Exhibiting Simple Machines at the Nantucket Old Mill

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For more information, please see https://wp.wpi.edu/nantucket/projects/2018-projects/nha/

Abstract

The goal of this project was to research and design methods to enhance the visibility of Nantucket's Old Mill. The project team worked with the Nantucket Historical Association to evaluate the engineering principles that could be conveyed through interactive, age appropriate museum exhibits at the site. We also developed recommendations for signage around the mill, as well as social media graphics that can be used to promote the Old Mill online. Our final deliverables include this final report, four interactive museum exhibits focusing on simple machines in the Old Mill, final recommendations, and supplemental resources to aid in the use of the interactive exhibits such as instructional panels, teacher's guides, and an interactive booklet.

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Introduction

The Nantucket Old Mill, shown in Figure 1, is a historic landmark recognized by the American Society of Mechanical Engineers for being America's oldest still operating smock windmill. It is among seven historic sites owned by the Nantucket Historical Association on the island. Being a stand out example of historic engineering, the NHA feels that the Old Mill has the potential to draw more attention from the local and tourist visitors by having an educational impact on the island.

Executive Summary Figure 1. The Old Mill

Project Statement

The goal of this project was to research and design methods to enhance the visibility of Nantucket's Old Mill, ultimately by creating family-friendly interactive museum exhibits to showcase the history and engineering of the mill. To achieve this goal, our team researched the history of Nantucket and its Old Mill, as well as other historic windmills and living museums in the Worcester area. Using this information, we designed and created exhibits that educate visitors about the engineering principles supported by the Old Mill. The experience students and families gain through using the interactive exhibits will provide an immersive experience even if the Old Mill isn't operating on the day of their visit or if they are unable to access the Old Mill building. Our team also analyzed the existing social media presence of the NHA and the Old Mill to create recommendations for developing an enhanced social media presence, as well as provided a comprehensive list of signage improvements that could be made to the Old Mill.

Project Objectives

To achieve this goal, the following project objectives were developed.

1. Design a series of interactive museum exhibits appropriate to a variety of audiences that can be used to teach the history and engineering principles of the Old Mill in comprehensive exhibits.
    - Research background material relevant to understanding the history and educational potential of the Old Mill.
    - Create a list of design criteria that coincide with the background research.
    - Design age-appropriate exhibits on the Old Mill site that teach how the mill operates.
2. Recommend improvements to the Old Mill property to enhance visibility of the site.
    - Develop standardized sign templates for the Old Mill.

- Create a comprehensive list of new signs, and signs that need to be updated.
- Develop sample social media posts to promote the Old Mill on NHA social media platforms.
- Identify educational activities that link common themes between NHA sites to promote a fun, but educational environment.

To accomplish the first objective, the project team created detailed designs of several interactive exhibits which were reviewed and revised before fabrication. The final designs were prototyped and constructed in the NHA Gosnold Center before being presented to a focus group for design validation. The second objective was accomplished through onsite research and forming educated recommendations on the topics accordingly.

Project Outcomes

Using the design criteria developed in the early stages of research, the project team designed five interactive exhibits (Figure 2). These criteria took into consideration safety, manufacturability, multi-sided capabilities and relevance. The exhibits are each designed to convey a different engineering principle, while still being fun and easy for children to interact with. Additionally, each exhibit is accompanied with an instructional panel to help guide the user and offer them challenges while interacting.

Executive Summary Figure 2. The Simple Machine Exhibits at the Old Mill

The "Box of Rocks" exhibit is derived directly from the Old Mill. It is a large lever weighed down by a box of rocks that users lift using ropes attached to the large lever arm. Three ropes are strung from the lever arm at differing distances from the pivot point. These ropes demonstrate that the different distances from the pivot change the effort required to lift the box. Each rope has a grip with a different color, corresponding to the difficulty of lifting the box of rocks. The title of the machine, "Can you lift the Box of Rocks?" poses a challenge to the visitor, allowing them to solve the problem using exploration as they investigate the easiest way to lift the box. Focus group testing of this exhibit found that it was very durable and could withstand repetitive pulling.

The "Shifting Gear" exhibit at the Old Mill demonstrates how changing the gear ratio in a transmission will affect the speed of an end effector. By shifting a cage gear, similar to the one in the mill, the visitor will be able to move a wheel modeled after the grindstone in the mill. The

title of this exhibit proposes a question, “How Fast can you Spin the Grindstone?”, encouraging users to think critically about why the different gears change the speeds of the grindstone.

The “Sheets to the Wind” exhibit is a simplified version of the Old Mill that has a moveable smock top with vanes and attachable sails. The users place the sails on the vanes, made of canvas similar to the material the Old Mill’s sails are made from allowing them to get the tactile experience of raising the sails on the mill. The exhibit provokes the question, “How many sheets to the wind?” with information that provides details about how many sheets the actual Old Mill uses depending on the wind speed. This exhibit provides the participants a simplified experience of what it is like to attach the sheets to the vanes and turn the smock into the wind to optimize the efficiency of harnessing wind energy.

The “Race to the Top” exhibit conveys the lesson of distributed loads across pulleys as well as basic physics lessons using trigonometry. This simple machine consists of two ramps with tracks built in them that carts sit into, pulleys, and weights. Users are able to fill their cart with corn, manipulate the angle that the ramp sits on between 3 angles, and add weights to the pulleys to change the rate the cart travels up the inclined plane. This exhibit is similar to common high school science experiments, but ties in the themes of the Old Mill and solving the puzzle of transporting products like corn in and out of the mill itself.

The “Gear Puzzle” exhibit demonstrates how gears are an easy way to teach how to transfer rotational energy to move something. The title of the machine, “Who will make the mill turn first?” tasks the user to have a friendly competition with their friends or family to solve the puzzle. This interactive element is a three-sided structure where participants must place gears on pegs such that the gears fit together and spin the windmill at the top when they crank the gears. Due to time constraints, the team was not able to fabricate a full assembly of this exhibit, and recommends the NHA use the detailed drawings included to build and implement this exhibit.

To tie the different exhibits together, supplementary material was provided to enhance the experience of the participants. The project team created a teacher’s guide/lesson plan to emphasize the different engineering principles in each of the exhibits. This guide is available to all school teachers and is targeted towards children between grades 6-8. Additionally, the team produced a “Voyage Log” that is a creative map resembling the outside of the Old Mill and the location of the different exhibits. The goal of the Voyage Log is to give visitors an incentive to visit all of the exhibits by collecting stamps at each, and finally a completion stamp after all have been visited.

Recommendations

Updating Signage

In addition to the educational exhibit elements on the outside of the Old Mill property, the project team recommends the NHA update the signs and labels inside the building. We identified types of signs to be improved for both the inside of the Old Mill, as well as the exterior property. The signs the team recommends be improved were the labels on different elements of the mill or artifacts displayed there, captions explaining photos, and existing signage that needs to be updated.

Executive Summary Figure 3. Future signs locations inside the Old Mill

Increase Social Media Presence

The project team found the social media usage by the Nantucket Historical Association to be very active in promoting the NHA's events and properties. However, with only a few posts about the Old Mill in the year proceeding this project, and the site being a landmark of Nantucket, the project team recommends a series of improvements to the existing NHA social media posts to boost visibility of the mill. Posts on Facebook and Instagram can be used promote the Old Mill and advertise when the mill is operating. Snapchat can also be used to show the mill operating and people using the exhibits can be posted on a public story.

Connecting Historic Sites

The project team recommends that the Nantucket Historical Association capture thematic connections through the sites by using signage, activities, and site maps. The NHA can capitalize on the summer months and increased tourist traffic by hosting "Field-Days" between the Old Mill, the Oldest House, and the Old Gaol.

The team recommends that the outcomes from this project can be expanded in the future to encompass future exhibitions at the other NHA sites, all offering their own stamp books, challenges, and interactive games to encourage visitors learning outside of what the interpreter conveys to them on their tours.

Chapter 1. Introduction

Nantucket built its name on the reputation of the whalers who scoured the oceans from the late 1700's to the mid 1860's. However, the rich rewards the islanders obtained from the whaling industry were not sustainable. The whaling industry on Nantucket collapsed as the urbanized city of New Bedford wielded more resources than the small island. Simultaneously, the more readily available kerosene took the place of whale oil. As a result, the island had to turn to a new, more sustainable source of income.

During the era of whaling and the years that followed its collapse, agriculture was an important aspect of life on the island because of the need for the community to be mostly self-sufficient. The island relied on the land as well as the sea to provide food and business for the residents. Corn was an abundant crop on the island, so much so it was traded in markets on the mainland. Supporting the plentiful corn crop, there were a total of seven grist (corn grinding) mills on Nantucket, five of which were windmills including what is now known as the Old Mill, built in 1746. The use of grist mills created a need for Millers, specialized workers who operated and maintained the mills.

In 1894, about thirty years after the Nantucket whaling industry collapsed, the Nantucket Historical Association (NHA) was formed, an organization responsible for the preservation of Nantucket's historic sites. Currently, the NHA owns seven historic sites on the island, one of which is the Old Mill, America's oldest still operating smock windmill. This fully-functional windmill serves as a local icon, as well as an underutilized resource for the Nantucket Historical Association as they seek to expand the lessons taught about the history and engineering prowess of the early Nantucket residents. In addition to the Old Mill, the NHA maintains six additional historical landmarks on the island; the Oldest House, the Thomas Macy House, the Old Gaol, the Quaker Meeting House, the Fire Hose Cart House, and Greater Light. Even though Nantucketers and tourists are aware of these locations, they are not as frequently visited as the NHA's downtown Nantucket Whaling Museum.

Historic landmarks are locations across the United States that commemorate the importance of landmarks in American history (National Park Service, 2018). The Old Mill is a unique historical artifact recognized by the American Society of Mechanical Engineering for being the oldest still operating smock-type mill in the United States (American Society of Mechanical Engineers, n.d.). The historic structure still produces cornmeal for tourists to purchase, however the Old Mill also has the potential to support educational lessons such as simple machinery, harnessing wind power, and the agricultural history of Nantucket.

