# Designing a Historically-themed Portable Miniature Golf Course as an Interactive Family Exhibit for Worcester Historical Museum

An Interactive Qualifying Project submitted to the faculty of Worcester Polytechnic Institute in partial fulfillment of the requirements for the Degree of Bachelor of Science


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## Abstract

In hopes of attracting more families and expanding its interactive exhibits, Worcester Historical Museum (WHM) has proposed to develop a Worcester history-themed, portable miniature golf course that will be used by the museum during special events and functions. The goal of our project was to establish the learning outcomes of the course, determine the most popular and appropriate themes for each hole, and create bid-ready designs for the course. We determined criteria and developed designs for our project through a series of focus groups, interviews, surveys, and field research with project stakeholders. We provided the museum with a recommended design, any necessary graphics, and description of each of the nine holes.

## Acknowledgements

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Next we would like to thank our sponsoring organization, Worcester Historical Museum, and its entire staff for giving us this project and providing us their input every step of the way.

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# Executive Summary

## Introduction

The city of Worcester, Massachusetts has a rich history. Worcester is the site of many inventions and firsts such as Shredded Wheat breakfast cereal, the first liquid-fuel rocket launch, the first pressurized space suit, the first National Women's Rights Convention, and the popular 1970's "smiley face" (Grosvener, 2012). The city's fascinating story is being kept alive by Worcester Historical Museum (WHM). Founded in 1875, WHM is the only institution devoted to preserving Worcester's history (About the Museum, 2013). Worcester Historical Museum has asked our group of Worcester Polytechnic Institute (WPI) students working through the WPI Worcester Community Project Center to assist with helping the museum expand their exhibits by creating a design plan for a Worcester-themed, portable nine-hole miniature golf course. The target audience of the course consists of student visitors, families, and special-event attendees, however, elementary school children are the primary target audience. The course is meant to offer an engaging look at Worcester history and help WHM become a more prominent part of the city of Worcester.

## Background

Worcester Historical Museum is a non-profit organization that strives to preserve pieces of the city of Worcester's vast history. The institution has been driven by its original principle of "rescu[ing] from oblivion such matter that would otherwise be lost" ("Museum History"). Worcester Historical Museum, like other museums, has suffered the financial consequences of the 2009 recession because funding for museums is highly dependent on the amount of disposable income within a population (American Alliance of Museums, 2013; Chiang, 2013). Concerns from families that historical museums are not family-friendly enough have potentially affected the attendance at historical museums as well (Reach Advisors, 2007). To address this concern, a valuable set of family-friendly exhibit guidelines, created in 1998, serve to help museums work towards this goal and can be seen in Table 1 below (Borun, 2013).

| Characteristic | Description |
|---|---|
| Multi-sided | "The family can cluster around the exhibit." |
| Multi-user | "Interaction allows for several sets of hands and bodies." |
| Accessible | "The exhibit can be comfortably used by children and adults." |
| Multi-outcome | "Observation and interaction are sufficiently complex to foster group discussion." |
| Multi-modal | "The activity appeals to different learning styles and levels of knowledge." |
| Readable | "Text is arranged in easily-understood segments." |
| Relevant | "The exhibit provides cognitive links to visitors' existing knowledge and experience." |

Table 1: Philadelphia/Camden Informal Science Education Collaborative (PISEC)'s seven characteristics of a family-friendly exhibit (Borun, 2013).

## Methodology

To begin the exhibit design process, we had to identify the desired learning outcomes for the course as determined by WHM and relevant stakeholders. A learning outcome is an idea or concept that a user should understand or ponder during and after visiting a museum exhibit. To identify ideas for learning outcomes, we conducted semi-structured interviews with educators in the Worcester School System. Acquiring information regarding learning outcomes, themes, course criteria, and engaging course components was completed simultaneously.

While establishing themes for the miniature golf course, we focused both on our stakeholders' favorite pieces of Worcester's history and their opinions on which themes would be most valuable for our target audience. We conducted theme-related semi-structured focus groups with two elementary aged school groups at WHM, and we also interviewed Worcester teachers regarding theme ideas. We then compiled a list of themes that WHM staff ranked for us to make a final decision regarding what themes will be included within the course.

Worcester Historical Museum asked us to design a miniature golf course that is portable, lightweight, durable enough for adults to stand on, does not require electrical sockets, and does not need to be repainted often. We also needed to comply with codes and regulations from both the U.S. ProMini Golf Association and the Americans with Disabilities Act (ADA). To develop and finalize our design criteria, we sent out email surveys to eight miniature golf course owners in the United States, in addition to getting continuous feedback from WHM staff, particularly Executive Director William Wallace and Exhibit Coordinator Vanessa Bumpus.

Our project group also had to discover what miniature golf course components are most appealing to our target audience. Some examples of miniature golf course components are hills, obstacles, and scenery. We held semi-structured focus groups at WHM with first and second grade students from the Worcester School System, and conducted field research by observing a predetermined exploratory group of children play through a miniature golf course. We sent out open-response surveys to various miniature golf course owners/designers around the country to gain a better understanding of what course attributes people prefer from a designer's perspective. Through focus groups, interviews, and field research, we compiled a set of attributes that appeal to our target audience.

Finally, we revised and compiled all of our information to create a completed design for the course. We presented our draft hole designs to WHM staff and a group of second grade students from Worcester to acquire feedback and suggestions for revisions.

## Findings and Recommendations

The design of this interactive exhibit went through many stages and was influenced by the elementary-age children, Worcester area public school teachers, and WHM staff whom we consulted. The primary groups with which we conducted research are children, parents, teachers, WHM staff, and miniature golf course designers/owners. Our project group made use of three documents to influence our project as well, which are the findings from PISEC, the Massachusetts Common Core of Learning (MCCL), and past surveys conducted by WHM regarding the Alden Family Gallery. Below we detail our project group's findings.

*Students should connect the themes of the miniature golf course to people and places that they have seen and learned about in their lives.* Two groups of stakeholders, teachers and WHM staff, stressed the importance of students connecting course themes to what they have seen in their lives. Connecting themes to everyday life will make the course more appealing because the themes are relatable to the participants. In addition, golfers may also be introduced to new landmarks in Worcester that they may choose to visit or research after using the miniature golf course. This finding is further supported by WHM's mission, PISEC, and the MCCL.

*Students would benefit from utilizing problem solving skills and techniques to complete the miniature golf course.* Problem solving techniques include understanding actions and reactions,

hitting the ball at certain angles and with certain force, and scorekeeping. Individuals from two groups with whom we conducted research, teachers and children, supported this idea. We recommend that problem-solving skills be incorporated into this miniature golf course. Incorporating this within the miniature golf course will allow students to learn not only about history, but about general problem-solving as well.

*Challenging holes, as opposed to easy holes, will appeal to our entire target audience.* A challenging hole has multiple obstacles and hills, and the hole is not a straight hole. An obstacle is an object that is not a hill and that individuals must putt through or around. Children, parents, teachers, and course designers stressed the importance of incorporating challenging holes: children, parents, teachers, and course designers. Based on this data, our recommendation regarding challenging versus easy holes is to include many challenging holes and few easy holes to best appeal to the entire target audience.

*Adult players will be interested in trivia related to Worcester's history, and trivia can also educate younger players.* Both parents and staff suggested the inclusion of trivia. Trivia will educate younger players while simultaneously entertaining older players. Trivia may also spark conversation between individuals. We recommend that the course includes a sign at each hole that contains information about the theme of the particular hole. We also recommend that some holes require putting into a correct cup or putting through the correct obstacle based upon answering a trivia question.

*Light, sound, and movement will appeal to the course's target audience.* Individuals from all five of the groups with whom we conducted research, in addition to document analysis, support the use of light, sound, and movement. Inclusion of these three design ideas will add entertainment value to the course while simultaneously offering additional ways for individuals to learn from the course. Our project group recommends that the course should make use of lights, sound, and movement to appeal to our target audience and to support individuals with different learning preferences (Borun, 2013).

*The target audience will enjoy objects that they can interact with on the course, as opposed to only including objects that they can putt around or over.* Children, teachers, course designers, and WHM staff supported the inclusion of interactive objects. The idea of interactivity is further

backed by both PISEC and past WHM surveys conducted regarding the Alden Family Gallery Exhibits within WHM. Consequently, we recommend that the course contains objects that can be pushed or pulled, including items that move when the ball comes in contact with them, to allow for interaction within the course.

The themes chosen as the most valuable for this course were developed based upon information gained from focus groups, interviews, and surveys with different groups of individuals: children, parents, teachers, and WHM staff.

## Conclusion

This project was designed to offer individuals an engaging look at Worcester's rich history while simultaneously assisting WHM in becoming a more prominent part of Worcester. With the inclusion of PISEC's seven characteristics for a family-friendly exhibit, the miniature golf course will allow individuals of all ages to have fun while learning about the city of Worcester.

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# 1 Introduction

The city of Worcester, Massachusetts has a rich history, having been the site of many inventions and firsts ranging from Shredded Wheat breakfast cereal to liquid-fuel rocket launches. The first pressurized space suit was created in Worcester. The first National Women's Rights Convention was held in Worcester. The first Federally-Licensed AIDS test was developed in Worcester as well. In addition the "smiley face," popular in the 1970's, was designed in Worcester (Grosvener, 2012). The city of Worcester has a fascinating history, and its story is being kept alive by Worcester Historical Museum (WHM). Worcester Historical Museum was founded in 1875 and is the only institution devoted to preserving Worcester's history (About the Museum, 2013).

Worcester Historical Museum, along with other museums, has suffered the financial consequences of the 2009 recession because funding for museums is highly dependent on the amount of disposable income a population has (American Alliance of Museums, 2013; Chiang, 2013). Consequently, WHM has been updating its exhibits and programs in order to draw in more visitors to increase revenue and expand knowledge of Worcester history. Following the increasing trend of interactive exhibits and taking into account various qualities that are necessary for a family-friendly exhibit, WHM has begun incorporating visitor engagement into its exhibit design.

Families' concerns with historical museums being family-friendly have potentially affected museum attendance as well. A survey was conducted in 2007 by the Reach Advisors, a marketing research group that serves the museum community, in order to access how well museums were addressing the desires of children and families. In this study, 5,500 museum-going families were asked to choose what type of museum they would most be interested in attending with their family. The participants were given eight different types of museums to choose from (historical, science, art, etc.) and found that historical museums came in last place

with only 23% of the participants saying they would attend a historical museum with their family (Reach Advisors, 2007). The lackluster performance of historical museums in this survey could be attributed to not pleasing their targeted audiences. If historical museums want to increase the interest of families and children, they need to target that audience. Once the desires of this demographic are met, attendance will increase.

Worcester Historical Museum plans to increase attendance by updating their museum to be more family-friendly. Consequently, WHM has asked a group of Worcester Polytechnic Institute (WPI) students working through the WPI Worcester Community Project Center to assist with this update. The project involved creating a design plan for a Worcester-themed, portable nine-hole miniature golf course for WHM. The target audience of the course consists of student visitors, families, and special-event attendees at the museum, with elementary school children being the main focus. The museum aspires for the course to offer an engaging look at Worcester history and include opportunities for use of math skills, hand-eye coordination, and teamwork. William Wallace, the Executive Director of Worcester Historical Museum, cares deeply about Worcester's history and the museum's well-being, and he is working with WHM staff to maintain the museum's relevance in the 21$^{st}$ century. This miniature golf course will allow children have fun while learning about Worcester's history.

Through interviewing various groups of individuals, such as children, parents, teachers, WHM staff, and miniature golf course designers, in addition to analyzing information provided by WHM, we designed a historically-themed, portable miniature golf course that will accomplish the learning outcomes desired by WHM. Through this goal, the staff of WHM wishes to reach a younger demographic. We explain the background research that we conducted regarding exhibit design in Chapter 2 of this proposal. We describe the challenges that museums face and the transitions that museums are going through. Next we describe how museums can continuously evaluate their exhibits in order to improve them. We then discuss Worcester Historical Museum, the changes that the staff are making to update their museum, and the project we created for them. In Chapter 3 we describe our methodology and our five objectives for this project: establishing learning outcomes for the course, deciding on themes for each hole of the course, establishing course criteria and constraints, discovering course components that appeal to our target audience, and compiling and presenting our project. Within Chapter 4 we discuss our

findings from this project and our recommendations for WHM. We describe each miniature golf course hole that we are proposing in Chapter 5. Finally, we conclude our paper with Chapter 6, which describes each hole in the proposed miniature golf course, explaining the theme for the hole, the learning outcomes involved in the hole, and the enjoyable course components included.

# 2 Background

## Introduction

Worcester Historical Museum is a non-profit organization that strives to preserve pieces of the city of Worcester's vast history. Operating at 30 Elm Street, the institution has been driven by its original principle of "increasing interest in Archaeological Science, and rescu[ing] from oblivion such matter that would otherwise be lost" ("Museum History"). In order to increase the attraction of Worcester Historical Museum's exhibits to younger generations and families with children, the museum has asked us to design a portable miniature golf course using Worcester's history as the theme.

In Sections 2.1 and 2.2 of this chapter, we describe the origins of public museums and the current problems that are plaguing small museums. In Section 2.3 we narrate the changing functions of museums within society. Next, we explain how to evaluate an exhibit in Section 2.4. We discuss WHM itself within Section 2.5. Finally, our project group explains the purpose of our project in Section 2.6.

## 2.1 Origin of Public Museums

Public museums have changed drastically over the past five centuries since their acknowledged existence. The Ashmolean Museum in Oxford, England and the Louvre in Paris, France are considered to be the origins of the public museum (Abt, 2011). Although they were formed in different regions approximately 100 years apart, these two examples provide great insight into how museums were formed and what role in society they fulfilled at the time of their inception.

The Ashmolean Museum, founded in 1683, was one of first museums to open its doors to the public (Abt, 2011). The museum's purpose was to display and preserve the artifacts that Elias Ashmole had collected throughout his lifetime (Lloyd, 1978). In order to accomplish this, the museum took a rigid approach as to how to handle staff and visitors. The curators of this museum created strict rules that dictated exactly how the museum was to operate and how visitors were to experience the exhibits at the museum (Lloyd, 1978).

The collection of art presented in the Grand Gallery of the Louvre was officially opened to the public in 1793 (Abt, 2011). Before the French Revolution, King Louis XVI held the paintings that make up the current day collection at the Louvre in Luxembourg Palace and limited who was able to view the private collection (Abt, 2011). The original purpose of the Louvre was to assist in the training of artists and display the wealth and sophistication of the royal family (Abt, 2011). When King Louis XVI was removed from power following the French Revolution, his collection was moved to the Louvre where it was opened to the public (Abt, 2011). Dr. Andrew McClellan, a professor specializing in the history of museums at Tufts University in Massachusetts, says "Elegant men and women of the world rubbed shoulders with artists and simple country folk [at the Louvre], some proud to be there, others hoping to learn, and some content to be seen" (McClellan, 1994, p. 12). Education was not the primary role of museums at the time they first opened to the public; there was a social aspect associated with attending museums since the average person could be seen with more sophisticated individuals. If a museum cannot identify its role in society and adjust to fit that role, then the museum will face challenges regarding attendance.

## 2.2 Challenges of the Modern Museum

Life in today's world is significantly different than that of the seventeenth and eighteenth centuries. There have been large leaps in technology, political revolutions, changes in education styles, and significant research done regarding museum exhibit design. In order to stay relevant, museums have had to move from the traditional sense of a museum, where museums presented information through collections and exhibits that were static in form, to a modern exhibit style. A modern museum does not present information the same way that traditional museums have in the past; their exhibits are dynamic and interactive.

Between 2009 and 2012 museum attendance increased for American museums that operate on an annual budget larger than $11 million (American Alliance of Museums, 2013). The Smithsonian, the American Museum of Natural History, and the Metropolitan Museum of Art are some of the biggest museums in this category. Unfortunately circumstances are different for mid-sized and smaller museums that operate on an annual budget of less than $11 million. Smaller and mid-size museums suffered because they were still recovering from financial repercussions of the 2009 recession. Museums depend on the discretionary income of patrons, which was limited during

and after the recession (American Alliance of Museums, 2013; Chiang, 2013). This recession in 2009 led to declining admissions for smaller and mid-size museums such as Worcester Historical Museum.

Declining attendance is not a new problem for historical museums; these institutions have faced this problem for decades. For example, attendance at the Smithsonian National Museum of Natural History, a museum in Washington, D.C., dropped from 8.4 million visitors in 2001 to 7 million visitors in 2013 ("Smithsonian: Visitor Statistics," 2013). Attendance at another Smithsonian Museum, the National Museum of American History, dropped from 5.2 million in 2001 to 4.4 million in 2013 ("Smithsonian: Visitor Statistics," 2013). In addition to larger museums experiencing decreasing attendance, smaller historical museums have suffered as well. Thomas Jefferson's Monticello, a luxurious colonial estate that is located in central Virginia, recorded 671,000 visitors in 1976 but only 440,000 in 2011; a 35% decrease in attendance (Freedom du Lac, 2012). Stratford Hall, the birthplace of Robert E. Lee, Commander of the Confederate Army during the Civil War, received a mere 27,000 visitors in 2011; a significant decrease from the 80,000 visitors recorded in 1976 (Freedom du Lac, 2012). This decrease in attendance has brought financial hardships to museums.

