Search Database Program**

Table 13: Mobile Apps for Touchscreen terminals