In 2018, the Old Mill was operated more times than it had in the past 15 years but was still an underutilized asset for the NHA. As a result, this project was created to help make the Old Mill a leading attraction for the Nantucket Historical Association.

The goal of this project was to research and design methods to enhance the visibility of Nantucket's Old Mill, ultimately by creating family-friendly interactive museum exhibits to

showcase the history and engineering of the mill. To achieve this goal, our team researched the history of Nantucket and its Old Mill, as well as other historic windmills and living museums in the Worcester area. Using this information, we designed and created exhibits that educate visitors about the engineering principles supported by the Old Mill. The experience students and families will gain through using the interactive exhibits will provide an immersive experience even if the Old Mill isn't operating on the day of their visit or they are unable to access the mill's building. Our team also analyzed the existing social media presence of the NHA and the Old Mill to create guidance on building an enhanced social media presence, as well as provided a comprehensive list of signage improvements that could be made to the Old Mill in the future.

Figure 1. The Nantucket Old Mill

Chapter 2. Background

This background chapter presents the research conducted to understand the design of museum exhibits as well as the purpose behind different exhibit designs, and the education goals each try to achieve. Along with research on the various types of exhibits and their motivation for each design, we researched the history of Nantucket, the Old Mill, and other historical mills to understand the type of exhibits that would best fit the Old Mill.

2.1 History of Nantucket

Thirty miles off the southern coast of Cape Cod, Massachusetts rests a fourteen-mile stretch of land known as Nantucket. The first documentation of Nantucket dates back to 1641, when the entire island was deeded to Thomas Mayhew and his son by James Forrett. Not too long after in 1659, the island was populated by seamen and tradesmen after Mayhew sold the island to a group of investors for "the sum of thirty Pounds...and also two beaver hats, one for myself, and one for my wife" (Macy, 1835).

When first settled, the soil of Nantucket proved ideal for agriculture. In 1729, Ebenezer Barnard yielded 250 bushels of corn from just five acres of land, an impressive number for its time. The crops were so abundant that the island farmers were able to trade their produce in Boston (Macy, 1835).

Along with corn production, whaling was a leading industry for Nantucket. Whaling first became a prospect around 1672 when a "scrag" whale lingered in the Nantucket harbor for three days; the islanders engineered harpoons and successfully killed the whale (Macy, 1835). Their encounter was one of the first before the whaling industry took hold of the island. The locals enlisted the help of a professional whaler named Ichabod Paddock, who educated the locals on the most efficient ways to hunt and extract whale oil. The whaling industry also brought collaboration between the English settlers and Native American people, the latter who became avid whalers, "capable of conducting any part of the business" (Macy, 1835).

By 1850, the whaling industry was in decline, falling to the replacement of whale oil with kerosene in Pennsylvania as well as the urbanized whaling industry of Bedford, MA. As a result, Nantucket faced a severe economic depression, which was worsened by the Great Fire of July 13th, 1846 which burned down a third of the downtown and left hundreds and in poverty. The resulting depopulation left most of Nantucket's buildings untouched and uninhabited.

After the Great Fire and inhabitant exodus to the mainland, the remaining island residents recognized that they needed another method to draw people to their scenic home. Scenic Nantucket and the preservation of the island's historical culture, presence, and artifacts became the incentive that reeled in visitors in the summer. The residents soon formed the Nantucket Historical Association (NHA), which since 1894 has been devoted to maintaining and preserving Nantucket's rich history through artifacts as well as physical locations and buildings. While the

island itself is not a historic landmark, the people of Nantucket treat it as such, and actively work to keep the island as historically accurate as possible.

2.1.1 History of the Old Mill

While the island is mostly renowned for its whaling history and artifacts relating to that history, one of the more notable artifacts that remains on the island to this day is the Old Mill, America's oldest operating smock grist mill.

Constructed in 1746, the Old Mill provided cornmeal to the Nantucket island, and beyond when it was in its prime years during the late 1700's through the mid 1800's. Interestingly, articles in the New York Times from the mid 1900's suggested that the people of the island had minimal knowledge of the windmill's dubious construction, as "it had always been there". Fortunately, in the late 1930's the mill was restored for the sake of tradition and the mill is now recognized by the American Society of Mechanical Engineering (ASME) as a historical landmark for being America's oldest currently operating smock windmill, the term smock denoting the ability to rotate the roof into the wind (NHA, 2018). The Old Mill has been used as a tourist attraction for the island by the NHA ever since the 1930's restoration.

2.1.2 Evolution of Wind Power

Harnessing wind power for pumping water, milling seed, and sawing wood among other applications were well developed practices long before the island of Nantucket was settled by the English. Prior to the construction of the Old Mill in 1746, it was common in areas like the Netherlands to utilize windmills for producing corn meal or running a saw mill (Kaldellis, 2011). However, the Old Mill on Nantucket was used to produce cornmeal using wind power to turn a grind stone (**Figure 2**).

Figure 2. Grindstone for Nantucket Old Mill [Susan Wyman]

In present day, wind turbines use the same basic structure as the windmills constructed in the 1700s, although the purpose of the mills have changed - most modern windmills are used for generating electricity. Power-generating windmills were developed in the U.S. as early as 1888, when the first electricity generating wind turbine was implemented in Cleveland, Ohio (Kaldellis, 2011).

Figure 3. Current Wind Turbine on Nantucket [Nantucket Energy Office]

2.2 Historic Sites and Exhibits

According to the National Park Service, National Historic Landmarks are defined as, "Historic places that possess exceptional value in commemorating or illustrating the history of the United States" (National Park Service, 2018). Buildings, sites, structures, objects, and districts make up the 2,500+ National Historic Landmarks, with only 16% belonging to the Federal government. The majority of National Historic Landmarks are owned by private individuals, universities, non-profit organizations, corporations, or local and state governments (National Park Service, 2018).

To designate a site as a National Historic Landmark mandates the site meet multiple requirements as specified by the National Park Service. According to the National Parks Service, these requirements include that a potential site:

1. Be associated with events that have made a significant contribution to, and are identified with, or that outstandingly represents, the broad national patterns of United States history and from which an understanding and appreciation of those patterns may be gained; or
2. Be associated importantly with the lives of persons nationally significant in the history of the United States; or

3. Represent some great idea or ideal of the American people; or
4. Embody the distinguishing characteristics of an architectural specimen exceptionally valuable for the study of a period, style or method of construction, or that represent a significant, distinctive and exceptional entity whose components may lack individual distinction; or
5. Are composed of integral parts of the environment not sufficiently significant by reason of historical association or artistic merit to warrant individual recognition but collectively compose an entity of exceptional historical or artistic significance, or outstandingly commemorate or illustrate a way of life or culture; or
6. Have yielded or may be likely to yield information of major scientific importance by revealing new cultures, or by shedding light upon periods of occupation over large areas of the United States. Such sites are those which have yielded, or which may reasonably be expected to yield, data affecting theories, concepts, and ideas to a major degree (National Parks Service, 2018).

National Historic Landmarks provide tangible pieces of history that are irreplaceable to our society. Although historic writings and artworks enrich one's vision of the past, landmarks allow one to experience the history.

2.3 Museum Exhibits and Learning

A museum curator is, "one who has the care and superintendence of something," as defined by Merriam-Webster dictionary. The curator's role is to define the visitor experience through their museum exhibits, rather than the visitors defining their own. There is no flow of information and content, except from the curators to the viewers (Simon, 2011).

Based on the traditional museum method, museum designers can fine tune the exhibits for their patrons to ensure that the content is accurate and well presented by the curators and explained by the museum docents. Museum curators can also deliver their content in complex and interactive ways.

This section focuses on participatory, interactive, living, family-orientated museums, and the methods and examples each explore. Along with the delivery of content comes some key points that museums must keep in mind to have successful exhibits; the standards of education, historic storytelling, exhibit evaluation, and relevance.

2.3.1 Participatory and Interactive Museum Exhibits

Participatory museums differ from traditional museums when the static, "do not touch" exhibit design becomes an immersive and dynamic museum experience. Participatory museums have exhibits that are designed to deliver a unique experience, one where the visitor heavily engages with the educational elements of the exhibit (Simon, 2011).

The phrase "interactive exhibit" is used to discuss museum exhibits that offer a more creative path to education. In their article, Naomi Haywood and Paul Cairns explain,

"Interactivity therefore allows visitors to determine what the exhibit presents … It must be noted, though, that not all exhibits that claim to be interactive would actually meet this criterion" (Haywood & Cairns, 2006). There is a balance that needs to be struck between interacting with an exhibit (i.e. toys or button pushing), and learning the content presented by an exhibit. The authors detail a study done at the Science Museum in London, England where 10 children interacted with an exhibit, Energy Everywhere. The results of this study categorized how the kids learned information as participation, narration, and the co-presence of others (Haywood & Cairns, 2006). Participation is the idea that the visitor can engage with some element of the exhibit, and it is not passive. If an exhibit has a core narrative, it is able to convey a lesson to the viewer, which is a key concept in designing exhibits. Lastly, introducing the idea of co-presence to your exhibit can be beneficial when working with a family-friendly museum so that children interact not only with their parents, but each other. These core concepts support Nina Simon's definition of the "participatory museum", as an exhibit that utilizes active participation on the exhibit with others, with a core narrative that underlies the whole exhibit.

EcoTarium

The EcoTarium in Worcester, Massachusetts is an example of a hands-on participatory museum for children in the Worcester community. The EcoTarium features simple games and activities that children can learn through by interacting with the exhibits. The exhibits feature a variety of topics, such as aquatic life, architecture and city planning, and natural phenomena. When visiting this museum, both the outside exhibits and inside floor exhibits are teeming with young kids and their parents as they explore science. One thing we noticed while observing the kids' interactions with the exhibits, was that these interactions were fundamental in participant education. All of the exhibits had an element that was able to be manipulated to further the concept that was being taught, whether it be a large wheel that was spun to reveal text/image or building a bridge across a canyon.