### 2.2.1 Financial Hardships


**Figure 1: Percentages of where museums in the US received their funding in the year 2009 (United States Department of State, Bureau of International Information Programs, 2012).**

Figure 1 depicts percentages of where museums in the US received their funding in 2009. Although the number of museums considered being in financial stress is beginning to decrease,

67% still represents a large population of museums that are struggling to make progress despite their lack of resources. The reason for this economic stress is complicated since museums do not receive their funding from a single source, and each funding source has its own problems and benefits associated with it.

The government provides 10.3% of the funding for nonprofit historical museums nationwide (Institute of Museum and Library Services, 2008). Historical museums are sponsored jointly by the federal and state governments. The largest federal government support comes from the National Endowment for the Arts (NEA). The NEA is tasked with supporting the arts through grants. Historical museums fall into this category, meaning that they are allowed access to some of the grant money as well. The NEA received $138 million in appropriation for 2013, down from $146 million in 2012 (National Endowment for the Arts, 2013). This decrease means that either fewer museums will be able to take advantage of the funding that the NEA has to offer, or that the same number of museums will now get less money.

Government funding for museums is not stable funding. One can determine the stability of a funding source by its likeliness to be available in the future, either short-term or long-term. Government funding is inconsistent year to year as taxpayers move from tax bracket to tax bracket without notice. This volatility in funding can lead to budgetary imbalances that museums cannot foresee (Institute of Museum and Library Services, 2008). Funding stability is important because it allows for museums to better plan the future of their organization.

The revenue generated from museum admissions and merchandise is an important source of income for historical museums. This is called earned income, and was greatly affected by the Great Recession between 2009 and 2012. In October of 2009, early on in the recession, the unemployment rate rose to 10% in October of 2009, causing a stark drop in the amount of people's disposable income (Bureau of Labor Statistics, 2013). As the unemployment rate slowly declines (Bureau of Labor Statistics, 2013), it is expected that the amount of disposable income will increase allowing more people to attend museums once again. As it is, museums are working to make admission as cost-effective as possible in order to better fulfill their missions: 35% of museums across the country were free back in the year 2006, and among those museums that were not free, 62% had free admission days (American Association of Museums, 2006). A more recent statistic from the American Association of Museums shows that in 2011, 40% of

museums had free admission or suggested admission only, and the other 60% offered some free admission days or discounted admission ("Museum Facts," 2013). While the percentage of museums that offer free admission days or discounted admission decreased by 2%, the number of museums that have free admission year-round increased by 5%. The revenue generated from the visitor admission often does not cover the cost of serving the visitor. This cost is not insignificant because it includes the salaries of museum staff, as well as any overhead costs such as utilities, maintenance, and mortgage costs. The median cost to serve a single visitor is $23, while the median admission fee is $6 (American Association of Museums, 2006). Museums have to find other sources of income to cover the remainder of the cost of operation.

The remainder of funding for nonprofit historical museums comes from private donations (46.0%) and institution financial investment (21.4%) (Institute of Museum and Library Services, 2008). Private donations, ranging from the donation of a single visitor to a corporate sponsorship, change with the state of the economy and make private donations just as volatile and unstable as government funding.

Earned income is what museums can control the most. While earned income is not an entirely stable source of income, museums hold some control over earned income due to having control over the quality of their exhibits. If exhibits are appealing to a visitor, that person will be more likely to attend a museum and encourage others to attend as well. Therefore there is more pressure on museums to meet changing customer needs and provide a great visitor experience.

## 2.3 Changing Functions of the Museum within Society

The role that museums play in society has changed considerably in just one generation. Museums have continued to adapt to the changing preferences of their audiences by updating exhibit design and collections. The International Council of Museums (ICOM), founded in 1946, is an international forum of museum experts that work together to address challenges faced by museums worldwide (ICOM website, 2013). Following the ninth General Conference of ICOM in 1972, ICOM identified four roles museums served in society. Much has changed between 1972 and 2013, and museums are struggling to adapt to these needs despite their full-hearted effort. The role and functions of museums have evolved to embrace educating the population through various forms.

Dr. Élise Dubuc, a professor in the Department of Art and History at the Université de Montreal, has identified a list of eight functions that museums currently play in society. The differences in the roles and functions of museums in 1972 versus 2011 are listed below in Table 1.

| ICOM Defined Functions (1972) | Modern Museum Functions (2011) |
|---|---|
| Conservation | Conservation |
| Collection | Culture |
| Research | Social |
| Exhibition | Scientific |
| | Education |
| | Economics |
| | Politics |
| | Symbolic |

Table 1: This table compares the defined functions of a museum (Dubuc, 2011).

Table 1 illustrates how the list of functions has expanded and changed in the last 40 years. Conservation is the one function that can be seen in both lists, but they have slightly different meanings. The 1972 ICOM definition is "to conserve actual items such that they can be used to explain a situation of the past" (Dubuc, 2011). The modern definition is more abstract because it focuses on conserving the knowledge associated with an item, rather than conserving the item itself. Dubuc uses Japan's conservation of Shinto temples as an example to explain the modern definition of conservation. The Japanese focus on preserving and transmitting their artisans' knowledge rather than simply conserving the original artifacts (Dubuc, 2011). The exhibits within a museum must be altered in order to adapt to this new definition. For example, rather than just showcasing an ancient relic, additional information should be included so that the visitor can get an understanding of the time that it is from and the people that used it.

A museum's educational role is to give an ordinary person a broad and relatable experience through the engagement of exhibits at a single place (Dubuc, 2011). Museums have found a niche in the education theory that has developed over the past century. A visitor may visit a historical museum and see a vase from the age of the Roman Empire. The visitor could see that people from that era had a problem with transporting water from one place to another and used

problem solving skills to develop the vase that allowed them to move water. The vase showcases how the problem solving process was applied to the real world, and being able to apply lessons to the real world is an established goal of the education system (Trilling & Fadel, 2009). Therefore, museums can fill a need of the education system if they can accomplish the education function of the museum through their exhibits. Sometimes accomplishing this task is difficult with smaller museums' limited resources.

A museum is considered to have a social function if it allows for the integration of a diversified population at its exhibits. A social function is important because it has the ability to bring people out of their comfort zone and engage with people that they may not have engaged with previously. The Grand Gallery at the Louvre is a great example of why a museum's social function is important to its success: When the Louvre was finally opened to the public, it provided a place for people of a lower social-standing to be in the same place as famous artists and other people of a high social standing (McClellan, 1994). This intermingling of individuals from different classes helped the museum thrive. Today if a modern museum does not allow for a wealthy scholar and a low-income or uneducated individual to gain similar experiences viewing the exhibits, then the museum is not accomplishing this function.

### 2.3.1 A Swift Change in Demographic

The demographic of people that attend museums in general has changed over the course of the last century. According to Elisa Barosso, author of an article about attracting and educating young museum visitors, museum exhibits traditionally have targeted the "baby boomers" (Barosso, 2009). Baby boomers are individuals who were born soon after World War II and are currently ranging in age from 68-73 (Barosso, 2009). Although baby boomers still represent a significant funding source for museums by paying entry fees, museums must broaden their audience (Barosso, 2009; Roberts, 2012). Children and their families play a significant role in the continuation of historical museums. Because different styles of exhibits appeal to different audiences, museums must adjust their exhibits accordingly to gain interest of a broader audience. For example, a static exhibit such as famous painting would not mean as much to a child as it would to an adult who could analyze the painting. This difference in what individuals look for in an exhibit is due in part to a difference in age, where an adult can understand and appreciate

something that a child cannot, and a change in education theory that has developed in recent decades.

Education theory encompasses how people learn to solve real world problems that they might face. An understanding of education theory, which has evolved in recent decades, is important in order to ensure that learning outcomes are reached through engagement with an exhibit. Education is moving away from era of "dispensing content in a one-way direction – instructor to student" (Kratz & Merritt, 2011). The new concepts of an educational system are defined by a set of established goals, and these goals include skills in critical thinking, synthesizing information, being able to apply lessons to the real world, innovation/creativity, and teamwork/collaboration (Trilling & Fadel, 2009; Kratz & Merritt, 2011). Museums are benefiting from this shift in education theory because museums provide a way to accomplish these new goals of education theory (Kratz & Merritt, 2011). Rather than featuring static exhibits that followed along with the previous idea of education as described by Kratz and Merritt, museums must now feature exhibits that allow for education through interaction. Museums can complement other education mediums through the organization of school trips and family visits. Updating exhibits in order to incorporate new learning styles in the educational system allows museums to bring in more visitors.

### 2.3.2 Characteristics of Family-Friendly Exhibits

With the goal to improve museum exhibits to encourage family science learning, four museums in the Philadelphia area established the Philadelphia/Camden Informal Science Education Collaborative (PISEC). The collaborative of PISEC began a study in 1998, dubbed the 'Family Science Learning Research Project' (ESI -9355504). This three-year research and development project, funded by the National Science Foundation, consisted of three phases, each a response to a research question involving family learning and how to design an exhibit that facilitates family learning (Borun, 2013). Using the results from their research, PISEC compiled a list of seven characteristics of family friendly exhibits, which are shown in Table 2.

| Characteristic | Description |
|---|---|
| Multi-sided | "The family can cluster around the exhibit." |

| | |
|---|---|
| Multi-user | "Interaction allows for several sets of hands and bodies." |
| Accessible | "The exhibit can be comfortably used by children and adults." |
| Multi-outcome | "Observation and interaction are sufficiently complex to foster group discussion." |
| Multi-modal | "The activity appeals to different learning styles and levels of knowledge." |
| Readable | "Text is arranged in easily-understood segments." |
| Relevant | "The exhibit provides cognitive links to visitors' existing knowledge and experience." |

Table 2: This table displays PISEC's seven characteristics of a family-friendly exhibit (Borun, 2013).

When the four partaking museums incorporated the characteristics listed in Table 2, they found a measurable increase in family learning. This list contains valuable guidelines to use as a reference; however, more must be done in order to bring an interactive exhibit to its full potential (Borun, 2013). Some visitors simply wish to wander through a museum and learn something on their own while others prefer to have a social experience in groups. With goals of such varying possibilities, exhibits must be capable of appealing to a broad museum audience (Borun, 2013). Once these seven characteristics have been incorporated into an exhibit, the exhibit must be evaluated and reviewed.

### 2.3.3 The New Approach to Exhibit Design

What is desirable to a visitor today is much different than what was desirable in a traditional museum. As demonstrated by PISEC's "Seven Characteristics," museums are changing exhibits so that they appeal to a wider audience by "…[shifting] away from a curatorial view of the collection and towards an increased effort to communicate with a broader museum audience," (Borun, 2013). Changes in technology, learning styles, education, and expected functions of a museum have all influenced what visitors find appealing.

Interactive exhibits are now more frequently used in museums around the globe and have been defined in a variety of ways. Barry Lord and Gail Dexter Lord, authors of *The Manual Museum Exhibitions*, define an interactive exhibit as a demonstration or multimedia with the characteristic

of allowing for response to stimulus, meaning that individuals have opportunities to interact with an exhibit in some manner and make changes (Lord & Lord, 2002). Sue Allen and Joshua Gutwill, accomplished scholars in the field of visitor research, believe interactive exhibits to be an exhibit in which "visitors can act on the exhibit and the exhibit reacts" (Allen & Gutwill, 2011). While these definitions vary, it is clear that the central objective of interactive exhibits is to physically engage the visitor, causing the visitor to think and experiment.

The effectiveness of a museum exhibit can most clearly be seen if the exhibit accomplishes its goals of learning and leaves a lasting impression on its visitors. "Physical interactivity, the ability of an exhibit to respond to visitor actions, is considered a cardinal feature of science (and children's) museums," says Allen (2004). Allen continues, "Research on visitor learning in museums suggests that interactivity promotes engagement, understanding, and recall of exhibits" (2004). The ability to interact with an exhibit allows individuals to remember the exhibit more strongly. Barbara Schneider and Nicole Cheslock , authors of *Measuring Results,* discuss the impact of successful museum exhibits. Schneider and Cheslock write, "Hands-on exhibits are more likely to attract and hold visitors' attention, enhance social interactions, increase knowledge, and lead to more questioning and less 'explanatory' or telling behavior" (Schneider and Cheslock, 2003). They further support this argument by explaining a study done by Jeffrey Swanagan, an individual who in the year 2000 published an article titled "Factors Influencing Zoo Visitors' Conservation Attitudes and Behavior" within a journal known as *The Journal of Environmental Education*. Schneider and Cheslock describe how Swanagan compared an elephant show that only allowed viewing of elephants against an interactive elephant show that included a fact-based program. Individuals participating in the experiment retained more knowledge from participating in the interactive exhibit than from simply viewing the elephants (Schneider and Cheslock, 2003). Swanagan's findings are significant because they show how interactivity allows for knowledge to be retained more successfully. Once family interactivity is incorporated into museum exhibits, the exhibits convey their learning outcomes better while simultaneously providing better entertainment.

### 2.3.4 Please Touch Museum

The Please Touch Museum (PTM) began as a pilot project in 1976.

Figure 2: A model of a 1876-style train station in the Please Touch Museum ("The History of Please Touch Museum").

Equipped with limited staff and a low budget, PTM is dedicated to pleasing individuals of ages 7 and under, but visitors older than the museum's target demographic will enjoy the museum as well (Dobrin, 2008). The museum opened its doors to over 400 visitors on opening day and "children played, weighed and, of course, touched their way through exhibits that engaged their senses and ignited their imaginations, while parents fought the instinctive urge to warn, 'Don't touch that!'" ("The History of Please Touch Museum"). In only a few weeks, the museum's original 2,200 square foot space was deemed too small to fit its growing number of visitors. Two years later the museum changed locations to a larger space, and five years later they moved again to a three-story, 30,000 square foot building in the center of Philadelphia's museum district ("The History of Please Touch Museum"). The PTM continued to move until it reached its current residence in Memorial Hall in Fairmount Park. Some exhibits that children can interact with are an 1876-style train station, a construction zone, and a model of the Children's Hospital of Philadelphia Medical Center. The increasingly popular Please Touch Museum grew to uphold its desire to appeal to not only children, but parents and families as well. This desire to please children, parents, and families is one of their Core Values listed as "Child-centered and family-focused" ("Please Touch Museum's Mission"). Since its beginning, the PTM's exhibits arose from strong front-end evaluations, followed by formative evaluations over the years.

## 2.4 Evaluation of Exhibits

To judge the effectiveness of interactive museum exhibits, the exhibit needs an evaluative component. An evaluation that provides continuous feedback from its visitors over a long period of time communicates the audience's needs quickly and effectively, thus, multiple stages of evaluation are usually conducted during an exhibition's growth and development ("Exhibition Evaluation, 2013"). With such a system in place, museums can gauge the success of newer interactive exhibits and keep visitors interested by updating older ones. Randi Korn & Associates, Inc., a group of museum planning, evaluation, and research specialists, have described the various stages at which evaluations can be done to improve an exhibit's ability to achieve predetermined learning outcomes. The list of evaluations can be seen below in Table 3 ("Exhibition Evaluation, 2013").

| Name | Description |
|---|---|
| Front-end evaluation | Conducted after concept development, this form of evaluation informs teams on how the public thinks about their exhibition ideas. Front-end evaluation helps exhibition teams understand their audiences in the context of the exhibition ideas. |
| Formative evaluation | Conducted during design development, usually with prototypes, interpretive ideas and components are tested for functionality and the ability to communicate content. |
| Summative evaluation | Conducted after an exhibition is completed, this form of evaluation determines an exhibition's overall successes and shortcomings as well as examines behavioral, cognitive, and affective outcomes against the exhibition's goals and objectives. |

Table 3: This table lists various evaluations that can be done on interactive museum exhibits ("Exhibit Evaluation, 2013").

Front-end evaluation may be the most important form of exhibit evaluation, and museums must use front-end evaluation to erase any possible confusion that an exhibit may generate. While clearly not the intention of any exhibit, misunderstandings are not uncommon and are most prevalent in children in the developmental stages of growth. A child may be misinformed by what can be called 'naïve notions,' which can occur from misunderstandings or from adults who inadvertently share mistaken explanations for common phenomena (Borun, 2013). At its core, front-end evaluation is the main link between visitor and the exhibit designer.

During formative evaluation, tests are run and processed with the aid of visitors using anything ranging from drafts of text, graphics, and interactive prototypes. The audience essentially becomes a partner in the development of a new exhibit, because they possess the opinions that truly matter (Rand, Kiihne & Watkins). Summative evaluation, which is used only when it seems as though a tried and tested exhibit has been deemed "complete," can shed light on any last-minute issues that have not been encountered in previous steps of evaluation after the exhibit opened (Rand, Kiihne & Watkins).

Museums targeted at children have been leading the way in incorporating interactive properties into their exhibits, and through these incorporations, a number of problems have been uncovered with the widespread increase of implementation. Some exhibit design problems include a lack of seating for adult spectators or the creation of exhibits with no room for parental participation. Because of this, some museums have revised their objectives of serving just children to serving

families as a whole. Overall, a trend can be seen in the transition from static museum exhibits to dynamic exhibits that engage an entire family.