2.3.2 Living Exhibits

Like the concept of participatory museums, living museums can be one of the best mediums to showcase and teach history. In the chapter "Everyday Life in Living Museums" of *Living History: Simulating Everyday Life in Living Museums,* Jay Anderson describes living museums, "Living history can be defined as an attempt by people to simulate life in another time. Generally, the other time is in the past, and a specific reason is given for making the attempt to live as other people once did" (Anderson, 1982). The important mainstays of living museums are typically traditional clothing, authentic artifacts, and role-playing from actors who build an environment around them. This roleplaying is often the cause for a living museum to be popular with guests, not necessarily because they are interested in the depths of the history, but rather because they enjoy the scene of a theatrical performance of that history (Anderson, 1982).

Old Sturbridge Village

Old Sturbridge Village in Sturbridge, MA is the epitome of a living museum. It is the largest outdoor history museum in the Northeast and models a historic colonial village, including both role playing actors and livestock that bring the town to life (Old Sturbridge Village, n.d.). The staff at the village list hospitality and accessibility as some of their key priorities to the public.

Old Sturbridge Village describes how they maintain their museum as a place people want to visit and come back to as, "[By] making history dynamic, dimensional, immersive, hospitable and inclusive" (Old Sturbridge Village, n.d.). The town is a large-scale example of a living museum that can captivate its visitors with a wide range of content. Throughout the town there are people portraying colonial villagers. The colonial actors work in the village buildings and provide tourists with facts about their way of life. For example, in the blacksmith building there are two men who operate the furnace and make chain links. As they make the links they explain the process to visitors while answering questions the visitors may have. To help keep with the historically accurate aesthetics, there is very minimal modern technology throughout Sturbridge Village. Through using minimal technology as well as decorations and role playing museum staff and volunteers portraying the culture, Old Sturbridge Village immerses the visitor in the colonial time.

Plimoth Plantation

One of the oldest American settlements is located on the south shore of Boston, Massachusetts - Plimoth Plantation. This early colony settlement was founded by the Pilgrims, fleeing religious persecution in Europe. Their small rudimentary town still exists in Plymouth and is open for visitors to explore what the day-to-day life of colonists in their 17th century village. This museum is an example of a fully immersive living museum. Each guest experience is unique because the village adapts to the varying weather and Pilgrim personalities (actors/ actresses) as a real village would. Among the hands-on attractions is the old grist mill; a simple machine harnessing the power of flowing water to grind corn into cornmeal (Plimoth Plantation, 2018).

2.3.3 Elements of Museum Exhibit Design

Interactive Design

The design of museum exhibits is a key factor in the success of educating the visitors of that exhibit. One of the core concepts of the Energy Everywhere exhibit at the London Science Museum mentioned in §2.3.1 Participatory and Interactive Museum Exhibits was participation, one of the several concepts in the design of the exhibit that was incorporated to educate visitors. Haywood and Cairns cite two major design elements that built participation in this exhibit; simple graphics and empowering the user. When discussing the simple graphics featured in the exhibit, one volunteer in the study said, "Everything was painted in words, that's so unreal [...] it

made me think of different kinds of things I know [...] when moving around I felt like I could be part of these things [...] I liked it" (Haywood & Cairns, 2006). The designers of this exhibit knew the demographic for this exhibit were younger kids near 9-12 years old, and so the exhibit had screens and games to interact with because simple graphics help convey clear lessons. The second element that this study cited was giving power to the participant. The volunteers in this study enjoyed how they were able to make the display come to life, as the designers put the power in the kids' hands when they interacted with the exhibit and put life into an animation (Haywood & Cairns, 2006). Knowing your audience is one of the most important points in museum design so that your visitors will engage with the display.

Museum Layout

When designing a museum, it is important to understand how the visitor will move through the exhibits and the museum. By optimizing the layout of the rooms and exhibits the curator of the museum can help the patron educate themselves while not fatiguing quickly (Alt, Gosling, & Miles, 2012). Another important detail in the ergonomics of a museum's design is to reduce museum fatigue, a term coined in the 1910's by Benjamin Gilman to describe the slowing down of visitors as they get weary while exploring a museum floor. This fatigue can be a combination of both physical fatigue while walking long routes, as well as cognitive fatigue while being overloaded with information. Trying to proactively reduce museum fatigue for visitors while designing interactive and informative exhibits is an important step when determining the layout and design of said exhibit. (Davey, 2005).

2.3.4 Family Orientated Exhibit Design

To create successful family orientated museum exhibits, understanding the methodologies children learn best by is important so that the exhibit can be designed for a specific audience learning style and ability. According to Akerson, Flick and Lederman, teaching through analogies, or comparing one familiar situation to another, is a useful technique for children to gain knowledge (Akerson, Flick & Lederman, 2000).

During a research trip to the EcoTarium in Worcester, MA, we observed teaching through analogies at many exhibits. One example, seen in **Figure 4** of an analogy based exhibit was titled "Wind Flows Like Water", where a long table had a fan at one end with a sheet of fabric placed over the fan so it blew across the table; the sheet moved up and down in a wave-like behavior. Participants could then put objects on top of the blowing sheet and see how the object floated across the sheet as if floating on water. The exhibit also had supplemental information, explaining how both wind and water travel in currents. By taking a familiar idea like rushing water, the participants were able to better visualize the objective of the exhibit - the basics of wind.

Figure 4. "Wind Flows Like Water" EcoTarium exhibit

The design and layout of an exhibit are also important factors to consider when creating a family orientated exhibit. In the results of an experimental study, "Developing Family-Friendly Exhibits," seven characteristics were deemed key in family-friendly exhibits design (Borun & Dritsas, 1997). The characteristics are as follows:

1. Multi-sided: exhibits were deemed more successful when multiple people were able to cluster around the exhibit.
2. Multi-user: like multi-sided, this allows for more than one person to interact with the exhibit at a time.
3. Accessible: considering the primary audience is children, it is important to make sure children will be able to reach the interactive pieces.
4. Multi-outcome: the observation and interaction must be complex enough to keep the audience engaged but not so complex that it discourages participation.
5. Multi-modal: having a range of interactive options appeals to different learning techniques.
6. Readable: text should be arranged in manageable segments rather than large paragraphs - too many words will discourage participants from reading it.
7. Relevance: allows visitors to connect existing knowledge in a novel way and promotes group discussions.

Throughout Borun and Dritsas' research, three findings were particularly interesting to take into consideration when building an interactive exhibit. The first was when working with the "Naked Mole Rats" exhibit at the Philadelphia Zoo. After many trials and errors, they found that

including an interactive graphic station "proved immediately successful" (Borun & Dritsas, 1997). Interactive graphic stations are exhibits with informative text hidden within interactive pieces like pull tabs or moveable flaps and took place at almost every display at the EcoTarium. One example was an exhibit titled "Which of these in an Old Growth Forest?" shown in **Figure 5**. This station was a large panel with four sliding components labeled "Lift", and the participant lifts the panel over a picture of a forest and the lifted portion acted as lenses over the picture to highlight the objectives of the exhibit. Although the material being delivered was simple, the interactive tabs prolongs the amount of time a visitor stays at the exhibit and encourages interaction.

Figure 5. EcoTarium exhibit demonstrating "lift tabs"

Another interesting finding by Borun and Dritsas was that visitors were more likely to read an exhibit label when it was "short and started with a challenge in the form of a question" (Borun & Dritsas, 1997). The EcoTarium made use of challenges in several exhibits, one example being "Direct the Wind!" (**Figure 6**). This exhibit consisted of a large fan that blew onto a wall of pinwheels. Using provided objects, participants would arrange the objects in a way that directed the wind to blow on certain pinwheels. The description of the exhibit had a section labeled "Challenge: Work together to make the wind turn the top row of pinwheels…", this challenge is a call to action for the visitor to interact and learn. Like the moving parts of the "lift" tabs in the "Which of these in an Old Growth Forest?" example, this activity increases the amount of time a visitor spends at the exhibit. The proposed challenge also motivates the participant to complete the activity the exhibit provides.

Figure 6. "Direct the Wind!" exhibit at the EcoTarium

The third finding of the experimental study was that less is more. Borun and Dritsas discovered that visitors were discouraged by interactive exhibits that required too many steps (Borun & Dritsas, 1997). When improving the New Jersey State Aquarium Exhibit, Borun and Dritsas found that visitors shied away from the provided activity kits because the multiple activities exceeded the attention span of the children. To improve this, they vastly simplified the kits and made bold labels to clearly deliver the instructions, which proved successful after the exhibit attendance was increased.

2.3.5 Museum Exhibit Evaluation

When creating or revising a museum exhibit, it is important to understand how the viewers will interact with the display. To do so, certain metrics were developed to evaluate museum exhibits. This evaluation process is a 4-step assessment; Front-end, Formative, Remedial, and ultimately Summative Evaluation. These 4 steps are the process used in evaluating an exhibit at various stages of development, and are depicted in **Figure 7**. The Front-end and Formative evaluation steps are at the beginning of the museum design process and are the most important to researching an educational design for the exhibit (Kelly, 2009).

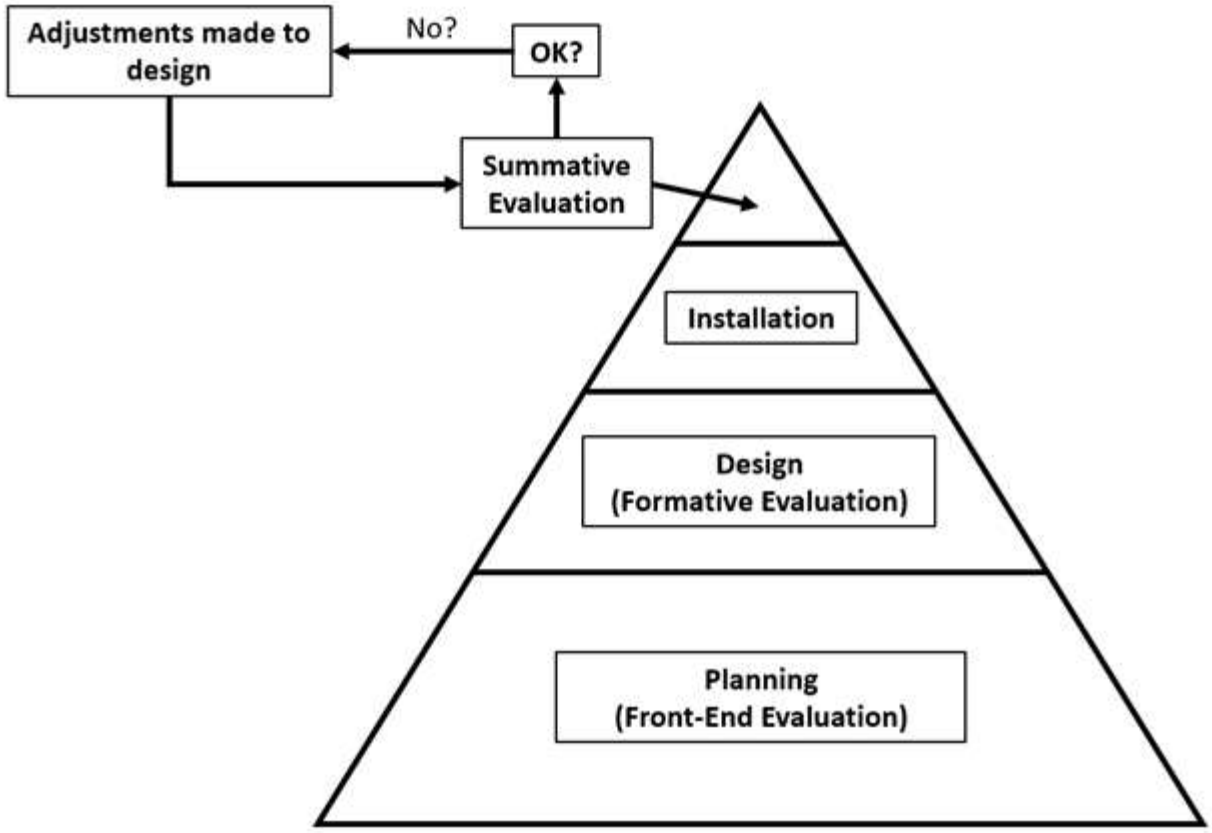

Figure 7. Museum Design Process (Adapted from Screven, 1989)

Front-End Evaluation

In the beginning stages of museum exhibit design, ensuring that the research topics of the display will be attractive to the public is essential. To collect all the background information for the display, it is common that exhibit teams utilize focus groups, literary reviews, and interviews. The process of front-end evaluation is, "to develop themes, audiences, goals, messages, and interpretive strategies" (Kelly, 2009). The other important note in front-end evaluation is in determining the balance between what your audience wants to learn from a museum exhibit, and deciding what lessons are best to be taught in an exhibit (Downey, 2002). Once the exhibit team has determined what will be taught in their display, the front-end evaluation will, "reveal the meaning the [visitors] make in response to a concrete exhibition concept" (Downey, 2002).

Formative Evaluation

The second evaluation method in museum design is an assessment made preemptively to try and reduce visitor fatigue and to capture their attention. Through formative evaluation, or developmental evaluation, exhibit designers can utilize rapid prototyping to quickly build samples of their exhibit's display or samples of text. Exposing focus groups to these prototype versions of the exhibit can help get feedback on graphics and models so that adjustments can be made to the design of the items so to be cost-efficient while in the design process. Screven says

that “Many problems surface in the first few hours or days of testing. If months of effort has been invested, poor results can be devastating to the morale of a professional exhibit team” (Screven, 1989).

It is important to remember that formative evaluation does not replace the actual design and research that does into exhibit design, it is an assessment to effectively check your work. The idea of formative evaluation is to research, with a group of volunteers if the lessons and message of your exhibit is communicated through the use of your chosen texts/graphics/items (Screven, 1989). This form of evaluation can be crucial in saving time, money, and resources further down the line when building and later implementing your museum exhibit.

2.3.6 Standards of Education

The state of Massachusetts has a set of curriculum frameworks in place for public schools, as well as being one of the few states to have standards set for STEM (Science, Technology, Engineering and, Math) education (Mass. Dep. Elementary, 2018). The main purpose of the Massachusetts Curriculum frameworks is to give simple guidelines for what each student should have learned at the end of each year. According to the Massachusetts Curriculum Framework, the standards for STEM education in each grade are the following:

1st Grade	(5-6 yo)	Observe and gather relative information on a problem and generate solutions to said problem.
2nd Grade	(6-7 yo)	Analyze data from two different solutions to a problem and identify strengths and weaknesses of both.
3rd Grade	(7-8 yo)	Identify a problem and include criteria for success and how realistic each solution is.
4-5th Grade	(8-10 yo)	Use models and sketches to design examples for prototypes of projects for potential problems.
6th Grade	(10-11 yo)	Create visual solutions to design problems; Analyze and compare properties of different materials including wood, metal, and ceramics; operate appropriate hand tools for a project such as hand-fasteners, sander, jigsaw, etc.
7th Grade	(11-12 yo)	Construct a prototype of a solution to a given design problem, show how components of structural systems work together to serve a functional purpose; explain forces, loads, tension, and torsion.
8th Grade	(12-13 yo)	Use information to describe how a product can be created using basic processes in manufacturing and assembly.

These curriculum frameworks for Massachusetts are designed to build off of the previous year and provide the students with a steady growth of skills and knowledge.

2.3.7 Creating Relevant Museum Exhibits

In Nina Simon's book, "The Art of Relevance", relevant experiences are defined as those that are, "connected to the needs, assets and interests of our community" (Simon, 2016). Relevance is the key to giving importance to a community entity. Simon breaks up relevance into two parts, (1) getting people to walk through the doors and (2) ensuring they return. Attracting people to walk through the front doors is considered easy. Simon uses the metaphor of painting the entrance a neon color; no matter how attractive the entrance, people will only return if their experience was rich. Relevance provides the audience with new information that adds meaning and makes a difference to them; according to Simon, relevance is an invaluable feature for a museum's success.

Along with the two-part system of getting people through the door and making sure they stay, Simon also has a two-part criterion for what makes information relevant to people. The first part of this criteria is, "how likely new information is to stimulate 'positive cognitive effect'", or the ability for information to yield new conclusions that matter to someone. The second part of this criteria is, "how much effort is required to obtain and absorb that new information?" (Simon, 2016). Simon confirms that the lower the effort the higher the relevance. This system can be demonstrated in one's decision to attend a museum. If one was interested in a certain museum, they might first look up reviews. If the reviews were informative and positive, this fulfills the first criterion of "positive cognitive effect" (Simon, 2016). Next, one would look up when the museum was open, where it was and how much it would cost. If the museum was open at a convenient time, located nearby and it was free to enter, the effort to visit the museum would be low, therefore having a higher chance of attending. However, if the reviews were negative, and the museum was 30 minutes away, one might not bother to visit at all. At least one of the two criteria need to be in place in order to get a visitor through the museum door.

According to Simon, there are two major misunderstandings surrounding relevance; the first is that people believe what they are doing is relevant to everyone; the second being that people believe relevance is irrelevant.

To make a community entity relevant, one cannot assume that everyone will find the subject matter interesting. To pull people towards an attraction, Simon recommends focusing on the needs and assets of a community. By promoting how one's exhibit, park, activity, etc., can enhance an asset they already have, suddenly what's being promoted feels relevant. An example of this is the "Direct the Wind" exhibit at the EcoTarium in Worcester, Massachusetts, as described in §2.3.5 Museum Exhibit Evaluation. The exhibit proposed a challenge to the visitors which highlights their problem-solving skills - enhancing an asset.

The second misunderstanding that Simon points out that "relevance is irrelevant" means that people don't believe they need relevance to pull audiences to their work - their work is so

profound that people will be drawn to it by themselves. Although this is possible, the "magic" of people being drawn into a wonderful experience on their own happens far and few between. An outside force probably guided you to an activity that you love. Whether one was dragged to a new restaurant by their friend or persuaded to read a book by some reviews, very rarely do people open the doors to try something new unless it feels relevant. This philosophy can be applied to an exhibit by knowing the community and audience to have people "open the doors".

2.3.8 Historic Storytelling

Storytelling is an important aspect of delivering historic information at museums and exhibits. Storytelling places visitors in the shoes of those who walked before them, induce empathy to the matter rather than just facts. History often implies readings of static information and lengthy textbook chapters; however, museum researcher Bedford finds storytelling as a way to let the imagination do most of the work. Stories are a powerful deliverable because they, "do not fill in all the blanks [but] open up a space into which the listener's own thoughts, feelings, and memories can flow and expand... [inspiring] an internal dialogue and thus ensure a real connection" (Bedford, L., 2001).

At Old Sturbridge Village, a participatory museum in Sturbridge, Massachusetts, actresses and actors told stories to the visitors of the exhibits as if they were from the early 1800s. At one exhibit called the "Blacksmith Shop", as shown in **Figure 8**, actors dressed as blacksmiths forge tools in front of the visitors and explain to them the processes and stories as if they are from the 1800s. Visitors are more likely to empathize with the experience than they would just reading the information from a poster.

Figure 8. The Blacksmith Shop [Old Sturbridge Village]

2.4 Historic Windmills Case Studies

Case studies are an important analytical tool when comparing the Nantucket Old Mill to other mills in New England. Performing case studies allows us to understand the methods and objectives of preservation and presentation of other historic mills; the compare and contrast analysis helps us better understand what the NHA does well and what it could improve at the Old Mill. The following case studies will discuss the varying perspectives that mills are portraying.

2.4.1 Windmills Case Studies

Scattered across New England are hundreds of windmills, many of which have been around for hundreds of years. All of these different windmills vary in style, location, function and operation. Some are still fully operational while some are no longer functioning and are just historical landmarks to visit. To get a better understanding of how some of these windmills run as historical landmarks, each can be viewed as a case study. The case studies selected were based on the Jonathan Young Windmill, the Brewster Windmill, and the De Zwaan Windmill. The three windmills were chosen based on their similar size and function to the Old Mill. These case studies include information on history, events, and social media for each mill.