## 2.5 Worcester Historical Museum

Over the past 130 years, Worcester Historical Museum (WHM) has taken more of a traditional approach when presenting the antiquity of the industrial city of Worcester. Staying true to the goal of its founder, the museum rescued artifacts from the city's past before they were lost. As a result, these delicate artifacts became the mainstay of the institution's guide to the past, presenting the visitor with a chance to only observe. In addition to the static exhibits, the museum staged short demonstrations to engage visitors. Within the past fifteen years, however, the question arose as to what demographic the museum was actually trying to reach.

After four years of hard work, WHM released a new exhibit in 1998. The primary goal of this exhibit was to entice new visitors with Worcester's history through interaction. The exhibition known as "In Their Shirt Sleeves" was put on by the institution, focusing on the history of the industry within Worcester (Magiera, 1998). Visitors to the museum were given an industry worker's time card upon entry and led through various areas of the display: they could listen to videos and dictations by actors, and they could view relics and photographs as well. Incorporated into this exhibit are interactive computer stations and recorded interviews, which include the multi-outcome and multi-user characteristics defined by PISEC. The technological and interview-style aspects of the display were used most often, thus the addition of computers was seen in a positive light (Magiera, 1998). While the exhibit did convey a new presentation style for the museum, it was unable to bring in an expanded clientele. In regards to the seven characteristics of family-friendly exhibits as defined by PISEC, many exhibits failed to establish multi-sided, multi-user, and child-accessible displays (Borun, 1998).

In an effort to appeal to the younger generation and address the challenges of the 21$^{st}$ century, the directors and curators of WHM spent three years developing the concept of "The New 30." The plan, referencing the address of the institution, allows the gallery to enter into the new technological age and develop into a "community museum." "We're the same place with a new vibe," said Worcester Historical Museum's communications manager Chad Sirois (Bergeron). The principle behind this theory is to appeal to a younger demographic through hands-on

experience and bring the museum into the public's eye. The museum was able to raise more than $500,000 to erect the Alden Gallery to house their new interactive exhibits (metrowestdailynews.com). To ensure the success of the new wing, the museum drew upon the successes of the Boston Children's Museum. Through this collaboration, WHM was able to create a design that would be educational while allowing the kids to have fun.

### 2.5.1 New Exhibits in the Alden Gallery

Worcester Historical Museum put a variety of new exhibits into action. Within the Alden Family Gallery are various child-friendly exhibits that parents can also enjoy. Journeying through the years in the exhibit, children and families are able to physically touch artifacts, all of which are at a child's eyelevel. The museum features an interactive old fashioned diner in which kids can play, cook, and learn the dialect of the era. In addition, there are a variety of play phones hanging on the wall, each of which contains a recording that describes important United States events. Telephones within the Alden Family Gallery can be seen in Figure 3. These new exhibits touch upon five of PISEC's seven characteristics of family-friendly exhibits: being multi-sided, multi-user, accessible, multi-outcome, and relevant (Borun, 2013). The exhibit is multi-sided to allow for families to surround the exhibit. The display is also accessible to both children and adults because it is built at an appropriate scale for both. In addition, the exhibit is relevant by presenting interesting and understandable items that relate to visitors' experiences. William Wallace, Museum Director, claims that the knowledge gained here is supposed to provoke conversation within the classroom (Magiera, 1998).

**Figure 3: Shown here are children watching videos and listening to sounds through telephones in the Alden Family Gallery (November 26th, 2013).**

## 2.6 A Miniature Golf Course

Continuing this theme of teaching through interactivity, WHM is looking to add a miniature golf course into its inventory of interactive, family friendly exhibits. The course, designed

specifically around the idea of appealing to a younger generation, will take players through different events in Worcester's history. Showcasing the idea of a "community museum," we will design the course to be portable, allowing it to be brought to schools, parks, and other public areas.

The main deliverable of this project is the set of plans for a nine-hole, portable miniature golf course, which is being designed for both entertainment and educational purposes. For our project, we are designing this course for WHM to help it continue its progress towards becoming a more interactive museum. Becoming a more interactive museum would allow WHM to increase revenue and help the museum become a more significant part of the city of Worcester. Our project will increase interest in key pieces of Worcester history in an interesting and engaging way.

# 3 Methodology

## Introduction

The overarching goal for this Interactive Qualifying Project is to develop a historically-themed, portable miniature golf course that achieves the learning outcomes desired by Worcester Historical Museum (WHM). In order to accomplish this, we completed fives objectives. Objective 1 involved establishing the course learning outcomes. Objective 2 focused on determining the exhibit themes. Objective 3 defined the design criteria for the course. Objective 4 was to establish components for course design that will appeal to children. Finally, objective 5 was to compile and propose a completed design for the miniature golf course. Museum exhibit design has shifted from static to dynamic exhibits, which occurred when exhibit designers adapted exhibits to coincide with the newly-established idea that people learn in many different ways, which involves making use of dynamic exhibits that offer multiple ways to take in information, such as written text, sound, visuals, and objects to interact with (Denig, 2004; Blashki, 2007). Consequently, we worked to design for WHM a course that meets the seven characteristics of family-friendly exhibits. Our team made use of surveys, focus groups, interviews, and content analysis in order to create a course that is both enjoyable and educational.

In Section 3.1, we discuss our approach for establishing the miniature golf course's learning outcomes. We describe our methods for designing each hole for the course in Section 3.2. In Section 3.3 we explain how we determined the project criteria. In Section 3.4, we discuss how we established components for hole design that appeal to our target audience of elementary-school children and families. Finally, in Section 3.5 we explain how we compiled our research and used it to create our recommended course design.

## 3.1 Objective 1: Development of Learning Outcomes

In order to begin the exhibit design process, we had to identify the learning outcomes that WHM and relevant stakeholders wanted for the miniature golf course. A learning outcome is an idea or concept that a user should understand or ponder during and after a museum exhibit. While focusing on Worcester's history was the primary focus of the project, we received the suggestion

to include learning outcomes in other school subjects. These learning outcomes were established in collaboration with the staff of WHM and educators in the Worcester School System.

To obtain ideas for the learning outcomes of this project, we used multiple methods. To begin, we held focus groups with first and second graders from the North Brookfield School. A focus group is a method that involves a small group of people who meet with a facilitator and discuss a particular topic (Berg & Lune, 2012). Focus groups also allow for a discussion and development of ideas through participant interaction, something a survey or interview may not be able to achieve. These first and second graders were visiting the museum for a class trip, and we chose to speak with these students because they are included within the elementary school-aged demographic that WHM has established as the main audience for the miniature golf course. The first group of participants was 30 first graders and the second a group was 30 second graders. These focus groups were conducted during their lunchtime because this was the only time when we could speak with the children due to the museum's planned schedule for the students' visit. In these semi-structured focus groups, we were able to ask questions regarding the children's favorite subjects in school. These focus groups we held with these students were one method used to acquire data.

Our project group also gathered information from teachers, in addition to students. Clare Nadolski is a long-time educator in the Worcester Public School System that currently works to facilitate school trips to WHM, and she was able to connect us with educators in the Worcester School System. We met with her in the first week of our project to review the material that she gives to teachers before they attend WHM. During this meeting Mrs. Nadolski offered to contact a few teachers that she felt were knowledgeable and willing to meet with us. Within a few days of this meeting with Mrs. Nadolski, we received phone calls from anxious teachers in the Worcester School System who were excited about the opportunity to help with the development of the miniature golf course. Originally we wanted to hold a focus group to speak with these teachers because focus groups allow for the discussion and development of ideas. Unfortunately scheduling became an issue, which caused us to conduct interviews instead of holding a focus group. Teachers have very busy schedules and large amounts of work to do even after the school day is finished, and this caused most of our interviews to be on a very strict time limit during an

off-period, during a lunch-period, or directly after school finished for the day. We used a semi-structured interview approach so we could compare responses across numerous interviews while still allowing flexibility in idea generation. We created a specific set of questions for each of the interviews, but the wording and order was adapted from interview to interview based upon the flow of the conversation (Berg & Lune, 2012). Due to the semi-structured style of the interviews, the interviewee was able to ask additional questions in order to clarify or elaborate on the topic of discussion, in addition to the interviewer being able to ask unscripted questions as well (Berg & Lune, 2012). Specifically, we spoke with Connie Ouellette, a 1st grade teacher from Midland St. Elementary School, Karen Manning, a physical education teacher from Norrback St. Elementary School, and Lisa Regele, a 1st grade teacher from Worcester Arts Magnet School. Their insight was valuable to our project because they work with our target audience, elementary age children, and consequently have a greater depth of understanding of how to affectively engage and facilitate learning in that demographic. These educators' input was essential so we could more confidently design a course that successfully achieved the learning outcomes. The questions are presented in Appendix A: Interviews with Teachers.

## 3.2 Objective 2: Development of Course Themes

After defining the learning outcomes for the exhibit, we established themes for the miniature golf course. Worcester Historical Museum stated that the themes for the course should be based upon Worcester's history; however we were allowed flexibility for the inclusion of specific events and themes in the exhibit. We conducted document analysis, focus groups, and distributed surveys to determine the most impactful theme for each of the nine holes. We used these methods to educate ourselves about what our target audience finds interesting, in addition to what knowledge would be valuable for our target audience to gain from the miniature golf course according to educators. Our process began with interviewing/holding focus groups with children, parents, and teachers, and then we compiled this information and our own ideas for themes into a list that WHM staff reviewed in survey format. Once we analyzed the results of the WHM staff's survey, Executive Director William Wallace and Exhibit Coordinator Vanessa Bumpus gave final input regarding the results of the WHM staff survey to produce a finalized list of themes.

As previously stated, we first chose to speak with students from the local school systems because the miniature golf course is primarily geared toward elementary age children. We conducted

focus groups at WHM when two school groups came in for field trips on separate occasions. The focus groups were geared to evaluate children's specific interests and also aspects of the museum. With pictures for reference, the students were asked if they were able to identify specific artifacts and other pieces of Worcester's history by show of hands. One example of an artifact shown to the children was a monkey wrench, which was created in the city of Worcester. These questions can be seen in Appendix C: Focus Groups with Elementary Age Students.

We supplemented our interviews with teachers and students with focus groups. As discussed in Chapter 2, a previous Interactive Qualifying Project (IQP) student-team drew upon public knowledge through interviews in order to identify what a successful interactive museum gallery was. Within the IQP 'Museum Education Materials,' the group highlighted museum staff as one important group with whom to conduct a focus group. As experienced individuals, the museum staff has seen what elements allow for a successful exhibit within their particular setting (See Alperin Lau, Erik John & Briana Kay, 2007).

When we set up a meeting with the staff members of WHM, we specified a time restriction to prevent repetitive discussion and to keep the meeting on track. As advised by the University of North Carolina School of Social Work, "To keep [a] group from endless debate, agree to a time limit on discussion before decisions are made" (Managing Meetings, 2004). The goal of the meeting was to have WHM complete a survey focused on the evaluation of themes we established based upon our prior research. We chose to hold a meeting to have staff complete our survey so we could quickly acquire data. We gave the staff a survey containing a list of facts about the city of Worcester, and we asked them to rank the importance of these facts for use in the golf course design. This survey can be seen in Appendix F: Themes Survey for WHM Staff. Staff members were asked to give a ranking of 5 to items that they felt were most important for us to include in this course, and a ranking of 1 was to be given to anything that the participants felt was least important. We then tabulated and ranked the results. Most of the items with the highest ranking became established themes, while the rest were debated amongst the group and compared to what children in previous surveys had offered. One problem with this method is the fact that not all of the employees at WHM have experience working with children, and because of this we had to get second opinions on the results of this survey before finalizing our themes. To get a second opinion, we ran these findings by William Wallace, Executive Director of the

WHM and Vanessa Bumpus, WHM Exhibit Designer to get their final opinions on what themes we should use. We finalized our themes with these individuals because they are both familiar with Worcester history, they both have experience working with children, and because these two individuals will be in charge of the next steps in the development of the course once our part of this project is completed. This is how we developed and grouped our themes for this project.

Finally, we conducted document analysis upon surveys provided to us by WHM. Three separate surveys were created: one for teachers from the Worcester School System, one for children, and one for parents. These surveys were focused on the Alden Family Gallery, a new set of exhibits at WHM. The individuals were asked questions about what parts of the exhibit they enjoy, what parts of any museum exhibits are enjoyable, and what educational value should come from museum exhibits. While the number of individuals surveyed was small (all three surveys were given to less than fifteen people per group), these surveys contained valuable information that our project group made use of when designing this miniature golf course's themes.

## 3.3 Objective 3: Developing Design Criteria

Worcester Historical Museum provided us with a rough, initial list of parameters for the miniature golf course that related to portability, materials, and electrical power. One of the more significant and obvious constraints we had to contend with was how large the course and its components could be. Another parameter for our design was deciding which materials should be used when building the course. The approximately 40' by 45' auditorium, which is where the portable miniature golf course would be set up in the museum, has a few electrical sockets, but our sponsor preferred that any power supply be limited to battery power. Our sponsor also specified that the course not use solar power or water and that it should not require excessive maintenance for painting and reconstruction. Worcester Historical Museum staff also requested that the course be designed with easy assembly in mind, while still being durable and in accordance with federal regulations. This means the setup, breakdown, and storage of the course must be as simple as possible, and this relates to the number of pieces for the base of each hole of the course, the objects that need to be set up on each hole, the methods done to connect all pieces of each hole together, and ease of carrying and packaging all pieces of the course. The course's pieces must not be too heavy, but they should be able to be placed firmly on the ground. The materials used in making the course should be durable enough to withstand years of play.

We also had to keep in mind the accessibility of the course in terms of wheelchairs and strollers. The course's audience is mostly families with elementary aged children, and as such, the course had to be wheelchair and stroller-friendly for anyone that wished to play or navigate around the course. We researched various codes and regulations from both the US ProMiniGolf Association and the American Disability Act (ADA) for miniature golf courses in order to design a course that is compliant with applicable regulations.

To develop and finalize our design criteria, we emailed a set of open-ended interview questions to several miniature golf course owners and designers to glean information about their courses. We found the contact information for these course owners and designers by using internet search engines, in addition to recommendations made by WHM staff. We spoke with Arne Lundmark, owner of Adventure Golf Services Inc., Dutch Magrath III, President of Amusement Products LLC, John Wilson, director of Franklin Square Miniature Golf Course in Philadelphia, Pennsylvania, Mark Daley, director of Golf on the Village Green Miniature Golf Course in Natick, Massachusetts, Joseph Buckshon, president of Mini Golf, Inc. These questions sent to these course owners and designers can be seen in Appendix B: Interview with Course Designer/Owner. This information ranged from how their course(s) were designed to any challenges they faced to anything they would like to tell our group. While our limited time prevented us from conducting face-to-face interviews with several course owners, the information we did gather was very useful for designing courses, especially the varying materials each course was constructed with. Speaking with multiple experts in the miniature golf industry allowed us to triangulate our data.

We also had the opportunity to ask these interview questions in semi-structured face-to-face interviews with Debbie Powell, the owner and designer of the Crystal Caves Miniature Golf Course in Auburn, Massachusetts, and Charlie Trombetta, the owner and designer of the miniature golf course at Trombetta Farms in Marlborough, Massachusetts. Mr. Wallace suggested that we contact Debbie Powell, and Mrs. Bumpus recommended that we speak with Charlie Trombetta. We spoke with these two course owners and designers because both of their courses have been running for over a decade. Once we designed the course, we spoke with some of the course owners again in order to gain continuous feedback on our ideas. This continuous

feedback allowed us to refine and modify our designs. Through speaking with owners and designers of courses, we were able to establish the course criteria.

## 3.4 Objective 4: Establishing Appealing Hole Components

In addition to establishing learning outcomes, themes, and course criteria, we also had to discover what components of miniature golf courses are most appealing to our target audience. Some examples of miniature golf course components are hills, obstacles, and scenery. We spoke with elementary age children, parents, miniature golf course designers, and miniature golf course owners in order to establish a set of hole components that are appealing to these individuals.

To establish what our target audience enjoys in miniature golf courses, we held focus groups at the WHM with first and second grade students from the Worcester School System, as mentioned above in Section 3.1. These focus groups were semi-structured. The questions can be seen in Appendix C: Focus Group with Elementary Age Students. We asked them questions such as, "What is your favorite part of a miniature golf course?" to establish what children's favorite course components are. This information was useful because we could reference children's preferences when designing the course. This information was also valuable to us because we took into account the ages of the children, in addition to their preferences, when designing the course. We designed the course to appeal to elementary school children, and the focus groups gave us specific ideas of what children in first and second grade enjoy in miniature golf courses.

We incorporated field research into our methodology as well by observing a predetermined exploratory group of children play through a miniature golf course. Worcester Historical Museum contacted children who they worked with in the past regarding exhibit development and asked that they let us observe them play on a miniature golf course and ask them questions related to the course mid-play. Mrs. Bumpus suggested that the field research took place at Trombetta Farms in Marlborough, Massachusetts because this course is indoors, and therefore rain would not affect our ability to gather data. As the children played through each hole, we asked them specific questions related to what they enjoyed and did not enjoy about each hole based upon our observations. These questions can be seen in Appendix D: Field Research Questions. For example, one hole was made up entirely of hills and contained no obstacles, and we asked each of the children whether they enjoyed the hills or if they would have preferred obstacles instead. We also observed how they behaved on the course; specifically, we observed

children's reactions to the varying hole designs—did they hit the ball very hard to accommodate for a hill, or did they hit the ball really hard regardless of hole configuration, in addition to observing if the children were respectful of the obstacles in the course, and of one another. We conducted this field research to gain a firsthand understanding of how children behave when using a miniature golf course. "One of the advantages of [field observation]," as stated within USERfit, an established methodology that focuses on the creation of specifications for usability, "is that users can be observed in the environment where the system is normally used," (Abascal, 2002). This information was valuable because it impacted what type of golf balls we should purchase in order to protect the museum's walls, the height needed to keep the ball in play, how we should design the course, and what materials we should recommend for construction of the course. However, something we had to take into account regarding this method is described by Abascal as the 'Hawthorne Effect,' which is "the fact that people usually perform better under observation because of the attention paid to them" (2002). We needed to account for the fact that some of these children may have been more well-behaved than they typically are because we were observing them. While we do not know the children personally and therefore cannot differentiate between normal and improved behavior, we were still able to gain a some understanding of how children act when using a miniature golf course.

In addition to interviewing and observing this predetermined group of children at Trombetta Farms, we held semi-structured focus groups with parents to ask them about miniature golf when visiting Trombetta Farms. We asked them why they take their children miniature golfing, what they feel their children enjoy about miniature golf, if they personally feel that miniature golf is fun, and what valuable parts of miniature golf courses are enjoyed by children and adults. These questions can be seen in Appendix E: Field Research - Parent Questions. We also asked the parents if they have a preferred course that they bring their children to, and why they choose to bring their children to those specific courses. We asked these questions so we could gain an understanding of what parents want in a miniature golf course for both their children and for themselves. While the course was targeted at elementary school children, we needed to account for parents as well so that the course is family-friendly as a whole.

We spoke with various miniature golf course owners and designers to gain a better understanding of what course attributes people enjoy most, in addition to what course attributes are most

feasible to include within our design. As previously mentioned, we held in-person interviews with Charlie Trombetta, the owner and designer of the miniature golf course Trombetta Farms, and Debbie Powell, the owner and designer of Crystal Caves in Auburn, Massachusetts, and we asked them what obstacles and other course components of miniature golf courses are particularly successful and which are not in their experiences. We also sent out open-response surveys to various miniature golf courses around the country to acquire more information from a wider range of sources. Our questions related to challenges faced in their experience with miniature golf and how those challenges were overcome, what the course owners have learned in terms of design, construction, and maintenance, and experiences working in the miniature golf industry. These questions can be seen in Appendix B: Interview with Course Designer/Owner. These individuals were able to provide us with qualitative information, such as information about past experiences, and we have also attempted to quantify our data by recording how many people gave the same response to certain questions. Through these interviews with various course owners and designers, we have acquired information regarding successful course components from an owner's perspective. Through focus groups with children and parents, observing and interviewing children as they play miniature golf, and speaking with course designers and owners, we composed a set of miniature golf course attributes that appeal to our target audience.

## 3.5 Objective 5: Compile and Propose Completed Design

Once we completed our first four objectives, we compiled all of our information to create a completed design for the course. We utilized modeling programs to show our proposed designs for each hole, in addition to creating blueprints that include size dimensions for each obstacle.

The designs were shown to the staff of WHM, teachers, and families during the design period so that feedback could be acquired. These meetings were done through focus groups and interviews. We chose these methods because they allowed us to receive immediate feedback from participants, in addition to allowing for a semi-structured setup that let us deviate from our set questions. Deviation from set questions was necessary because some participants brought up topics and ideas that we had not originally considered. We first presented potential hole layouts to Mr. Wallace, Mrs. Bumpus, and Lynn Soucy, the office manager of WHM once we had created initial designs with WHM staffs' previous survey answers in mind. We presented our potential hole layouts to these individuals to acquire feedback and revise our designs.

Once we revised our designs based upon suggestions from members of WHM, we then obtained feedback from elementary school students. A group of second-grade students from Tatnuck Magnet School in Worcester visited the museum on November 26th, and we had the opportunity to hold a focus group with them for half an hour. This study was conducted because multiple revisions are necessary to improve upon and add to our initial ideas. Questions from this focus group can be seen in Appendix G: Final Focus Group with Elementary Age Students. Our objectives of this focus group were to see if the students could identify what is featured in each hole, understand what features children liked and disliked, and ask if anything seen in the holes relates to something found in these children's lives. These questions were framed around our findings from our project. Based upon the information gained from these students, the course design was altered.

Following the feedback that we received, we were able to finalize our designs to develop a set of blueprints. One of the project deliverables that WHM asked of the project team was bid ready designs. This means that a general layout of the course could be given along with detailed drawings, assembly drawings, and potentially video files to show how components could be assembled. The drawings created by the group had to be detailed enough so that potential contractor would be able to create the exhibit with these documents alone.

To develop the dimensions for the miniature golf course, we first created a general floor plan of the course within a 3-dimesnional computer-aided design software called SolidWorks. The idea behind this was to create a digital version of the auditorium in which the staff of WHM could use to set up the exhibit. Within the SolidWorks file, we assigned each hole the highest dimensions possible, while still meeting the American Disabilities Act guidelines. To do this, the project team made sure that the layout allowed for wheelchair traffic in addition to having each element of the holes be within a three foot reach. Once the hole layouts were mocked up within SolidWorks, it was time to put concept into reality. With a dimensionalized floor plan in hand, we went into the auditorium (the location of the future course) to tape out the potential sizes of the holes. When we taped outlines of some holes onto the floor, we noticed the holes were too large. As a result we made adjustments in order to shorten the length of each hole.

Each hole was modeled with SolidWorks to develop the finalized blueprints while assessing the issue of potential weight. Within the SolidWorks software, there is a feature in which you can

assign materials to elements of the proposed model. These programmed materials include the density of the material and rigidity properties. As a result, we evaluated the potential weight of each hole and discovered that the sections had to be broken down into smaller components if the same materials were to be used: 2”x4” supports, 2”x6” supports, and ¼” sheets of plywood. Therefore, holes were broken down into sections of 4’ by 3’ or 4’ by 4’ sheets of plywood.

With all the hole components assembled and the issue of weight tackled, we created detailed drawings to present to the member of WHM. These drawings not only provide instructions for assembly, but also the dimensions for each component within the hole. Also included were video files that display the assembly instructions in addition to paper copies, and results from our interviews, surveys, and focus groups.

# 4 Findings and Recommendations

## Introduction

This interactive exhibit is a portable, nine-hole miniature golf course being designed by our student group for Worcester Historical Museum (WHM) in Worcester, MA. The course highlights various landmarks and historic events of Worcester, such as the Blackstone Canal, the David Clark Company, Candlepin Bowling, and the iconic "Smiley Face" of the 1970's. The course's design went through many stages, and it was influenced by multiple groups of participants and documents: children, parents, teachers, WHM staff, miniature golf course designers/owners, the findings from the Philadelphia/Camden Informal Science Education Collaborative PISEC, the Massachusetts Common Core of Learning (MCCL), and past surveys conducted by WHM regarding the Alden Family Gallery. Table 4 lists each of our twelve findings discussed in this chapter, and Table 4 also shows which stakeholder or document supported each finding.

To begin this chapter, we discuss in Sections 4.1 through 4.3 various findings and recommendations related to potential learning outcomes of the course. In Section 4.4, we explain the reasons why MCCL influenced the development of our project's learning outcomes. We then describe our choice of themes and the data to support them in Section 4.5, followed by our findings and recommendations regarding course criteria within Section 4.6 through Section 4.11.

| | | FINDINGS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Connecting Themes to Life Around Us | Problem Solving Skills | Positive Results from Patience | Using MCCL | Themes | Inclusion of Challenging Holes | Benefits of Trivia | Light, Sound, Move--ment | Interaction with Objects | Materials | Handicap- and Stroller-Accessible |
| SUPPORTED BY | Children | | ✓ | | | ✓ | ✓ | | ✓ | ✓ | | |
| | Parents | | | | | ✓ | ✓ | ✓ | ✓ | | | |
| | Teachers | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ |
| | Course Designers | | | | | ✓ | ✓ | | ✓ | ✓ | ✓ | |
| | WHM Staff | ✓ | | | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ |
| | PISEC | ✓ | | ✓ | | | ✓ | ✓ | ✓ | ✓ | | |
| | MCCL | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | | |
| | Past WHM Surveys | ✓ | ✓ | | | | | | ✓ | ✓ | | |

Table 4: The table below lists each finding across the top row and stakeholders along the side. Check marks represent if a particular stakeholder or document supported each finding.

## 4.1 Course Learning Outcomes

***Finding #1: The Massachusetts Common Core of Learning (MCCL) is an important aspect of grade school education that benefits students in the Massachusetts Educational System.*** All five educators who we interviewed recommended including pieces of the MCCL within this project. From September of 1993 to June of 1994, 40 individuals developed the MCCL so the state of Massachusetts would have a set of guidelines to explain broad goals of education in public schools. In addition, the MCCL includes the need for education to be interdisciplinary and describes what children should know and be able to do (Antonucci, Kaplan, Marquez). Members of the committee that composed the MCCL had various qualifications, for example: a school principal, a Commissioner of Education in Massachusetts, a high school student, a school superintendent, an education consultant, and the Chief of Police of Boston. In addition to the committee itself, 50,000 people participated either directly or indirectly in the creation of this set of guidelines. The beliefs and ideals that are the basis of the MCCL all focus on four things:

education is a lifelong objective, the value of effective written and spoken communication, the importance of respecting the diversity in our society, and the need to acknowledge worldwide issues, such as environmental issues (Antonucci, Kaplan, Marquez). Students must also learn how to take responsibility for their actions and learn how to make valuable contributions to society.

We recommend that the educational aspects of this course include pieces of the MCCL to better establish learning outcomes the miniature golf course. This miniature golf course teaches about history of Worcester, a city in Massachusetts, and inclusion of the MCCL would be a valuable way to teach Worcester's history in accordance with guidelines designated by the state of Massachusetts.

***Finding #2: It is important to stakeholders that students benefit from connecting the themes of the miniature golf course to people and places they have seen and learned about in their lives.*** Both teachers and WHM staff supported this idea. Three of the five teachers interviewed stressed the importance of students connecting themes of the course to what they have seen in their lives. The staff of WHM support this idea, which is backed by WHM's mission to educate the community about Worcester's rich history.

The findings of PISEC emphasize the importance of making connections between the exhibit and the lives of players. One quality of a family-friendly exhibit, as described by PISEC, states that an exhibit must be relevant. PISEC defines "relevant" as "provid[ing] cognitive links to visitors' existing knowledge and experience" (Borun, 2013).

Lastly, in the beginning of 2013 WHM surveyed an exploratory group of teachers when designing their Alden Family Gallery exhibit, and one teacher stressed that museums need to be personal and connect to visitors' lives (Past WHM Survey, 2013).

Due to support of two groups with whom we conducted research and the results of our analysis of past WHM survey material, we recommend that this miniature golf course contains informative signs alongside each of the holes. The signs will give basic historical information

about well-known points of interest in Worcester which students may recognize from their own life experiences.

***Finding #3: Students will benefit from utilizing problem solving skills and techniques to successfully complete the miniature golf course.*** Problem solving techniques include understanding actions and reactions, hitting the ball at certain angles and with certain force, and the idea of scorekeeping. Individuals from two groups with whom we conducted research, teachers from the Worcester School System and children with whom we conducted research, supported this finding. Three of the five teachers we interviewed supported the inclusion of problem-solving skills. Children themselves also support the inclusion of problem-solving, revealed from analysis of the interview data from sixty second grade students from Tatnuck Magnet School in Worcester, Massachusetts on November 26th, 2013. Of the Tatnuck Magnet School students who interacted with a problem-solving/puzzle-like piece at/in the Alden Family Gallery, fifty students (84%) said they enjoyed the challenge of using their skills to complete the puzzle. One student wanted try to find more working combinations for the puzzle after having already solved it once (Anonymous, personal communication, November 26, 2013). Both children and teachers showed support for the inclusion of problem-solving skills within the course.

Figure 4: The Alden Family Gallery within WHM features gear "puzzles" that visitors must put together correctly. When correctly assembled, the gears can be turned (November 26th, 2013).

The use of problem-solving skills is further supported by analysis of the MCCL and past WHM surveys. The MCCL addresses problem solving in three different instances in which students must: monitor progress and learn from both success and mistakes," reasonable inferences and evaluate information," and "develop, test and evaluate possible solutions" (Antonucci, Kaplan, Marquez). In addition to being mentioned in the MCCL, problem-solving skills are highlighted

in WHM's past survey responses. One child, age unknown, surveyed by WHM about the Alden Family Gallery enjoyed doing experiments and solving problems, further demonstrating that children are enthusiastic about problem solving (Past WHM Survey, 2013). Due to the support from document analysis and two groups of stakeholders, we recommend that, problem-solving skills are used by participants to complete the WHM miniature golf course.

***Finding #4: Thoughtful play in an interactive environment will benefit students.*** Both parents and teachers supported the idea of incorporating patience and thoughtful play into the course design and its learning outcomes. All seven parents who participated in our focus group agreed that their children would learn the following from playing miniature golf: the concept of winning and losing, interaction, sportsmanship, self-control, and fair play (Anonymous, personal communication, November 10, 2013, Trombetta Farms in Marlborough, Massachusetts). Three of the five teachers with whom we conducted interviews acknowledged the importance of patience and thoughtful play as well. Two groups who participated in our research, in addition to the MCCL, support the idea that children should learn to exercise patience when using our project group's proposed interactive exhibit.

Figure 5: The diner within the Alden Family gallery allows children to "create" their own dishes (November 26th, 2013).

The Alden Family Gallery within WHM currently features numerous interactive exhibits that require patience. For example the diner within the Gallery, shown above in Figure 5, has one register and one stove. Consequently, only a small number of children may play with each item at a time. This part of the Alden Family Gallery helps to teach children patience, and our project

group observed that the student groups who visited WHM heavily used and enjoyed the register and stove.

We recommend that patience and thoughtful play be a learning outcome of this course, not only including the patience required to correctly follow the rules of miniature golf (for example, only one person may hit the ball at a time), but also within other aspects of the course. For example, patience could be required if only one student at a time were able to pull a lever or have some other interaction with the course.

Figure 6: One second grade student (anonymous) is shown filling out WHM's Salisbury Store scavenger hunt (November 26th, 2013).

***Finding #5: Adult players will be interested in trivia related to Worcester's history, and trivia can also educate younger players.*** Individuals from two of the different groups with which we conducted research suggested the inclusion of trivia. Both parents from our Trombetta Farms focus group and WHM staff expressed interest in the inclusion of trivia. One parent supported the idea of trivia because reading trivia is "something for the adults to engage in while waiting for their child" (Anonymous, parent 1, November 10, 2013). Our analysis of PISEC and the Massachusetts Common Core of Learning also inferred the importance of incorporating trivia. The "relevant" characteristic of PISEC states that an exhibit must link to a visitor's life and experiences (Borun, 2013). In addition, the Massachusetts Common Core of Learning states that students must read and listen for both education and enjoyment (Antonucci, Kaplan, Marquez). This education and enjoyment can be achieved with the inclusion of trivia.

We recommend that the course includes a sign at each hole that contains information about the particular hole's theme. This will appeal to parents, especially those who are waiting for their children to finish playing at the hole. The course will also contain some holes that involve putting into the correct cup or putting through the correct obstacle based upon answering a trivia question. Lastly, we recommend the use of a scavenger hunt to encourage children to read the

signs posted at each hole. Worcester Historical Museum includes a small scavenger hunt within their Salisbury Store exhibit. At this Salisbury Store exhibit, children must look through the different drawers in the store to locate various items on a scavenger hunt checklist. This scavenger hunt has been successfully used by children in the past, and this supports the idea that scavenger hunts are enjoyable by visitors. Therefore, we recommend the inclusion of trivia and a scavenger hunt within this miniature golf course.

## 4.2 Course Themes

***Finding #6: The most popular miniature golf themes, according to our research, are space, immigration, Worcester's parks, factories, education, the Seven Hills of Worcester, Transportation, Sports, and Worcester's "First and Famous."*** In addition, the idea of Worcester being the Heart of the Commonwealth was also supported. First we will discuss our findings from focus groups with various school groups that visited WHM and that accompanied us to Trombetta Farms in Marlborough, Massachusetts. We then discuss our findings that we drew from the information we got from our interviews with various teachers in the Worcester School System. Next we detail our findings from a focus group that we conducted with parents of the children who accompanied us to Trombetta Farms. Findings from the various sessions are separated below.