The Jonathan Young Windmill

The Jonathan Young Windmill (**Figure 9**) is a smock grist mill built in 1730. First known as Elisha Cook's Mill the windmill was originally built on Kendrick's Hill in South Orleans. The mill was then physically moved to Young's Hill and owned by Jonathan Young, who the mill was named after. The mill has been moved several times, finally being sold to the Orleans Historical Society who moved it back to Orleans and gifted it to the Town of Orleans. Having been physically moved many times and still in almost perfect condition, the Jonathan Young Mill shows the significant value of preservation.

While the inner mechanics of the mill do work, the mill is not operating for the public. The Jonathan Young Mill now functions as a historical museum with guided tours held during July and August. The tours educate tourists about the history of the mill as well as show visitors the inner mechanics of the mill. No specific exhibits are located at the mill, but events including weddings and the Lighting of the Lights ceremony during the Christmas Season are held there throughout the year (Orleans Historical Society, 2016). The Town of Orleans has a Facebook page dedicated to the Jonathan Young Windmill with pictures and information about history of the Mill, as well as posts from people who have visited the site. The Facebook page is linked to the official Orleans Historical Society's Facebook page where people can see upcoming events being held at the Jonathan Young (Orleans Historical Society, 2016).

Figure 9. The Jonathan Young Windmill [Orleans Historical Society]

The Brewster Windmill

The Brewster Windmill (**Figure 10**), also known as Old Higgins Farm Windmill, is a smock grist mill built in 1795. This windmill was originally located on Ellis Landing Road in Brewster, MA. A few years later the mill was sold and moved to a new location in Brewster. The mill functioned as a golf club house until it was given to the Brewster's Historical Society by the owner Mrs. Nickerson. The Brewster Historical Society kept the Old Higgins Farm Windmill as a historical landmark and is open to the public. The mill does not operate as a smock mill anymore but is open to tours during the week (Brewster Windmill, n.d.). Each year a three-day festival, Brewster for the Holidays is held at the Drummer Boy Park where the mill is located; the festival consists of food, activities for the children, tree lighting, and windmill lighting. There is no dedicated Facebook page to the windmill however there is a Facebook event for the Brewster for the Holiday Windmill Lighting festival. The Windmill Lighting event is located at the windmill and the Facebook event includes the location as well as link to the Historical Society where tourists can learn more about the mill (Brewster Historical Society, 2018).

Figure 10. The Brewster Windmill [Brewster Historical Society]

De Zwaan Windmill

The De Zwaan Windmill (**Figure 11**) is the only Dutch Windmill in the United States. The windmill was moved from the Vinkel, Netherlands to Holland, Michigan in 1964. Due to the disassembly and reassembly of the windmill, it was left nonfunctional for 59 years when moved to Michigan. The windmill finally started operating again 2013 when the cap was replaced making the blades easier to rotate. Today, the mill is still being run by a Dutch-certified miller to make flour for fresh pizza and other baked goods that are sold in local restaurants. The Holland Historical Society tells the rich history of the Netherlands through the windmill. Costumed tour guides run tours daily in which they describe the history and function of the windmill. One of the stories the tour guides share is that the windmill was used in World War II to convey information to Nazi controlled towns. Bullet holes can be seen in the blades showing the impact of the war. The mill has been built on top of bricks that are layered Dutch style to make the mill look as it did when in the Netherlands. The mill is located in a 36-acre park, Windmill Island Gardens, full of beautiful flowers and places for families to picnic and spend time. The Windmill Island Gardens are open seven days a week April through October. Admission is $10 per adult and $5 for youth as well as separate admission costs for various events. Events are frequently held at the mill, these events include Water Festivals, Art Festivals, Bird Watching and much more (Heest, 2018). A Facebook page is dedicated to the Windmill Island Gardens in which all the events are promoted and shared by the community (The Windmill Island Gardens, 2010).

Figure 11. De Zwaan Windmill [Windmill Island Gardens]

2.4.2 Discussion of Case Studies

Social Media

A local committee in Eastham, Massachusetts hosts a Windmill weekend every year. This committee made a Facebook page to promote each weekend to locals as well as tourists. All of the locations including the Nantucket Old Mill in these case studies have Facebook pages, but some of the pages have more traffic than others. Genevieve, of Social Media Today, provides 10

tips to run a successful Facebook Business page (Lachance G., 2013). The two tips that stand out most to this case study are "Your Cover Should Talk" and "Post Regularly". Facebook pages with profile and cover photos are easier to identify, compared to the pages that do not have either images.

Blog Posts

A blog "is a discussion or informational website published on the World Wide Web consisting of discrete, often informal diary-style text entries" (Russo, 2008). Blogs are a way for people to engage in an open discussion on events as well as allow people to show their opinions (Russo, 2008). Bloggers who visit these locations write entries talking about what they liked about their visit as well as questions and concerns they might have. Blogger Bob Outer wrote a blog in 2017 promoting Windmill Weekend in Eastham as one of "best weekends" in the town (Sheldon R. J, 2013). This blog not only promoted the Windmill weekend, but also provided useful information people will need to know if they are going to attend.

Some teachers have been concerned about the validity of social media posts being used as a credible source for their students to use (Russo, 2008). One example of social media being credible was in Sydney, Australia when an email hoax was sent around stating that Mars will be unusually close to Earth for one night. People in Sydney were confused and excited for this to happen and prepared for the evening, while others were skeptical and not sure whether to believe the source. The Sydney Observatory quickly posted on social media explaining that this hoax was not true. Many people responded thanking the Observatory for clarifying the mistake. One email even said, "I headed straight over to the 'professionals' here at the Sydney Observatory to set my mind straight" (Russo, 2008). This situation demonstrates the power of social media and how important it is to have credible sources.

Fees

Money is needed to maintain any historical exhibit, museum or site. The money is needed to pay taxes on the land, pay for events held at the locations and for other numerous reasons. The ways the companies owning a historical landmark obtain the money includes holding fundraisers, asking for donations, requiring a fee for admission, and obtaining local and state grants.

Events

As shown in the case studies there are events held at the windmill locations. Events are one way to attract tourists and residents to the location. These events include weekly tours, fairs, and field trips for students.

2.4.3 Windmill Engineering

A windmill by simple definition is a wind driven wheel that powers a machine. Windmills can be classified into two different categories, horizontal turbines and vertical

windmills. Horizontal turbines (**Figure 12**) consist of a wheel that rotates in the horizontal plane around a vertical axis and has vertical metal or plastic blades that catch the wind to spin the generator. These turbines are energy efficient solutions to sustainable wind energy as they are low profile and discrete while capturing natural wind.

Figure 12. Horizontal Wind Turbine [Siemens]

Vertical windmills consist of vanes made of cloth sails that rotate in the vertical plane. The three types of vertical windmills are post mill, tower mill and smock mill. The different types of vertical windmills are identified based off how they are built. The Old Mill (**Figure 13**), a vertical windmill, is a smock mill meaning the top section, the "smock" can rotate freely in order to face the vanes into the wind. There is a lattice of gears inside a smock mill that are used to grind the grain the mill is making.

Figure 13. The Nantucket Old Mill [Nantucket Historical Association]

As shown in **Figure 14**, The Old Mill has four blades and a wooden spoke attached to a wooden shaft which runs through the center of the windmill. When the blades rotate the wooden spoke also rotates and at the same speed. The wooden spoke is interlocked with the wooden cage gear. When the wooden spoke rotates the cage gear also rotates but because there are more teeth on the wooden spoke than the cage gear, the cage gear rotates faster. The cage gear is attached to the split wood shaft and iron shaft which are attached to the revolving stone. The revolving stone rotates when the cage gear rotates, so the revolving stone also rotates faster than the blades do. The corn is poured through the wooden hopper into space between the revolving stone and the nether stone. The corn is ground up when the two stones are pressed together, and the revolving stone rotates. After the corn is ground up the corn falls down the chute and is stored in the metal box (Library of Congress, n.d.).

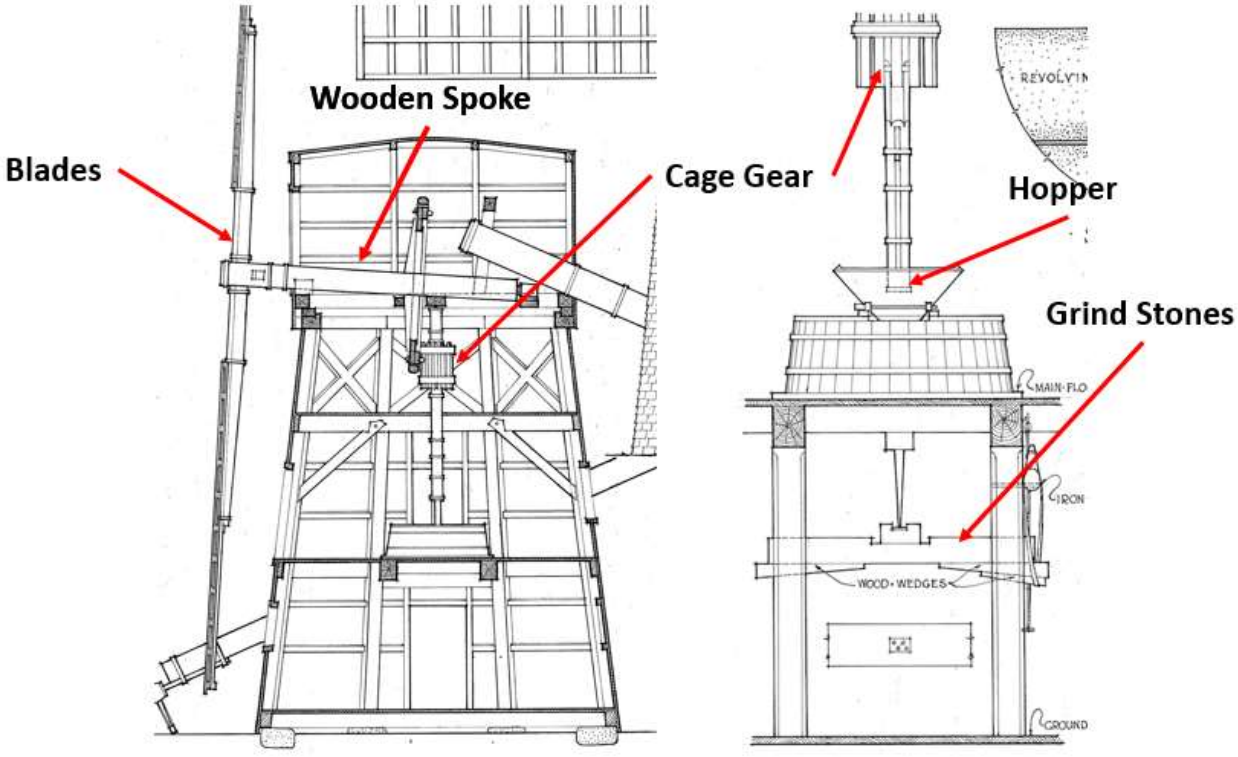

Figure 14. East Elevation of the Old Windmill Nantucket [Library of Congress]

2.5 Nantucket Historical Association

The Nantucket Historical Association (NHA) is the organization that runs and oversees the history, programs, and properties they own on Nantucket. The NHA was founded in 1894 and in 1895 Susan Brock, the first curator, defined the goal of the NHA as, “Our Society is, as its name implies, the custodian and conservator of the history of Nantucket”. Over the next hundred years the NHA acquired seven historical landmarks in Nantucket.