### 4.2.1 Children

On November 6th, we conducted a focus group with a group of sixty first graders from the North Brookfield School (North Brookfield, Massachusetts). The students were asked to raise their hand once to show what their favorite aspect of the museum was as we listed off each section of exhibits within the museum. One third of the students responded to this question that the diner within the Alden Family Gallery was their favorite aspect of the museum, and another third of the group chose space-themed items as their favorite part of the museum. However, Mr. Wallace advised us not to include diners as a miniature golf theme due to the magnitude of its representation in the museum already, so the idea of including a diner within the miniature golf course was omitted. We presented images to the students from North Brookfield School in North Brookfield, Massachusetts asked them to identify the displayed artifact if they could. Of these images, the students were able to recognize an astronaut suit from the David Clark Company, and Harvey Ball's "Smiley Face," but struggled with recalling Harvey Ball's name.

On November 8th, we held a second focus group with sixty second graders. During this focus group, we asked the students to raise their hands if they were able to identify any of the images of items from WHM within a slideshow presentation we developed. The goal of this focus group was to identify which items students recognized from Worcester's history. Having previously focused on what children enjoy about Worcester's history in our previous focus group, we now wanted to target items that children did not learn about, items that our project group felt were important parts of Worcester's history due to our own research and recommendations from WHM staff. Due to the fact that we were speaking with these young children during their lunch time and were under a time constraint of around fifteen minutes, specific quantitative data was not our goal. We also chose to focus on children's general reactions to various theme ideas to gain a better understanding of what the children would like to see in the miniature golf course. A majority of children could identify the monkey wrench, Robert Goddard's rocket and the Salisbury Store. One hundred percent of the students were able to identify the smiley face.

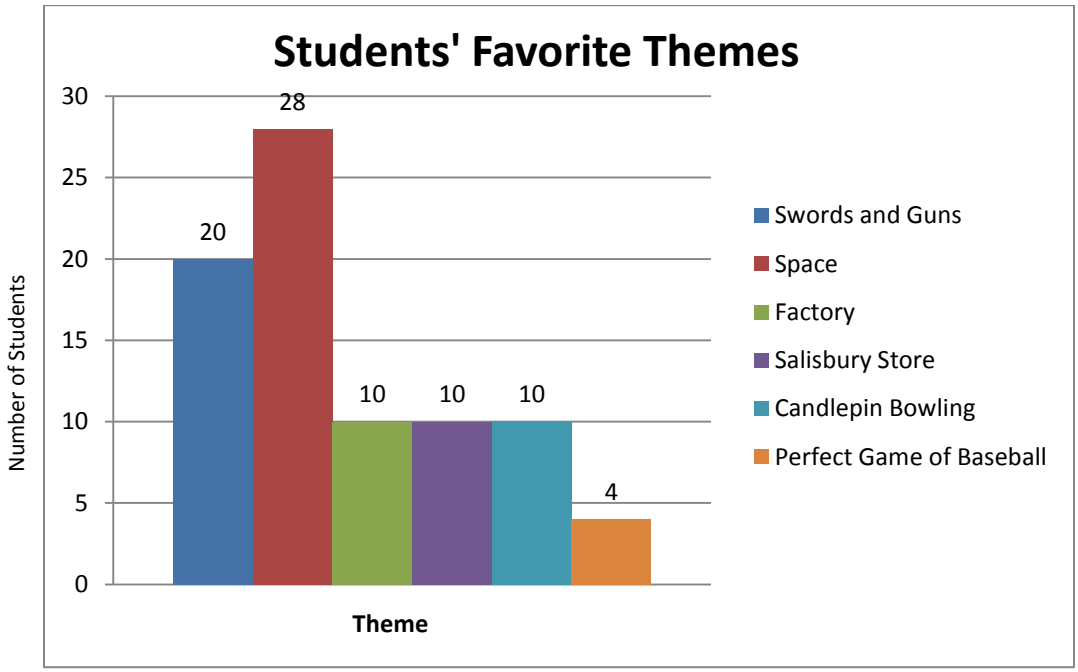



Figure 7: This graph shows the responses from North Brookfield Elementary School and the exploratory group of children from Trombetta Farms to items within WHM's exhibits.

Figure 7 depicts the responses we received from the students of North Brookfield Elementary School and the exploratory group of children from Trombetta Farms regarding theme ideas. Based on the results from the children, we recommend that factories, space, and a form of

technology should be themes within the miniature golf course. Although 20% of the children of North Brookfield Elementary School did respond by saying that their favorite artifacts were the guns and swords on display, WHM staff decided that this should not be included in a miniature golf course that is primarily targeted to the younger generations, and the principles of safety and interactivity were taken into account when making decisions upon inclusion of various themes.

### 4.2.2 Teachers

In addition to conducting research with children, our project group also interviewed various teachers from the Worcester School System. To begin our semi-structured interviews with teachers, we conducted an interview with Mrs. Ouellette, a first-grade teacher from Midland Elementary School and received suggestions regarding theme ideas based upon what she felt was most valuable for children to learn about. Mrs. Ouellette suggested including parks, transportation, biotechnology, and the Seven Hills of Worcester. Mrs. Ouellette also suggested that the information incorporated into the course should be simple, being mindful of the elementary-aged audience of the exhibit. We then brought these theme suggestions, in combination with themes backed by analysis that we conducted upon WHM's exhibits, when we met with second grade teacher Mrs. Regele of the Worcester Arts Magnet School. Mrs. Regle supported the ideas we had listed for her (which were Harvey Ball Smiley Face, immigration, parks, maps, diners, the Seven Hills, David Clark Company, transportation, Robert Goddard, Colleges, Salisbury Mansion, and Heart of the Commonwealth) and had no additional suggestions, and because of this we focused more on learning outcomes when speaking with her. Mrs. Ouelette and Mrs. Regele are the two teachers with whom we interviewed regarding themes. To present Worcester's History to families without providing subject matter that children could not understand, we recommend that the themes of parks, the Seven Hills of Worcester, mapping, and transportation should be utilized within the course.

**Figure 8: Our project group had the opportunity to interview Mrs. Ouellette from Midland Elementary School in Worcester, Massachusetts.**

### 4.2.3 Parents

On November 10th WHM arranged and sponsored a group of children from the Worcester area, ages 4-14, to visit Trombetta Farms Miniature Golf Course in Marlborough, MA in order to help develop the course criteria of this historically themed miniature golf course. While the 14 children played through the course, the seven adults were taken aside and asked a series of questions regarding engaging course components and potential themes for the course. Various parents within the group made theme suggestions, and we then asked the group as a whole about each theme idea. All parents supported the inclusion of transportation, the Blackstone Canal, railroads, and Valentines, and because of this we supported adding these themes to the course.

### 4.2.4 WHM Staff

Once we had conducted research with children, teachers, and parents, our project group created a list of potential themes that can be seen below. This list was then turned into a survey that our project group gave to eight staff members of WHM, staff members that Executive Director William Wallace chose for us. We asked the staff to rank the various Worcester facts that were provided. A rating of a 5 represented the most important topics in history that must be incorporated into the miniature golf course. A rating of a 1 was given to the facts that were not essential topics. The results were tabulated and the responses are provided below.

| Theme | Total Points Received |
|---|---|
| 1. Diner | 35 |
| 2. Robert Goddard | 34 |
| 3. Heart of the Commonwealth | 33 |
| 4. Three-decker houses | 31 |
| 5. Railroad, Blackstone Canal, and transportation | 30 |
| 6. Monkey Wrench, Valentine, Industrialization, and Women's Rights | 29 |
| 7. First perfect game | 28 |
| 8. Candlepin Bowling and David Clark Company | 25 |
| 9. Seven Hills of Worcester | 24 |
| 10. Casey at the Bat | 24 |
| 11. American Steel/Wire, Salisbury Store, and working women | 23 |
| 12. Morgan Construction Company | 19 |

Other ideas suggested at the bottom of the survey in the write-in portion:

1. Worcester Corset Company
2. Parks

3. Barbed Wire
4. Biotech
5. Modern Aged Elements

Following the survey given to WHM staff, a meeting was held with Mr. Wallace and Mrs. Bumpus to combine potential themes and begin layouts for each hole. Our group, along with Mr. Wallace and Mrs. Bumpus, took into account which themes were most child-friendly, which were not significantly highlighted already in the museum (for example, because the diner is a very prominent part of the Alden Family Gallery, it was removed from our list), and which are the most relatable and enjoyable for museum guests. Table 5 illustrates the popularity of each theme. We recommend that the following themes be included within the miniature golf course: space, immigration, Worcester's parks, factories, education, the Seven Hills of Worcester, Transportation, Sports, and Worcester's "First and Famous."

| Theme | Children | Parents | Teachers | WHM Staff | Total |
|---|---|---|---|---|---|
| Robert Goddard/ David Clark Company | 28 | | 2 | 7 | 37 |
| Factories of Worcester | 10 | | | 7 | 17 |
| The Seven Hills of Worcester | 2 | | | 7 | 9 |
| Parks of Worcester | | | 2 | 2 | 4 |
| Colleges of Worcester/Education | | | 2 | 2 | 4 |
| Maps/Immigration | | | 2 | 2 | 4 |
| Transportation | | 7 | 2 | 7 | 16 |
| Harvey Ball Smiley Face | | | 2 | 5 | 7 |
| Candlepin Bowling | 10 | | | 6 | 16 |
| Valentines | | 7 | | 7 | 14 |
| Casey at the Bat/ The Perfect Game | 4 | | | 7 | 11 |
| Heart of the Commonwealth | | | 2 | 7 | 9 |

**Table 5: This table displays how many individuals from the different groups we gathered research from supported each of our final themes. (In this table, support from a WHM staff member means a ranking of 3 or higher was given on our survey we gave to staff).**

## 4.3 Course Design

***Finding #7: Challenging holes, as opposed to easy holes, will appeal to our entire target audience.*** A challenging hole has multiple obstacles and hills, and should not be a straight hole.

An easy hole does not have many hills or obstacles. An obstacle is an object different from a hill that individuals must putt through or around.

Figure 9: Kurtis Banville, one group member for this project, speaking with a child (anonymous) who had not played miniature golf before this day and who preferred more challenging holes over easier holes.

Children, parents, teachers, and course designers stressed the importance of incorporating challenging holes. Of the children from the Trombetta Farms exploratory group who were asked about challenging versus easy holes, 80% said they preferred challenging holes. In addition, 100% of parents at the focus group held at Trombetta Farms said obstacles make courses more fun for them and for their children. Mini Golf Inc.'s success shows that challenging holes can appeal to both parents and children. This miniature golf company attributes their great success to the appeal to children and parents of the course's difficulty.

Not only do stakeholders' recommendations support the idea of challenging holes, but document analysis also encourages interaction. The "multi-modal" characteristic from PISEC states that an exhibit must appeal to individuals with different levels of knowledge and learning styles (Borun, 2013). The inclusion of challenging holes will appeal to a wider audience than easy holes will, and this will successfully complete the "multi-modal" objective of PISEC. This data gathered from stakeholders, in addition to the support from document analysis, supports the finding that our project's target audience enjoys challenging holes.

Our recommendation regarding challenging versus easy holes is to include many challenging holes and few easy holes to best appeal to the entire target audience.

***Finding #8: Lights, sounds, and movement would appeal to the course's target audience.*** Individuals from all five of the different groups of stakeholders we gathered data from suggested using light, sound, and movement. John Wilson, the director of Franklin Square Miniature Golf Course in Philadelphia, Pennsylvania, suggested use of sound due to guests' enjoyment of sounds featured at his miniature golf course. "Hole 18 (Liberty Bell and Independence Hall) is one of the favorites because the Liberty Bell rings" (J. Wilson, personal communication,

September 13, 2013). Parents and children from the focus groups held at Trombetta Farms corroborated this evidence by also expressing their interest in light, sound, and movement. Seventy-five percent of the children from our second focus group with second graders were interested in lights when the idea was discussed. Finally, when presented with the ideas of light, sound, and movement, WHM staff strongly approved the inclusion of these elements. All five groups with whom we conducted research expressed interest in the inclusion of light, sound, and movement within the course.

Our project group was also encouraged by document analysis to use sound to educate because sound is another method by which individuals can learn. This is demonstrated by the "multi-modal" characteristic from PISEC, which states, "The activity appeals to different learning styles and levels of knowledge" (Borun, 2013). The characteristic of being "multi-modal" is also expressed in the Massachusetts Common Core of Learning in a section that states students must read and listen for both education and enjoyment (Antonucci, Kaplan, Marquez). Not only are light, sound, and movement suggested by the peer-reviewed documents of PISEC and MCCL, but past WHM surveys about the Alden Family Gallery that were given to children corroborate this idea as well. These past surveys given to children by WHM show that the children's favorite part of the Alden Family Gallery was the diner, which included a music box that plays music based upon which button children press.

Our project group recommends that the course make use of lights, sounds, and movement to appeal to our target audience. Children will trigger these tools based upon where children hit the ball throughout the course.

***Finding #9: The target audience would enjoy objects that they can interact with on the course, as opposed to only including objects that they can putt around or over.*** Children, teachers, course designers, and WHM staff expressed interest in interaction. Seventy-one percent of the children from our second grade focus group were interested in the inclusion of obstacles that let you hit the ball through them as opposed to over or around them, and 84% of the children supported the idea of levers.

Document analysis of PISEC and past WHM surveys also show the value of including objects to interact with within the miniature golf course. The "multi-outcome" characteristic of PISEC states that observation and interaction must be included to foster group discussion (Borun, 2013). The appeal of an exhibit being "multi-outcome" is shown in the results of WHM's past surveys given to visitors of the museum's Alden Family Gallery. Worcester Historical Museum's surveys given to children show that the children's favorite part of the Alden Family Gallery was the diner because they could interact with the food, grill, music box, and cash register within the diner. Teacher surveys regarding the Alden Family Gallery also support the idea of interaction. The teachers that were surveyed stressed the necessity for hands-on activities to engage children, specifically suggesting the opportunity to use past inventions.

**Figure 10: Christina Aiello, one of the members of this project group, is shown counting the number of second grade students who were interested in the idea of levers within the course.**

We recommend that the course contains objects that can be pushed or pulled, including items that move when the ball comes in contact with them, to allow for interaction within the course.

***Finding #10: During the design and construction of the course, suitable materials must be used to ensure that each piece of the course has reasonable weight, durability, and manageability.*** Each of the owners/designers we contacted through email suggested slightly different materials based on their own experience, but a clear majority offered similar advice: The materials must be durable, especially taking into account how children sometimes behave when at miniature golf courses and, maliciously or not, damage pieces of the course. One hundred percent of the eight golf course owners and designers we interviewed stressed the importance of durability. We also had to take into account WHM's limitations for this course: one person must be capable of setting up the course alone and it must fit in their storage closet. Taking into account these limitations, we recommend the course be constructed with the following materials: 2"x4" wooden walls, 2"x2" wooden sides for obstacles that need to be

constructed, plywood and foam covers for obstacle siding, and a Polypropylene honeycomb structure for elevation of the course when necessary. Suppliers for these materials, in addition to paint and other materials needed for construction of the course, are included in a catalog that we created for WHM.

We recommend the use of 2”x4” wooden walls because they are tall enough to stop ball from leaving the course while also providing rigidity and durability for the structure. In addition, we recommend using a ¼” plywood base because it would be lightweight, yet solid enough to mount turf and objects upon. We recommend the use of plywood when extra strength is needed in constructing obstacles, and foam covers when possible. Foam is lighter and would be placed on an obstacle’s frame to conceal its interior, while the frame would be constructed of wood for durability and stability. Foam is already successfully used in Alden Family Gallery to depict various objects from Worcester’s history, as explained by Mrs. Bumpus. Finally, the course can include elevation by using a Polypropylene honeycomb structure, which is up to 2” thick. This honeycomb structure, while lightweight and able to handle a compressive load according to the material’s supplier, would only be used when absolutely necessary because of its price (A 4’x8’ sheet is around $60).These materials would offer durability while additionally being lightweight and therefore more easily transportable.

***Finding #11: Stroller accessibility and accessibility for the disabled are two important components for a miniature golf course.*** Two groups of stakeholders for our project, teachers and WHM staff, agreed it would be a very worthwhile endeavor to include the disabled in play, in addition to individuals managing strollers. Our project group recommends that, following the Americans with Disabilities Act (ADA)’s guidelines, there must be at least 36’’ of space between each structure, object or wall to make ample space for disabled persons or strollers to pass through. In addition we propose that the course is low enough and flat enough so someone in a wheelchair can freely reach their golf ball with a club from the side of the course. We have included longer putters within a catalogue for WHM to accommodate parents and other individuals who require a longer putter.

After conducting interviews and focus groups and distributing surveys, in addition to conducting document analysis and field research, our project group has composed a list of recommendations for the construction of this course. These recommendations include the materials that should be

used, exhibit learning outcomes, components of miniature golf courses that are most enjoyed by this course's target audience, and themes from Worcester's history that should be included within the course.

# 5 The Course: A Closer Look

Worcester Historical Museum (WHM) desires to appeal to entire families by adding a portable, Worcester history-themed miniature golf course to their array of exhibits. Our project group's goal was to design bid-ready designs for the course to be used by the museum during special events and functions. A miniature golf course was chosen because it offers an engaging look at Worcester's history that is accessible to individuals of all ages. During our time at the Worcester Community Project Center we determined design criteria and developed designs for the course using information gathered from a series of focus groups, interviews, surveys, and field research with children, parents, teachers from the Worcester School System, WHM staff, and miniature golf course owners/designers. From this research we identified the learning outcomes the course would be designed to meet. In this chapter we describe each hole in the course and how each incorporates our eleven findings.

Every hole in the golf course is designed to address: Finding #7, the appeal of trivia to both adults and children; Finding #10, specific lightweight and durable materials that will be used to construct the course; and Finding #11, the necessity for the course to be accessible for strollers and the disabled.

We carefully thought out setup of the course to ensure that the staff of WHM will easily be able to both set up and take down the course for special events. Each hole is split into 3-4 pieces, and each piece weighs around 20-25lbs. Each piece is connected together by a set of locating pins, as well as a metal latch to prevent the pieces from separating. To improve ease of setup, we propose that each piece of each hole have wheels on it to allow WHM staff to push or pull the sections on wheels rather than completely lifting them to move them. The use of wheels also removes the need for a secondary cart to hold and transport all components of the course.

The majority of the miniature golf course is composed of wood. The base structure is to be made out of plywood sheets and 2"x4" pieces of wood, which are available at most local hardware stores. Certain parts of the miniature golf course have to be elevated in order to allow for a cup that falls below the surface of the hole. We recommend the elevated portion be accomplished using a polypropylene honeycomb material available from Plascore Inc.


Figure 11: This is the polypropylene honeycomb material our project group recommends (Plascore: PP Honeycomb, 2013).

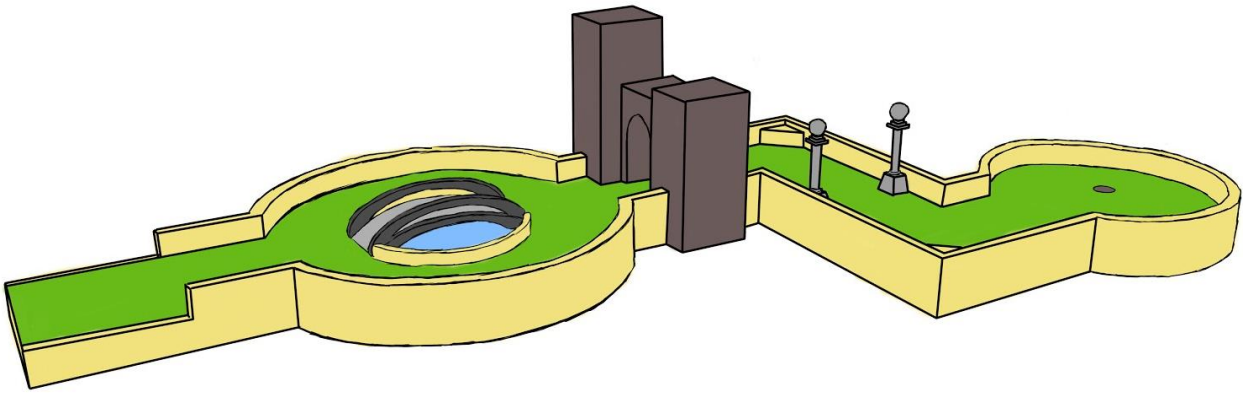
The polypropylene material, seen above in Figure 11, is lightweight and has sufficient rigidity to endure the wear and tear of elementary age children using the course. This material is more expensive than plywood, however, so the honeycomb will be used sparingly. Sections that require elevation will use the honeycomb material whereas flat sections will be constructed simply with a sheet of plywood because raising each hole off the floor with 2"x4"s would be too heavy. The use of wheels, plywood, and the polypropylene honeycomb material will allow for durability while also being lightweight. We designed the course obstacles using locally-available materials from Sears, Lowes, and Michael's Craft Store, and obstacles that required construction had their materials sourced locally as well. This will ensure that the contractor does not have any issues in acquiring the required materials.

| | | **FINDINGS** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | #1 Connecting Themes to Life Around Us | #2 Problem Solving Skills | #3 Positive Results from Patience | #4 Using MCCL | #5 Themes | #6 Inclusion of Challenging Holes | #7 Benefits of Trivia | #8 Light, Sound, Move--ment | #9 Interaction with Objects | #10 Materials | #11 Handicap- and Stroller-Accessible |
| **HOLE** | #1: Parks | ✓ | | | ✓ | ✓ | | ✓ | | | ✓ | ✓ |
| | #2: Seven Hills | | | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| | #3: Space | | | | | ✓ | | ✓ | ✓ | | ✓ | ✓ |
| | #4: Immigration | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| | #5: Transportation | ✓ | | | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓ |
| | #6: Education | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| | #7: Factories | | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| | #8: Worcester's "First and Famous" | ✓ | | | ✓ | ✓ | | ✓ | | | ✓ | ✓ |
| | #9: Casey at the Bat/Perfect Game | | | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ |

Table 6: This table lists each of our project group's findings and which hole incorporates each finding.

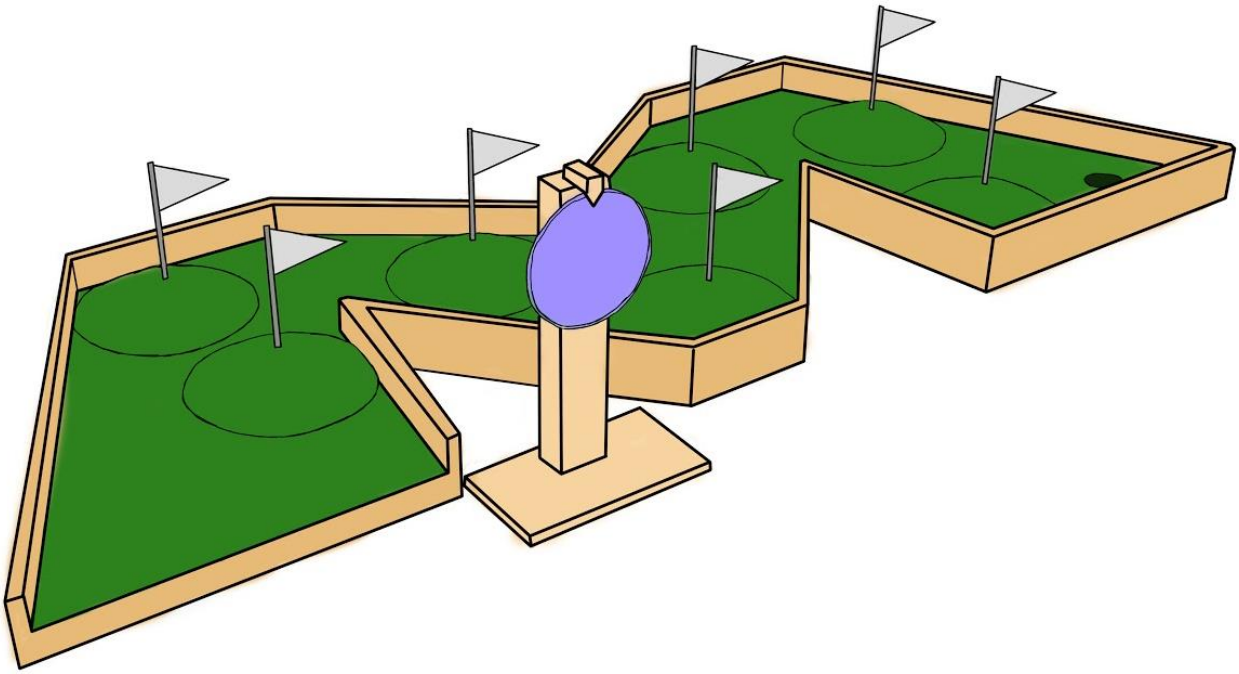
Table 6 lists each of our project group's findings and each hole feature within the course. A check mark represents where each finding was integrated within our designs. More detailed descriptions of each hole can be seen below.

## 5.1 Hole #1: Parks of Worcester



Hole #1 features various landmarks representing parks found in Worcester. There are 20 parks in the city of Worcester, with the most famous being Elm Park. Elm Park was created in 1854, and the creation of this park was one of the first times that land was set aside by a city to be a public park (Grosvener, 2012). The bridge featured within this hole is designed after the bridge in Elm Park. Bancroft Tower, the large square-like structure in the center of the hole, is found in Salisbury Park. The pillars are from Institute Park are featured as well. Hole #1 incorporates Finding #1 by including various well-known icons within the city of Worcester's parks.

## 5.2 Hole #2: The Seven Hills of Worcester



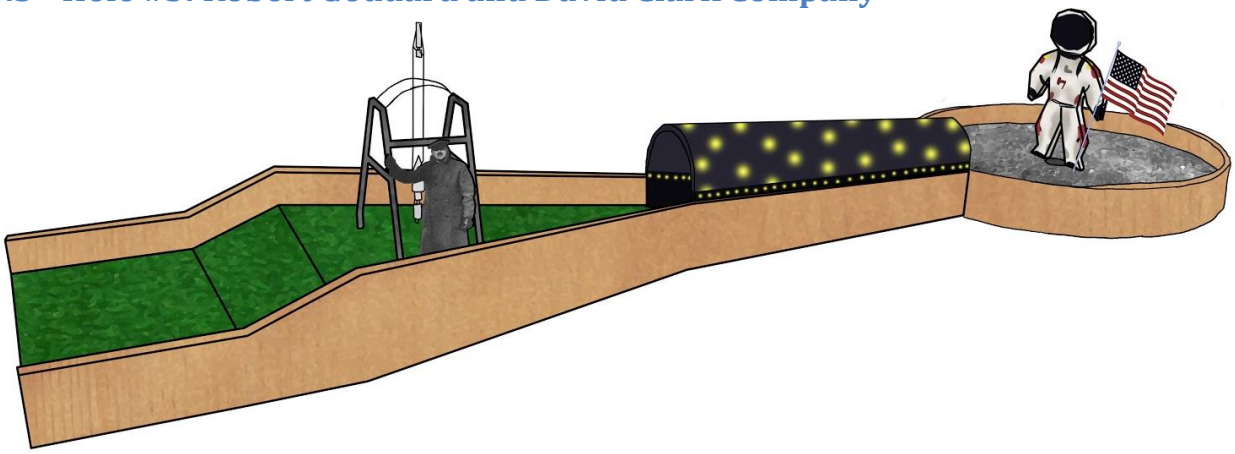
Folklore says that Worcester is built upon seven hills. These seven hills are Bancroft Hill, Hancock Hill, Newton Hill, Chandler Hill, Union Hill, Green Hill, and College Hill. Each of the Seven Hills of Worcester is featured in Hole #2. Each hill has a flag atop it, and written upon each flag is a number and the name of each hill. This hole will have the most sections for assembly. Each of the hills will be created using a thin layer of the plastic honeycomb material previously mentioned.


Figure 12: Shown here is a Mischief Spinner (Standard Mischief Spinners, 2013).

In addition, the "Mischief Spinner," created by the Tacki-Mac Family Entertainment Company, is featured at Hole #2. Players have the opportunity to spin the disc to choose a particular challenge, such as "Putt with one hand" (Mischief Spinners, 2013). This spinner will add excitement to a hole that does not feature obstacles to hit a ball through and only features hills. The Mischief Spinner can be moved from hole to hole upon WHM's discretion and adds an extra challenge to whichever hole it is used on.

Hole #2 addresses our recommendations based upon Finding #2, which maintains that children will experience positive results from patience and thoughtful play. Only one golfer at a time may use the Mischief Spinner, in addition the fact that children must obey the rules of the spinner. Hole #2 also presents a challenge due to the numerous hills featured within this hole and the challenges that the Mischief Spinner may present (Finding #6).

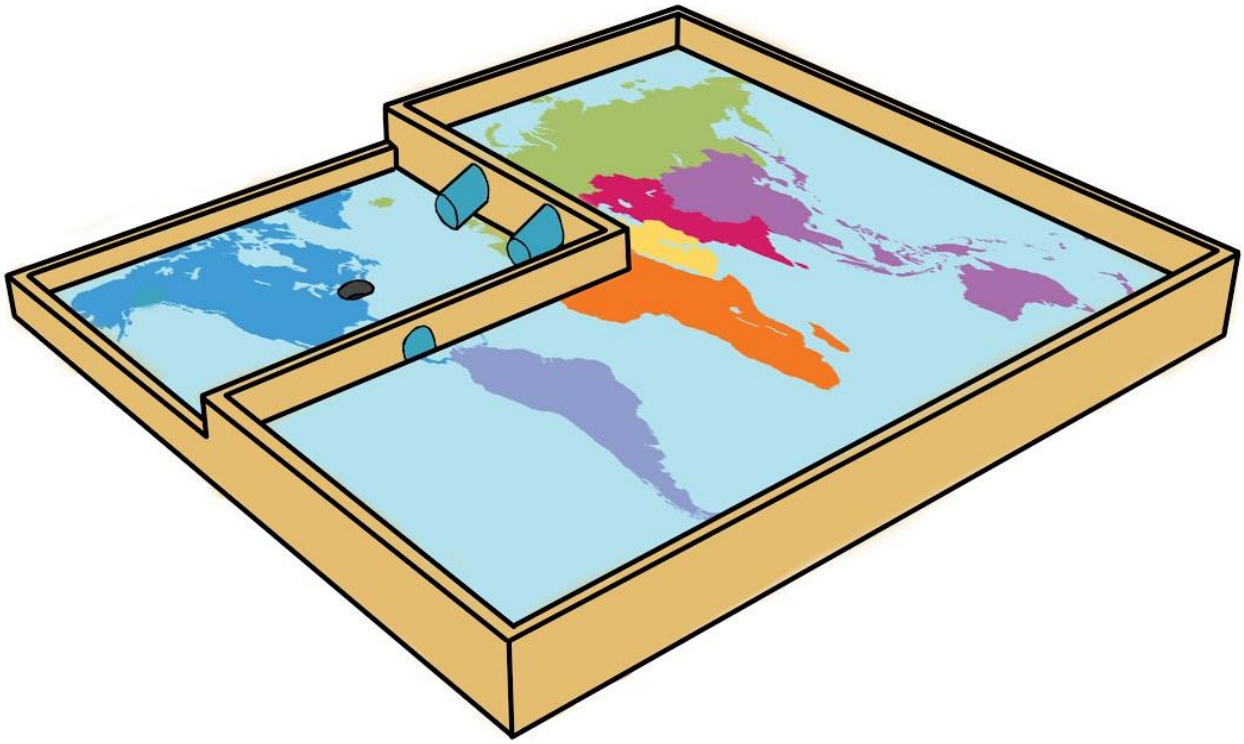
## 5.3 Hole #3: Robert Goddard and David Clark Company



Robert Goddard was a Worcester scientist who built and tested the first liquid-fueled rocket, which he called "Nell," in 1926. The David Clark Company, still operating in Worcester today, developed the first pressurized space suits. Hole #3 features a miniature replica of Robert Goddard's rocket, in addition to a foam cutout of Robert Goddard himself. We recommend that the replica of Goddard's rocket primarily be constructed of black polyvinyl chloride (PVC) piping, along with the proper fittings to shape it. Following the replica of Goddard's rocket is a tunnel with lights that light up when golfers hit their ball through the tunnel. The tunnel will have an infrared beam sensor at the beginning that will trigger a sound box and strip of LED lights (Light Emitting Diode). Finally, the hole ends with an astronaut on the moon who is wearing a suit made by the David Clark Company.

Hole #3 demonstrates recommendations based upon Finding #8 because the lights of the tunnel in this hole will be set off when a golfer's ball passes through a sensor hidden inside the tunnel.

## 5.4 Hole #4: Immigration



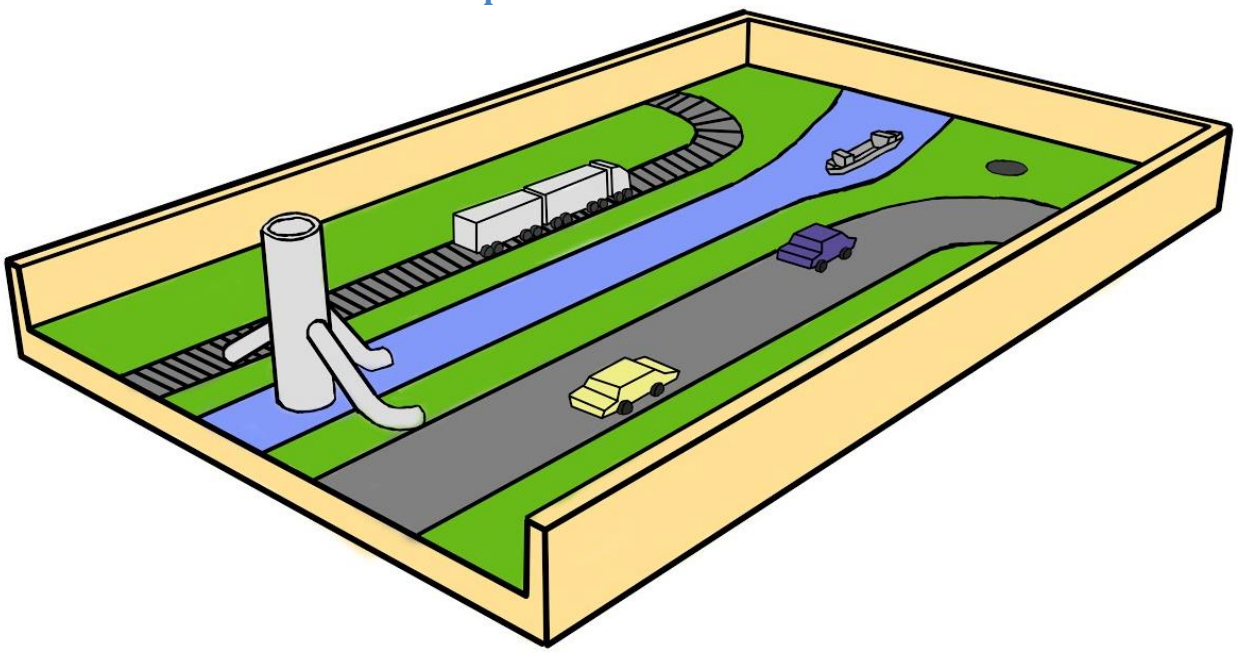
Many immigrants traveled to Worcester to work in factories. People emigrate from countries all over the world, including Africa, Vietnam, Lithuania, Poland, Italy, Greece, Finland, Syria, and Armenia. This helped make Worcester a culturally-diverse city.