2.5.1 Current NHA Historic Sites

While many tourists visit Nantucket for its pristine beaches, the island's preserved history offers a unique vacation experience that most beach destinations cannot match. The Nantucket Historical Association is the gatekeeper to that heritage, and they continuously work to make that history more accessible. The NHA has seven historic sites that are open for tours and visitation, including the Nantucket Whaling museum and the Hadwen House that hold walking tours for visitors looking for guided educational experiences. The flagship site for the NHA is the Whaling Museum, where the NHA has curated an expansive museum centered on what made Nantucket famous in the nineteenth century - whaling. While this museum may be the largest and most popular location that the NHA maintains, the other seven sites have just as much history to offer. The other sites include the Oldest House on Nantucket, the Old Mill, the Thomas Macy House, the Old Gaol, the Quaker Meeting House, the Fire Hose Cart House, and Greater Light. The mission of the NHA is, "to tell the inspiring stories of Nantucket through its collections, programs, and properties", and that mission is executed through this list of historic sites that tell the story of Nantucket (Nantucket Historical Association, 2018).

2.5.2 Current Events at the Old Mill

The NHA hosts several different themed events throughout the year, such as the Annual Harvest Fair shown in **Figure 15**. The fair consists of seasonal events, tours of the windmill, as well as seasonal snacks. The attendance at the fairs is almost exclusively local children and their parents, and because of this demographic, future plans include events at the Old Mill that would be more educational and interactive than what the Mill has to offer currently. The NHA is also working on implementing these types of fairs more often in the summer season to capitalize on the tourism that frequents the island. The NHA currently grinds and sells cornmeal to the public, the proceeds being used to fund Nantucket Historical Association.

Figure 15. Harvest Fair at the Old Mill [Nantucket Inquirer and Mirror]

Chapter 3. Methodology

Mission Statement and Objectives

The goal of our project was to enhance the visibility of Nantucket's Old Mill by creating family-friendly interactive museum exhibits to showcase the history and engineering of the mill. To achieve this goal, the following project objectives were outlined.

1. Design a series of interactive museum exhibits appropriate to a variety of audiences that can be used to teach the history and engineering principles of the Old Mill.
    - Research background material relevant to understanding the history and educational potential of the Old Mill.
    - Design age-appropriate exhibits on the Old Mill site that teach how the mill operates.
2. Recommend improvements to the Old Mill property to enhance visibility of the site.
    - Develop standardized sign templates for the Old Mill.
    - Create comprehensive list of new signs, and signs that need to be updated.
    - Develop sample social media posts to promote the Old Mill on NHA social media platforms.
    - Identify educational activities that link common themes between NHA sites to promote a fun, but educational environment.

The graphic shown in **Figure 16** illustrates the process for the overall methodology to this. As seen in **Figure 16**, feedback from stakeholders was solicited and analyzed as part of the developmental stage in making the final recommendations made to the Nantucket Historical Association.

Figure 16. Project Methodology

3.1 Design a Series of Interactive Museum Exhibits

Prior to the on-site phase of this project (BACKGROUND), we conducted research on museum exhibit design as well as the history of Nantucket, the Old Mill, and living museums. Through interviews with NHA Executive Director James Russell, we also established our target audience to be children ages 8-13, knowing their parents will also interact with the exhibit with their kids.

Drafting initial designs included creating a list of the educational lessons the Old Mill supports, creating sketches of possible exhibits, then asking for feedback from our sponsors. After we drafted the simple machines, our team utilized formative evaluation (§2.3.5

Museum Exhibit Evaluation) to revise our designs. To conduct our formative evaluation, the project team developed prototypes for the machines and then obtained rapid feedback on our designs so that user interaction was evaluated. The process of this evaluation is seen in **Figure 17**, this process called 'Formative Evaluation' is common in museum exhibit design.

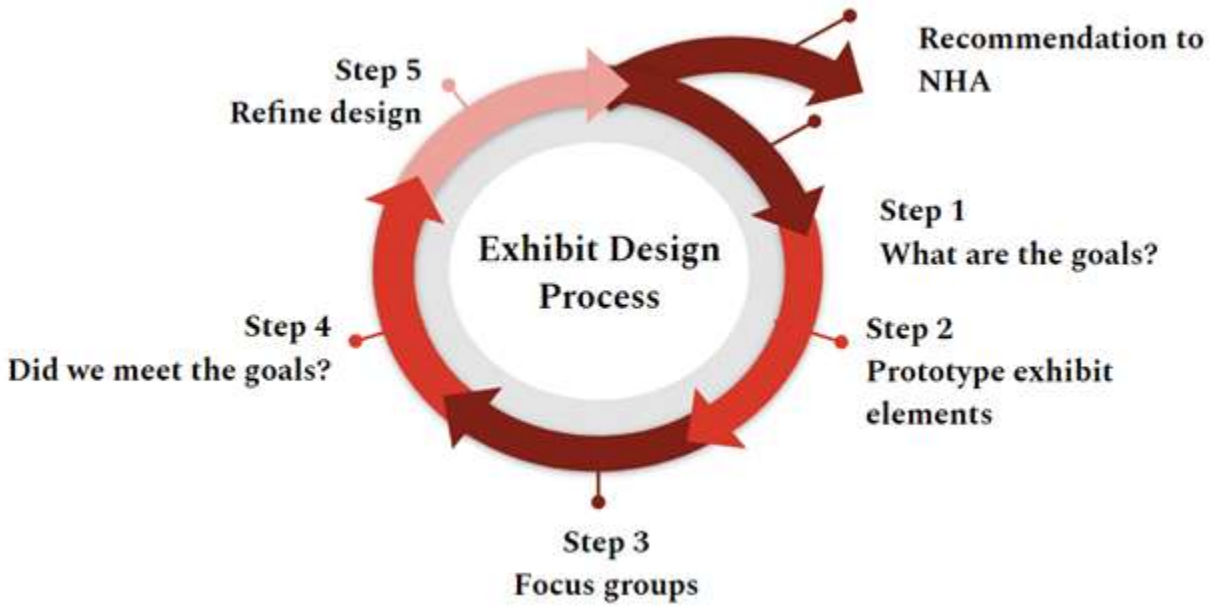

Figure 17. Flowchart describing Formative Evaluation

Figure 18 reproduces the exhibit design process previously shown in **Figure 7** (§2.3.5

Museum Exhibit Evaluation). The "Planning" stage in **Figure 17** was conducted in the planning period preceding the time working on Nantucket, followed by the formative evaluation stage seen in **Figure 17**. During the Formative evaluation stage, and Summative evaluation before installation, the project team continued to solicit feedback from the NHA, focus groups of students, and WPI advisors.

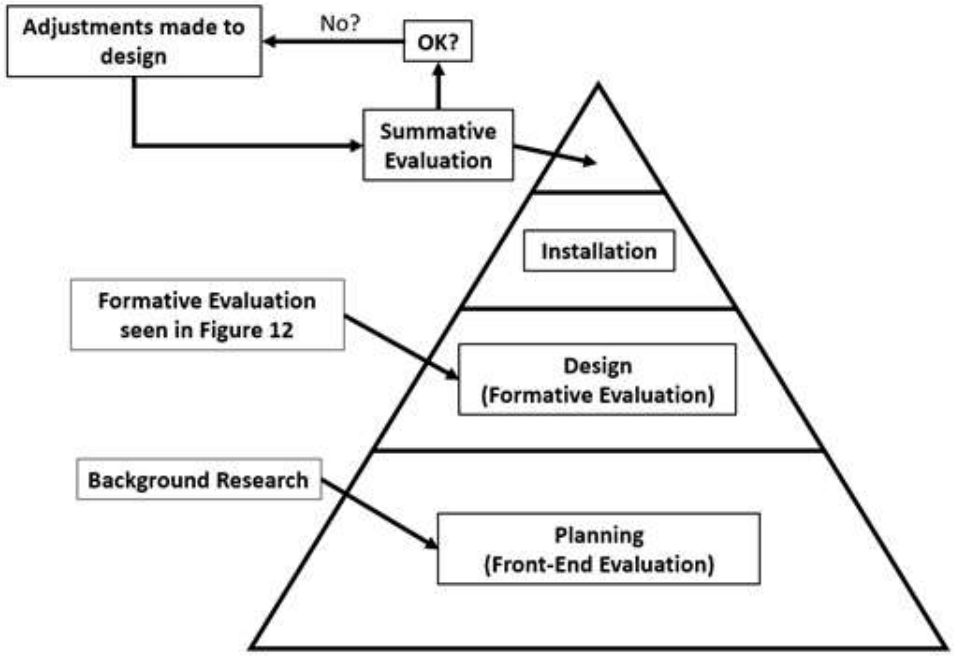

Figure 18. Detailed plan for designing museum exhibit (adapted from Screven, 1989)

3.2 Develop Recommendations to Improve the Old Mill

In addition to the onsite improvements that interactive exhibit pieces bring to the Old Mill, the project team observed other property improvements. The team noticed the space to add and update the signs and educational labels in and around the Old Mill. While the Nantucket Historical Association has an active social media presence, the team found there was no dedicated account for the mill itself or even hashtags commonly used. The NHA also sought to utilize the educational potential of the Old Mill across its other sites, and especially at the Whaling Museum where most of their visitors are.