A world map is featured in Hole #4 to educate golfers about immigration to the city of Worcester. The United States is on a lower elevation than the remainder of the world within this hole. The cup is centered on the location of Worcester. In order to get to the lower elevation, the golfer must hit the ball down a tube, representing the travel associated with immigration. There will be a wooden star featured on countries from which Worcester immigrants traveled from within this hole.

Hole #4 addresses Finding #1 by featuring a world map that will be familiar to children if they have seen the map in school. The map will give children an exciting opportunity to understand where immigrants from Worcester originated from. Each continent is a different color, and the name of each continent is written upon the map. Hole #4 addresses Finding #2 as well because

stars featured on this hole are raised and therefor serve as objects that golfers must find the best path around. Hole #4 also addresses Finding #6, the finding stating that challenging holes should be included within the course to appeal to the target audience. While this hole does not feature a variety of different objects, the inclusion of numerous raised stars increases the difficulty level of this hole.

## 5.5 Hole #5: Worcester Transportation

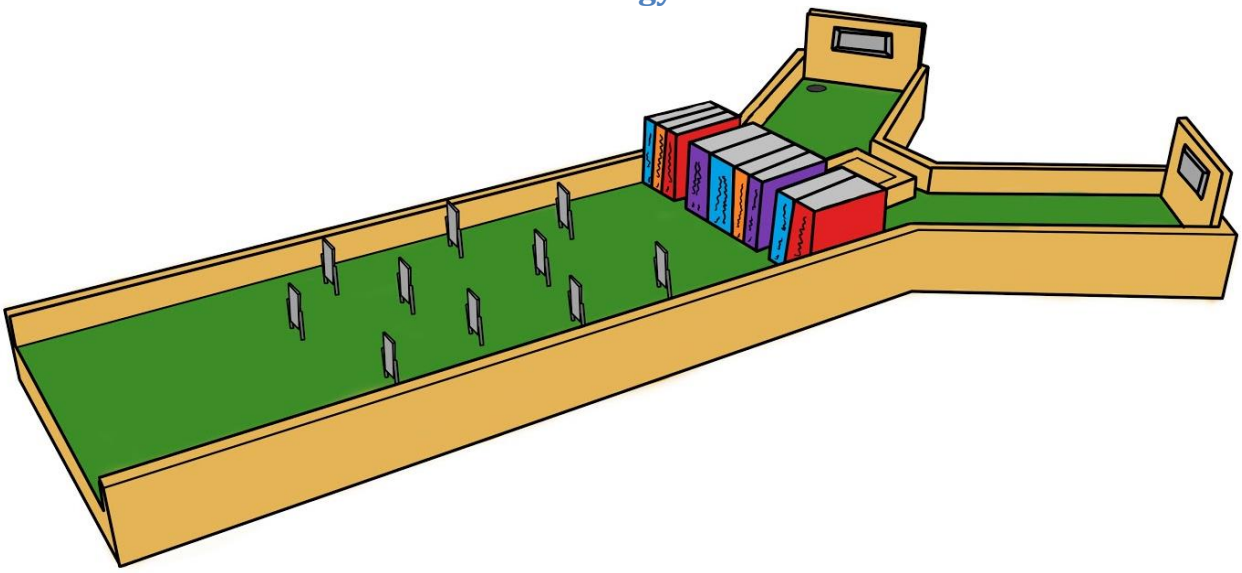


There are many ways to travel to and from Worcester. You can drive on highway I-290 or take a train into Union Station. While not meant for passenger travel nowadays, the Blackstone Canal lets freight boats travel from Worcester to Providence, Rhode Island. The Blackstone Canal's creation facilitated Worcester's transition from an agricultural economy to a factory-based economy. Hole #5 begins with a structure made of pipe that the golfer drops his or her ball into. The ball will then come out one of three tubes. From there, the golfer must try to hit the ball into a cup located in the "water" portion of the map. This represents the movement of goods from land to sea.

The start of this hole features a tube that golfers drop their ball into. Hole #5 also addresses Finding #1, the finding which recognizes that children will benefit from connecting the course themes' life around us. This hole features a highway, railroad, and canal that connect Worcester to the world, and these are methods of transportation that participants may already be familiar

with. If the golfer is not already familiar with these particular methods of transportation, this hole can educate the golfer about transportation methods available in the city of Worcester.

## 5.6 Hole #6: Education and Biotechnology

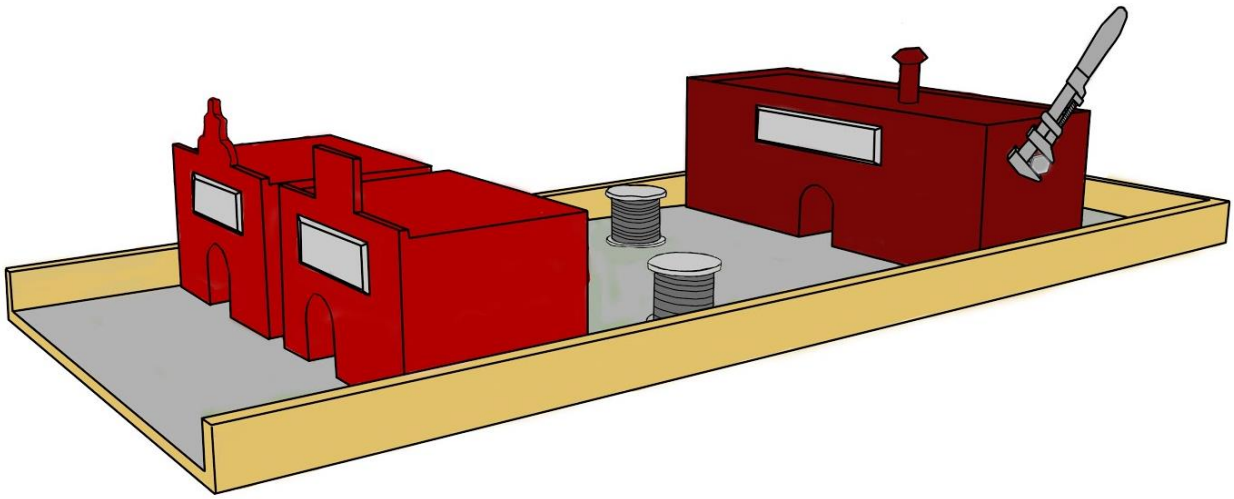


Worcester has become a center for high-tech products over the past 50 years, especially in the biotechnology field (as shown by successes made by UMass Medical School and other biotechnology companies within Worcester). There are numerous colleges in and around Worcester. Each college located in or nearby Worcester is featured on a small spinner object within Hole #6. Textbooks representing various disciplines are stacked in this hole, and the golfer must hit their ball through the stack of books based upon a question they must answer. The question is written across the textbooks, and there are two holes that the golfer may hit their ball through depending on the answer written above each one. The golfer must then putt his or her ball into the correct cup to answer the featured question. A mechanism will pop the ball out of the incorrect cup.

Featuring images of each of the colleges found in and around the city of Worcester, Hole #6 allows the player to connect to his or her surroundings (Finding #1). By featuring a question that golfers must answer, the hole encourages players to use problem solving skills (Finding #2). The golfer must read the question written upon the books within this hole and the possible answers written above the two cups in this hole. The golfer must then choose which cup to putt into based upon what the golfer believes to be the correct answer. We believe that the challenge presented by the numerous obstacles and question that must be answered within this hole will appeal to our

target audience (Finding #6). The spinners within this hole move when participants interact with them, addressing Finding #8 and Finding #9.

## 5.7 Hole #7: Factories of Worcester

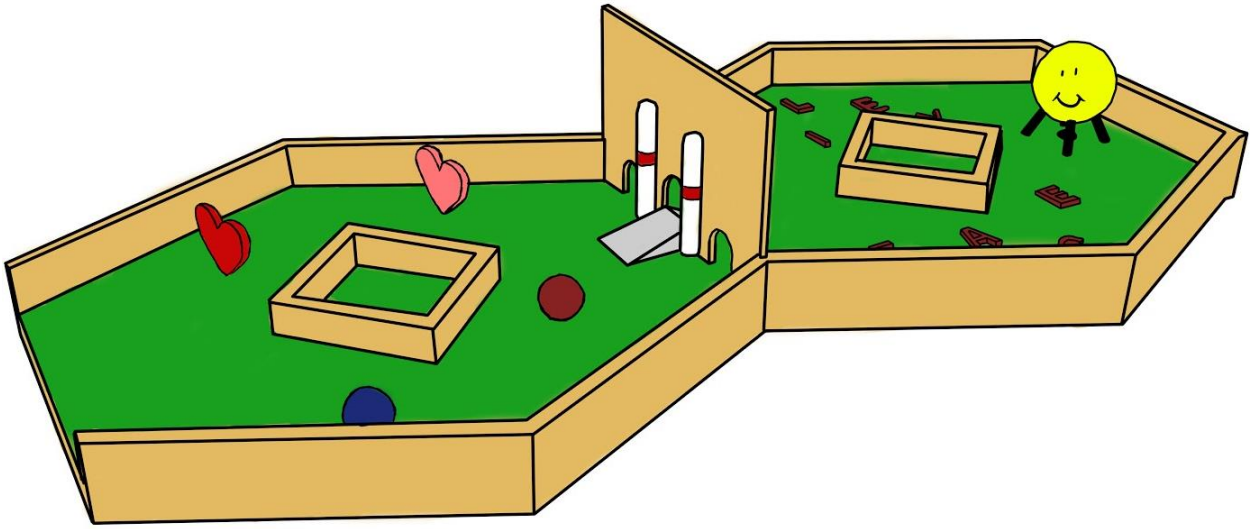


Worcester had a large farming economy prior to the industrial revolution, but over 100 years ago Worcester became an industrial city. Worcester Corset Company and American Steel and Wire were two important Factories in Worcester and are featured in this hole. Hole #7 features an additional generic factory with an interchangeable placard which allows the museum to customize the name of the factory. This allows the museum to change the name if, for example, a child were having a birthday party and wanted his or her name featured within the course.

Golfers must read the question written on the two front factories, Worcester Corset Company and American Steel and Wire, in addition to the answers below the question. Once the question has been read, the golfer must attempt to putt through whichever factory has the correct answer written on it. If the incorrect answer is chosen, the ball will roll back to the golfer so he or she may try again. The golfer must also hit the ball through a second factory, a factory designed such that the ball will be trapped once the golfer hits the ball into it. In order to release the ball into the cup that is immediately after the factory, the golfer must pull a spring lever. The handle of this lever is a replica of a monkey wrench, which was featured to connect the player to its invention in Worcester.

Hole #7 includes Finding #2 by featuring a question that the golfer must answer when putting. Hole #7 also addresses Finding #6 because the question featured within this hole, in addition to the obstacles and the lever that must be pulled, add difficulty to this hole. Finally, Hole #7 addresses Finding #9 by including a lever that golfers must interact with.

## 5.8 Hole #8: Worcester's "First and Famous"



There have been many famous "firsts and famous" in Worcester, three of which are featured within this hole. Candlepin bowling was created in Worcester by a man named Justin White in the year 1880. In addition, Worcester was the center of the commercial valentine industry in the United States for almost 100 years. Finally, the iconic "Smiley Face" was created by Harvey Ball in Worcester in 1963. Hole #8 is shaped like the number eight, and it features Valentines, Bowling Balls, and Candlepin Bowling Pins as obstacles. Behind the bowling pins are letters that spell out "Smiley Face," in addition to an image of Harvey Ball's iconic Smiley Face.

Hole #8 addresses Finding #1, the finding that explains the benefit golfers gain from connecting hole themes to life around them. Hole #8 contains various objects that golfers are familiar with and will educate golfers about where these items were created. Golfers may not have known that the various interesting objects featured throughout this hole were created in Worcester.

## 5.9 Hole #9: Casey at the Bat and the Perfect Game

"Casey at the Bat" is a poem by Ernest Thayer, a Worcester writer. The poem tells us about Casey, the star baseball player on the Mudville (a fictitious place) town team. Casey, the last batter during a game, intentionally misses the first two pitches because he feels he only needs one pitch to win the game. Unfortunately, Casey misses the last pitch, striking out and losing the game. In 1880, Lee Richmond pitched the first perfect game in professional baseball in Worcester.

Hole #9 only allows golfers to make one shot. If they hit the ball into the hole featured within the catcher's mitt, they successfully "threw a perfect game." If the ball does not go into the hole, it falls straight down and is collected into a box featured in the hole, allowing WHM to gather up each golfer's golf ball without having to individually collect them.

Golfers must be mindful of the angle and speed at which they hit their ball because they only have one opportunity to hit the ball through the hole (Finding #3). Hole #9 also addresses Finding #6 because this hole offers only one opportunity for the golfer to putt, is a challenge that takes skill and thoughtfulness to complete.

## 5.10 Conclusion

Following the increasing trend of interactive exhibits and taking into account various qualities that are necessary for a family-friendly exhibit, WHM has begun incorporating visitor engagement into its exhibit design. Worcester Historical Museum has asked our student group working through the WPI Worcester Community Project Center to assist with updating the museum to become more family-friendly by creating a design plan for a Worcester-themed, portable nine-hole miniature golf course. The target audience of the course consists of student visitors, families, and special-event attendees at the museum, with elementary school children being the main focus. William Wallace, Executive Director of WHM, aspires for the course to offer an engaging look at Worcester history and help WHM become a more prominent part of the city of Worcester.

Worcester Historical Museum, along with other museums, has suffered the financial consequences of the 2009 recession because funding for museums is highly dependent on the amount of disposable income within a population (American Alliance of Museums, 2013) (Chiang, 2013). Concerns that historical museums are not family-friendly have potentially affected the attendance at historical museums as well, as shown by a 2007 Reach Advisors survey showing that only 23% of participants would attend a historical museum with their family (Reach Advisors, 2007). Following the increasing trend of interactive exhibits and taking into account various qualities that are necessary for a family-friendly exhibit, WHM has begun incorporating visitor engagement into its exhibit design to draw in more visitors and to increase the variety of visitors to include families with children.

We accomplished five objectives in order to achieve our main project goal. Objective 1 established the course learning outcomes. Objective 2 focused on determining the exhibit themes. Objective 3 defined the design criteria. Objective 4 was to establish components for course design that will appeal to children. We completed these first four objectives simultaneously due to time constraints for our project. Finally, objective 5 was to compile and propose a completed design for the miniature golf course. We conducted focus groups with parents and children, interviews with teachers, surveys with WHM staff, and did field research with an exploratory group of elementary age children.

This project was designed to offer families an engaging look at Worcester's rich history while simultaneously assisting WHM in becoming a more prominent part of Worcester. With the inclusion of PISEC's 7 characteristics for a family-friendly exhibit, sections of the MCCL, and the data gathered from the five groups of stakeholders, this miniature golf course will allow individuals of all ages to have fun while being educated about the city of Worcester.

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## Appendix A: Interviews with Teachers

**Objectives from interviews with teachers:**

- Who has visited an educational/historically based miniature golf course
- Learning outcomes from MCAS that they would like us to incorporate
- What pieces of curriculum are hard for students to grasp & teachers to teach
- What parts of Massachusetts Common Core of Learning pieces are most important
- Other learning outcomes we could incorporate

**Introduction:** We are a group of students from Worcester Polytechnic Institute who are working with Worcester Historical Museum to design a portable, nine-hole miniature golf course based on Worcester's history. We are investigating learning outcomes and potential themes for the course. We are seeking your feedback and insights because of your teaching expertise. Our initial vision for the course is for it to educate participants on certain aspects of Worcester history as well as elements of other subjects, such as math and physics. Ideally the course learning outcomes will be well aligned with the Massachusetts Common Core of Learning, and the MCAS.

1. Have you visited an educational miniature golf course before, and if so, can you tell us about it? (By "educational," we mean a course that had some sort of learning outcomes, whether it taught about history, math, physics, or another subject.)
2. What parts of Massachusetts Common Core of Learning do you feel are the most important? (Provide them copies of Clare's document.)
3. Are there any pieces of your students' curriculum are hard for students to grasp, and if so, can you tell us about them?
4. What pieces of your students' curriculum would you most like to be supplemented by this miniature golf course that we will create?
5. What items from Worcester's history do you teach about in your classes?
6. What items from Worcester's history are not taught about in your classes that you feel are valuable pieces of information your students should learn about?
7. Are there any other potential learning outcomes that we have not yet touched upon that you feel would be valuable to include in the course that we are creating?

## Appendix B: Interview with Golf Course Designer/Owner

We are a group of students from Worcester Polytechnic Institute in Massachusetts. We are conducting a survey of miniature golf course owners/designers to help develop themes and learning outcomes for a miniature golf course at Worcester Historical Museum. We strongly believe this kind of research will ultimately increase interest and participation at Worcester Historical Museum. Your participation in answering our questions is completely voluntary and you may withdraw at any time if you wish. This is a collaborative project between WHM and WPI, and your participation is greatly appreciated.

**Objectives for meeting with owner/designer:**

- Examine the process that the developer went through to develop the miniature golf course in terms of:
  - Materials used to construct the course
  - Themes for each hole
  - Learning outcomes for each hole
  - Construction of the course
  - Maintenance
- Determine the challenges faced during the development of a miniature golf course (see list of five items directly above).
- Determine the extent of maintenance required on a miniature golf course.

**General Questions**:

1. Did you design this course yourself or contract it out?
2. Did you construct or contract out this course?
3. How did you determine what you would and would not include in the golf course?
4. Did you conduct any research before constructing the course? If so, what were your findings?
5. What were challenges that you faced during the development of the golf course? How did you overcome those obstacles?
6. What have you learned in terms of maintenance, construction, and materials for a miniature golf course?

7. What has been your best experience from the miniature golf course industry?
8. Is there anything else that you would be able to share with us about miniature golf course design or construction?

**For Portable Course Owners:**

1. What are challenges that you have faced during the development of your golf courses, and how did you overcome those obstacles?
2. What have you learned in terms of maintenance, construction, and materials for a miniature golf course? (Possibly specific things that definitely don't work well, and that do work well?)
3. Could you possibly recommend to us specific brands of carpet, paint, water repellent, or other materials that we could possibly use? Our project sponsors are looking for us to, in addition to designing the course, give a list of necessary supplies to build the course and a list of suppliers for the items needed. Could you possibly recommend to us specific brands of items you've used to construct the courses?
4. Do you have any recommendations in regards to using battery power for movement on a miniature golf course?
5. What was your favorite course that you built, and why?
6. Which of the courses that you've built has had the largest amount of positive feedback, and why?
7. What are the most important things to keep in mind when designing a course that is portable?
8. What has been your best experience from the miniature golf course industry?
9. Is there anything else that you would be able to share with us about miniature golf course design or construction?

## Appendix C: Focus groups with Elementary Age Students

Objectives for focus group with students:

- Favorite things about miniature golf
- Favorite courses and reasons why the courses are their favorites
- What items from the museum are familiar
- What items from the museum are not familiar to them (potentially items we could focus on)
    - Ex: When the WHM surveyed children in the past and asked what they learned about, none of the students mentioned Robert Goddard, however since he is a significant individual in Worcester's history, we could find a memorable way to include him in the course.
- What part of the museum was children's favorite
- What items in history children find interesting

**Introduction:** We're a group of students from a college in Worcester called WPI. We're creating a miniature golf course about Worcester's history, and we wanted to talk to you about what you like in miniature golf courses. The miniature golf course will be at Worcester Historical Museum.

**Questions:**

1. How many of you have played miniature golf before?
2. What is your favorite thing about miniature golf? What makes it fun?
3. Do you have a favorite miniature golf course? Why is it your favorite?
4. (Showing pictures of items from the museum, one by one) Do you know what this is? If so, please raise your hand. (We will count how many children recognize each item.) What is it?

   What was your favorite part of the museum? Why?

## Appendix D: Field Research Questions

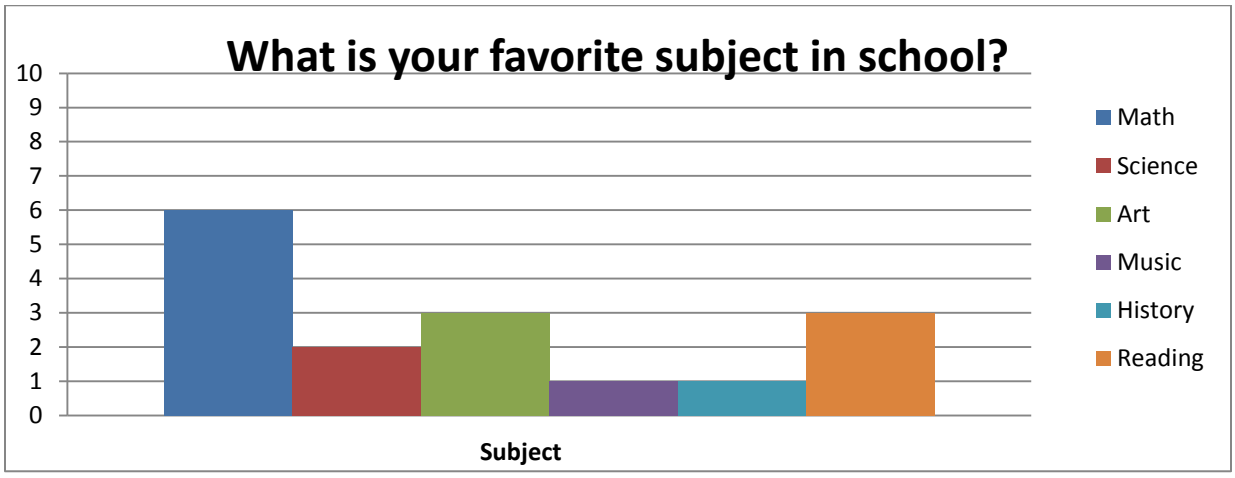
**Research Objectives:**

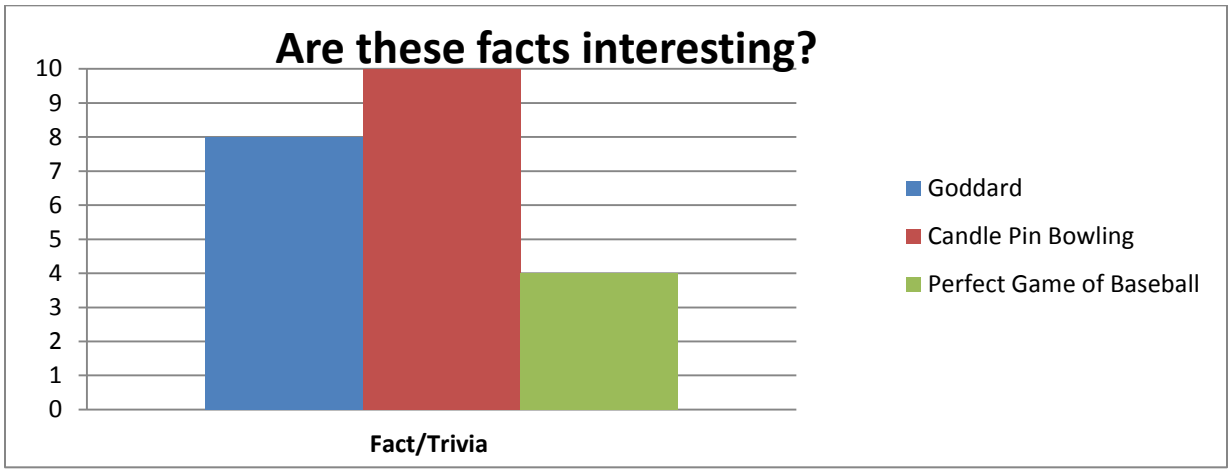
- Develop characteristics of an engaging and enjoyable miniature golf course.
  - Determine differences between holes that were engaging and not engaging.
  - Determine the importance of the environment surrounding the course.
  - Determine which holes are the most challenging for children.
    - Determine what about those holes are the most challenging.
    - Determine why the challenge was a frustrating or rewarding experience.

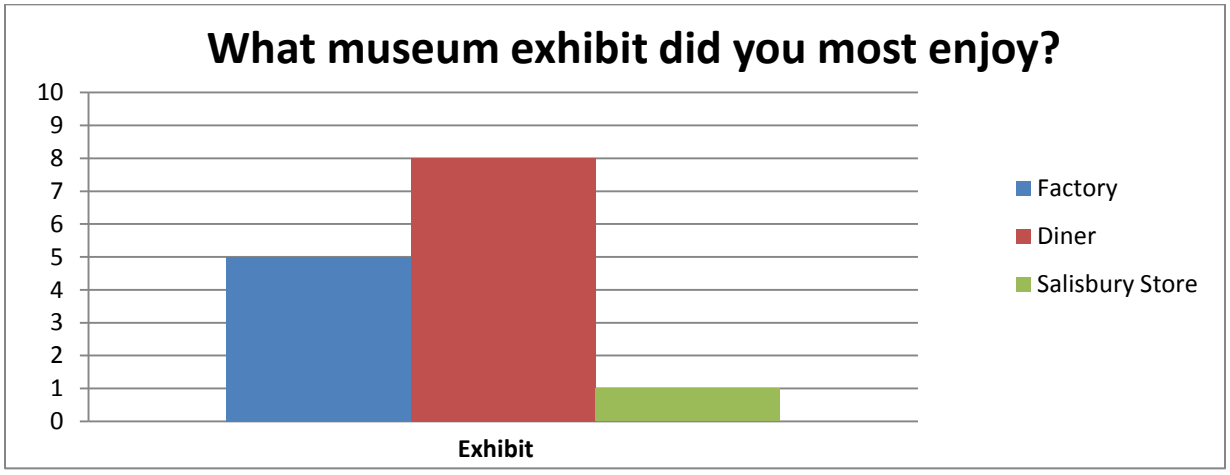
**Introduction for Children**: We're a group of students from a college in Worcester called WPI. We're creating a miniature golf course about Worcester's history, and we wanted to talk to you about what you like in miniature golf courses. The miniature golf course will be at Worcester Historical Museum.

- Questions to ask while playing:
  1. Did you find any of the holes to be hard? Did you like or dislike these holes?
  2. Ask who liked each hole after each one is done.
- Questions to ask children after playing miniature golf:
  1. Have you played miniature golf before today?
  2. What is your favorite thing about miniature golf? What makes it fun? (Ask half before playing through and the other half after)
  3. Do you have a favorite miniature golf course? Why is it your favorite?
  4. What hole here was your favorite? Why?
  5. Whose favorite subject in school is…
     a. Writing
     b. Reading
     c. Science
     d. Art
     e. Music
     f. Geography
     g. History

## Results


What is your favorite subject in school?
10
9
8
7
6
5
4
3
2
1
0
Subject
Math
Science
Art
Music
History
Reading


Are these facts interesting?
10
9
8
7
6
5
4
3
2
1
0
Fact/Trivia
Goddard
Candle Pin Bowling
Perfect Game of Baseball


What museum exhibit did you most enjoy?
10
9
8
7
6
5
4
3
2
1
0
Exhibit
Factory
Diner
Salisbury Store

## Appendix E: Field Research - Parent Questions

**Research Objectives:**

- Develop characteristics of an engaging and enjoyable miniature golf course.
  - Determine differences between holes that were engaging and not engaging.
  - Determine the importance of the environment surrounding the course.
  - Determine which holes are the most challenging for children.
    - Determine what about those holes are the most challenging.
    - Determine why the challenge was a frustrating or rewarding experience.

**Introduction for Adults:** We are a group of students from Worcester Polytechnic Institute who are working with Worcester Historical Museum to design a portable, nine-hole miniature golf course based on Worcester's history. We are investigating learning outcomes and potential themes for the course. We are seeking your feedback and insights because of your expertise with children. Our initial vision for the course is for it to educate participants on certain aspects of Worcester history as well as elements of other subjects, such as math and physics. Ideally the course learning outcomes will be well aligned with the Massachusetts Common Core of Learning, and the MCAS.

- Questions to ask parents:
  1. Do you find miniature golf fun?
  2. If so, what, in your opinion, makes miniature golf fun?
  3. What would you find a valuable addition or component to a miniature golf course so that the course appeals to both parents and children?
  4. Why do you bring your children to a miniature golf course?
  5. To follow up that last question, what do you think your children gain from playing miniature golf?
  6. If a miniature golf course were both fun and educational, would you choose that over a course that was not specifically educational?

7. Do you and/or your children have a favorite miniature golf course that you bring your children to? Why is it your favorite?
8. Did you feel a specific hole in your favorite golf course could be improved in some way?
9. If you know a bit about Worcester's history, do you have any thoughts on particular events/facts which may be worth incorporating into WHM's proposed course design?
10. Give out a handout with the following information for the parents to rank.

    **Some facts:**

    - Robert Goddard launched the first liquid-fuel rocket in Worcester.
    - There were many factories in Worcester.
    - There are many diners in Worcester.
    - Candlepin Bowling was invented in Worcester.
    - First perfect game in major-league baseball history happened in Worcester.
    - Harvey Ball created the iconic Smiley Face in Worcester.

    Which of the above facts are the most interesting, in your opinion?

## Appendix F: Themes Survey for WHM Staff

Please rate each fact about Worcester on a scale from 1 to 5 in terms of significance for our project (with 5 being the highest significance and 1 being the lowest).

| Theme | Rating |
|---|---|
| **Robert Goddard** launched the first liquid-fueled rocket on March 16th, 1926. | |
| **David Clark Company** in Worcester, MA was founded by Mr. David Clark in 1935. They designed and created space suits, one of which is the pressurized space suit used in the Red Bull Stratus Project. On October 14th, 2012, Felix Baumgartner did a record-breaking free fall from about 24 miles in one of these suits. | |
| **Three-decker houses** were built near factories to allow many families to live in one home. | |
| **The Salisbury Store** was started by Stephen Salisbury when he left his family in Boston to open a branch of the family business in Worcester. Everything sold in Stephen Salisbury's store in Worcester came from his family's store in Boston, and the store in Boston got many of their items from across the Atlantic Ocean. | |
| The **first National Women's Rights Convention** was held in Brinley Hall in Worcester. | |
| Almost 8,000 **women worked** in Worcester. Many operated machines that made textile, wire, metal, and paper goods. Many girls left school at age fourteen to work. | |
| **Industrialization** started with textile mills, making thread and cloth. The more you made when working in factories, the more you were paid. This meant workers needed to work quickly. | |
| **American Steel/Wire** employed over 3,000 workers. | |
| **Morgan Construction Company** made continuous rolling mills that roll pieces of steel into rods. This company is the only 19th-century large-scale firm in Worcester that is still family-run in Worcester. | |
| The city was built atop **7 hills**: Hancock Hill, Newton Hill, Green Hill, Chandler Hill, Union Hill, College Hill, and Bancroft Hill. | |
| The Providence & Worcester **Railroad** was incorporated into Massachusetts in 1844. The company also purchased the Blackstone Canal in 1845. These transitioned Worcester from a farming city to an industrial city. | |
| Written by Ernest Thayer in 1888, "**Casey at the Bat"** is a baseball poem that is believed to be about the city of Holliston, Massachusetts. This is believed to be the setting due to fact that it has a neighborhood called Mudville and because Thayer grew up in Worcester, MA. | |
| Knife maker Loring Coes incorporated a screw-based adjuster to a standard **wrench** in 1840, creating the **Monkey Wrench**. By turning the screw, you could adjust the wrench to fit any bolt size. | |
| The **Harvey Ball Smiley** first appeared in the early 1960s. Created by Harvey Ball, the logo was used to increase employee morale between the Guarantee Mutual Company of Ohio and State Mutual Life Assurance Company. | |
| The game of **candlepin bowling**, despite much controversy, was accepted to be first introduced between 1885 and 1890 in Worcester. The game got its name from the candle-like appearance of the pins. | |
| The **first perfect game** was thrown on June 12, 1880 by Lee Richmond. Richmond was a member of the Worcester Ruby Legs. The team played against the Cleveland Blues, and Richmond threw the perfect game in a 1-0 win at the Worcester Agricultural Fairgrounds. | |
| The first American **valentine** was made in Worcester in 1848. They were first made by Esther Howland in the same year that Worcester established itself as a city. | |
| Worcester is the **Heart of the Commonwealth.** | |
| **Diners** became an easy way for people to sit down, make new friends, and converse about what was going on in the city at that time. They were a place where news could easily be spread. | |

**Do you have any other suggestions for themes for this miniature golf course?**

_____

## Appendix G: Final Focus Group Questions for Elementary Age Students

**Objectives for focus group with students:**

- See if the students can identify what is featured in each hole.
- Understand what features of each hole the students like and dislike.
- Ask students if there is anything we could add to each hole that they would enjoy.
- Ask students if what they are seeing relates to something they have seen and/or experienced in their lives.

**Introduction:** We're a group of students from a college in Worcester called WPI. We're creating a miniature golf course about Worcester's history, and we wanted to talk to you about what you like in miniature golf courses. The miniature golf course will be at Worcester Historical Museum.

**Questions for pictures of holes:**

1. What do you see in this picture?
   (Describe the hole now.)
2. What do you like about what you see in the picture?
3. What do you not like about what you see in the picture?
4. What could we add to the picture to make it more fun?
5. Does this remind you of something you've seen before?