3.2.1 Enhance the Current Signage at the Old Mill

Our team also assessed the current NHA signage across their properties as well as specifically the Old Mill to see where improvements need to be made. Current signs, such as those in **Figure 19** can be improved at the Old Mill, where, for example, one sign even had "chute" misspelled as "cute". Based on the assessment we built robust templates that are efficient and suitable to the rest of the NHA's standards for signs at their exhibits. With standardized text displays, there can be uniform signage developed at the Old Mill site using the recommendations made, as well as any future additions of signs. There were also opportunities inside the Mill to create new signs, to label the different elements and pictures inside the Old Mill that were absent. Additionally, there were elements of the Old Mill - and even the Old Mill itself that were unlabeled on the exterior property of the historic site.

Acknowledging the limited time available at the project site, the team decided that the best course of action would be to supply the NHA with a comprehensive list of desirable signs

and labels at the mill, both inside and out, that could be implemented in the future – rather than creating the signage ourselves. To accomplish this goal, the team visited the Old Mill and composed a list of signs with the assistance of an NHA expert. This list will be used for future implementation of signs and labels at the Old Mill.

Figure 19. Unprofessional signs at the Old Mill [NHA]

3.2.2 Improve the Existing Social Media

As noted in the BACKGROUND, social media can play a role in the publicity of a historic landmark. By looking at how the Old Mill is currently seen on social media websites such as Facebook, Twitter, Instagram, and Snapchat, our team recommended a plan to improve these sites for increased visibility. The existing Facebook page when we arrived on Nantucket can be seen in **Figure 20**, it is lacking a profile picture as well as a cover photo that is appropriate for the site.

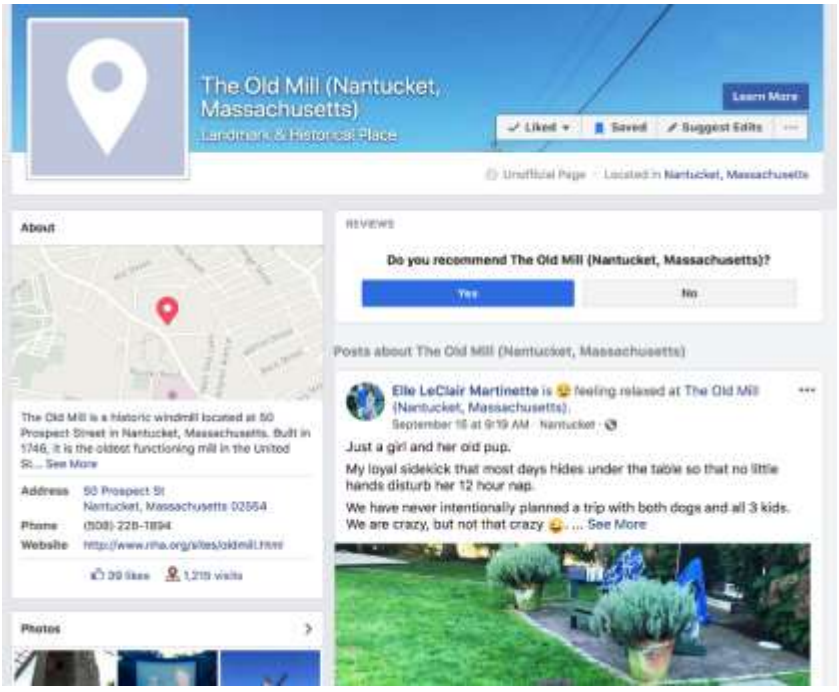

Figure 20. The Old Mill Facebook page

By first evaluating the existing status of the NHA and Old Mill social media accounts, as seen in **Figure 20**, our team began to evaluate the strengths and potential weaknesses of these platforms. Our team examined each platform for core factors that affect a page's visibility, such as profile picture, cover photo, and content of posts. This analysis helped us develop areas for improvement that are simple fixes that can be implemented easily. To create consistency in the future we developed samples of elements to be used when posting on social media. These recommendations include a variety of go-to hashtags, templates for Instagram stories, and Snapchat Geo-Tags for the NHA to further utilize social media as a tool for visibility.

3.2.3 Connect the Old Mill and Other NHA Sites

In order to enhance the visibility of the Old Mill on Nantucket the project team decided to propose strategies for further interaction between NHA sites. While the Whaling Museum is the flagship of the NHA's properties, there are other lesser-visited sites that the NHA owns. These additional sites include the Oldest House and the Old Gaol, and encouraging visitors to see all of these sites will not only increase participation at the Old Mill, but also at the other locations on the island. Through engaging with visitors at the more well-visited NHA sites, proposed strategies will increase the visibility of the Old Mill in the summer season. The exhibits the team designed can be easily transported to other sites and can reside in the Discovery Room at the Whaling Museum to suggest the fun, educational experience that is available at the Old Mill for families to visit.

3.3 Identifying Stakeholders and Their Needs

3.3.1 List of Stakeholders

The following list of stakeholders is organized by their importance to our project.

Stakeholders:

1. The Nantucket Historical Association
2. Families with young children
3. Educational Institutions (Schools)
4. Permanent Residents
5. The Old Mill
6. Millers
7. History Buffs

Through this list, our project team defined what objectives and deliverables are for which stakeholder group, as each have their own importance in relation to our project.

Nantucket Historical Association

The highest priority stakeholder is the Nantucket Historical Association. The Old Mill is owned by the NHA, and therefore is directly influenced by the outcome of our mission and objectives.

Families with young children

Another high priority stakeholder are the families and the children that visit the Old Mill. Our interactive exhibits are designed to specifically cater to this audience, as specified after several discussions with our sponsors.

Educational Institutions and Schools

The product of this project is marketed as a tool for educational institutions. The exhibit itself is influenced by the Massachusetts standards for education and facilitates learning of simple science lessons for the students that interact with the exhibit.

Permanent Residents

The people of Nantucket are also a relatively important group in the list of stakeholders. The overall theme of the community on Nantucket is to keep the island looking historical and authentic. Our project created a product that not only meets educational standards of the island, but also visual and historical standards.

The Old Mill

The Old Mill represents the Nantucket Historical Association personnel who own the Old Mill. The results of our project directly reflect on the NHA and is therefore a crucial stakeholder to consider throughout this project.

Millers

The millers are also a group that interact with the Old Mill. The millers' task is to operate and maintain the mill, so the exhibits we built must not interfere with the work of the millers, while being relatively close to the Old Mill.

History buffs

The final group of stakeholders are "History buffs", people who are interested in history but not professionals necessarily, and history experts in general. It is important that any information included in our exhibit was historically accurate to the Old Mill and engages with visitors who are seeking to learn and appreciate some of the finer details about the Old Mill's history.

3.3.2 Stakeholder Interview Methods

By understanding the stakeholders' needs, opinions, and expectations from our project (i.e. an interactive exhibit), our project team learned more about how the community perceives the Old Mill. Appendix B. Interview Plans contains the interview plans prepared by our team in advance of the interviews we held with the various stakeholders to gather information from their professional expertise in each of their respective fields. The questions were asked either in a formal setting during an interview, or informally as we gathered information related to our project onsite on Nantucket. Each specific interview plan has relevant questions to ask each different grouping of stakeholder, to collect a wide variety of information. Much of this

information collected from stakeholders was compiled to form a set of design criteria that was used to form the early prototype designs of the museum exhibits at the Old Mill.

3.3.3 Focus Group Methods

Our team conducted focus group studies to gather input on creating an interactive exhibit. Focus groups involved Nantucket families specifically targeted the families with children, as well as other key stakeholders like the Nantucket Historical Association. To ensure that our exhibit communicates the lessons that we designed the exhibit to teach, our focus groups looked to gain feedback on the qualities of the exhibit. These qualities include; Family-Friendly, Educational, Interactive, and Fun. The feedback from these focus groups helped our team refine our design to make sure that the overall exhibit exemplifies these qualities, as well as the 7 characteristics that Borun and Dritsas outlined in their research on family-friendly exhibit design.

While the focus groups will primarily investigate the design of our prototype museum exhibit design, we will also utilize group feedback on our designs for the updated signage at the Old Mill. The feedback from focus groups on this topic will help our team understand if the visuals we use communicate the instructional, guidance, and supplementary material we were creating.

3.4 Exhibit Fabrication Methods

The exhibit elements designed for the Nantucket Historical Association went through several stages of iteration. The exhibits were originally drawn out on paper while in the brainstorming phase of the process. Using pencil and paper allowed for easy redesign and fast paced development.

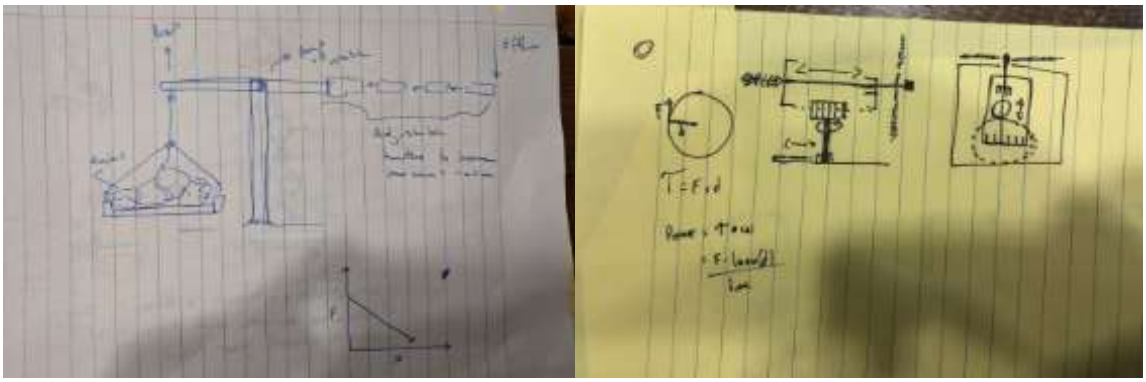

Figure 21. Hand-drawn sketches of early designs

From these hand sketches, solid models and detailed designs were built in the computer aided design (CAD) package SolidWorks. These models were great tools in communicating the designs to the NHA when getting early feedback. The assemblies were designed to be simple, and easily edited for changing the designs after prototyping and feedback changed the elements. Using the SolidWorks models, detailed eDrawings were made so that the parts were easy to fabricate when the design stage was over.

After receiving approval of our detailed designs from the NHA and creating a cost analysis for the fabrication of the prototypes, the building of the exhibit elements began. The project team utilized the NHA's carpentry workshop located at the Gosnold Collections Center to fabricate the exhibit elements. The project team utilized the workspace and tools to construct the prototype exhibits. At this workshop, the project team machined and assembled all of the exhibit elements, as well as quicker prototypes, which gave the opportunity to play-test the designs for durability and feasibility before moving onto a more permanent version.

Throughout the fabrication process, our designs were tweaked slightly as we got feedback from NHA community members in the workshop, as well as changing the designs to account for manufacturability.

Summary

The primary goal of our project was to enhance the visitor experience at the Nantucket Old Mill. To do this, we researched and analyzed both the history of Nantucket and the Old Mill, but also interactive and educational museum exhibit design. The research and interviews conducted by the project team helped them design and build a series of interactive simple machines at the Old Mill, as well as recommendations for improved signage and social media to be used onsite. All of these objectives improved the visibility of the Nantucket Old Mill, by developing further opportunities for education and interaction with one of the island's oldest landmarks.

Chapter 4. Project Outcomes

The focus of this project was to work with the Nantucket Historical Association to develop comprehensive exhibits and recommendations to improve the Nantucket Old Mill. The Old Mill is a historic landmark and is a testament to the agricultural and engineering history of the island. It is rich with innovative engineering principles that the NHA should take advantage of to teach STEM concepts. This project is one of the Nantucket Historical Association's first steps into expanding and linking the educational value of their sites' educational value beyond interpreter tours.

Currently, the Old Mill offers tours during the summer season by millers that are constantly present at the mill. While these tours are rich with education in regards to engineering principles at the Old Mill, the NHA believes that the historic site has the potential to draw more attention from its tourists and locals. To enhance the overall visitor experience and visibility of the site, our project team designed, prototyped, and fabricated 4 fully-functioning interactive simple machine exhibits that each explain an engineering concept in the Old Mill.

Extensive background and onsite research was conducted in order to create three different categories of criteria to guide the direction of each exhibit. After taking in these considerations, each exhibit was designed to convey a different engineering principle found in the historic windmill. "Can you lift the Box o' Rocks?" is an exhibit that uses a lever to demonstrate mechanical advantage in order to lift a box of rocks that exists in the mill. "How many sheets to the wind?" is an exhibit that replicates the experience of putting the sheets on the vanes of the mill and teaches the visitor how air density affects the number of sails needed to make the vanes rotate. "How fast can you spin the grindstone?" is an exhibit that demonstrates how gear ratios affects the speed of the end effector by cranking a crown gear similar to the one found in the mill. Lastly, "Race to the top!" conveys the principle of pulleys by pulling a weight up an inclined plane while also incorporating a fun interactive of carts and corn. The purpose of each exhibit is to highlight a simple machine used in the mill and educate the visitors on the engineering principles behind them.

Along with the deliverable of the four exhibits, supplemental educational materials were created. These materials include instructional panels to accompany each exhibit, a printable children's booklet that encourages participation and completion of the exhibits and the tour, and a teacher's guide to assist educators bringing their classes to the Old Mill for field trips. All of these supplemental materials add a deeper educational value to the exhibits.

The project team drafted recommendations for the Nantucket Historical Association to improve the signage at the Old Mill through new labels and exterior signs, social media posting to boost online visibility, and thematic connections between NHA locations.

Collectively the interactive exhibits, supplemental educational materials, and site recommendations are a set of resources to help guide the Nantucket Historical Association's expansion of the Old Mill's site. These resources will increase the visibility of the Old Mill and

present STEM education opportunities in conjunction with the agricultural history the Old Mill already offers its visitors.

4.1 The Old Mill Site

The Nantucket Old Mill, as discussed in §2.1.1 History of the Old Mill and §2.5.2 Current Events at the Old Mill, is one of seven historic locations maintained by the Nantucket Historical Association. This site is a testament to the ingenuity and innovation of the Nantucket people who worked to sustain their community. This section will detail the state of the Old Mill site before the project team developed their exhibits, and the criteria that guided the exhibits' designs. The physical site was important in the developmental process of the exhibits, as these exhibits and other future recommendations serve to provide visitors an equivalent experience to going inside the mill on a tour.

4.1.1 Existing Old Mill Site

Prior to this project, the Old Mill tour experience was purely informational, with little interactive elements involved. When the Old Mill is operating, there is always interpreters or millers available to give tours to visitors who come to the site. These tours include pointing out important facts and elements of the mill's construction and engineering, however some of these details can get lost easily for people who miss a small piece of the tour. Signage inside the mill is minimal, with terse labels on small pictures; element identification that did exist was simply laminated paper. The project team found the mill to be rich with history, with a foundation of engineering principles that held an opportunity for educational material. Outside the Old Mill, there are several worn-down grindstones that had been discarded from the mill and were embedded in the ground surrounding the building. There are no existing signs or labels that identify the importance of these artifacts at the Old Mill site.

4.1.2 Design Criteria for Old Mill exhibits

The design of the simple machine exhibits displayed at the site were constrained by several contributing factors. Design constraints aided the development of these exhibits by setting guidelines on the type of experience the users have with each element. For example, research indicates that multi-user displays attract more attention and encourage group learning because multiple people can use it at once. These design criteria were crucial in the development of the exhibits and were implemented after the completion of the designs to assess the validity of the exhibits.

Criteria Regarding Exhibit Design from PISEC Standards

These Old Mill exhibits were designed for families with children aged 7-12, but can still be enjoyed by both children and adults of all ages. Because of this targeted age range, it was important to recall the seven characteristics of design that Borun and Dritsas outlined in their study "Developing Family-Friendly Exhibits".

1. Multi-sided: exhibits were deemed more successful when multiple people were able to cluster around the exhibit.
2. Multi-user: like multi-sided, this allows for more than one person to interact with the exhibit at a time.
3. Accessible: considering the primary audience is children, it is important to make sure children will be able to reach the interactive pieces.
4. Multi-outcome: the observation and interaction must be complex enough to keep the audience engaged but not so complex that it discourages participation.
5. Multi-modal: having a range of interactive options appeals to different learning techniques.
6. Readable: text should be arranged in manageable segments rather than large paragraphs -- too many words will discourage participants from reading it.
7. Relevance: allows visitors to connect existing knowledge in a novel way and promotes group discussions.

These characteristics are dynamic and will not necessarily apply to every exhibit if the characteristic applies to all the exhibits as a whole. While not every design is multimodal, meaning involving a range of interactive options, the overall collective exhibit is as it offers a different interactive at every station.

Criteria Regarding Exhibit Design from NHA

While general characteristics like the Borun and Dritsas research can guide the development of a sample interactive exhibit, the Nantucket Historical Association set forth other, more immediate criteria. The NHA's goals for this project were to develop educational and interactive exhibits for the Nantucket Old Mill, and their specific design criteria helped further develop the guidelines that our exhibit elements would build upon. The following listed criteria for the exhibits are listed in order of importance to the NHA.

1. Safe: The exhibits must be safe and anticipate children to misuse the exhibit.
2. Durable: The exhibit must be able with withstand natural elements as well as heavy and anticipated inappropriate play by children.
3. Educational: Participants should gain a better understanding of the proposed educational lesson after they have interacted with the exhibits.
4. Simple: The exhibits must offer an interactive experience that is simple enough to be comprehended by children age 8-13 and have a clear cause and effect.
5. Creative: The exhibits must be both visually and conceptually intriguing in order to attract participants.
6. Innovative: The exhibits must offer a new and unique way to approaching the exhibits' proposed educational lesson.

7. Accessible: The exhibits must be portable and modular to be moved in and out of storage at the site of the Old Mill.

Criteria Regarding Exhibit Design from Operation of the Old Mill

Along with the given design considerations from the NHA, the designs for the exhibits at the Old Mill had to account for the daily operation of the site. The mill is a complicated machine that needs constant attention from trained millers: the operational needs of the Old Mill served as more constraints to consider when designing the exhibits.

1. Does not require miller supervision: The exhibits cannot require miller/interpreter supervision as each NHA employee has their own job that does not allow for supervising the Mill's exterior property.
2. Easily Stored: In the off-season, the museum exhibits should not be maintained outside on the property of the Old Mill site to prevent weathering. Each exhibit must be able to be stored either onsite or portable enough to be taken to the Discovery Room at the Whaling Museum.
3. Easy Setup: The exhibits should not be so complex that the millers/interpreters at the Old Mill need to spend time setting up the exhibits instead working inside the Old Mill.
4. Usable in High Winds: Due to the geographic location of Nantucket, there are often prevailing winds what limit the operation of the Old Mill. Exhibit structures should be available to be used even with high wind speeds to allow for continued visitor experience at the Old Mill.
5. Low Maintenance Required: In addition to functionality, each simple machine should be simple enough to be easily maintained or parts fixed when they break. The miller's might have to be able to make small repairs on these elements, so they should be easy.
6. Easily Transportable: The ability to move around and reposition the different exhibits is an important detail in creating unique experiences for visitors who visit the site multiple times. Because of this, the elements should be modular and able to reposition themselves or be able to be posited at different locations.
7. Available at the Whaling Museum: While the exhibits are intended to be used at the site of the Old Mill, some elements have increased functionality and are located in the Discovery Room of the Whaling museum in the off-season when the Old Mill is not open.

4.2 Exhibiting Simple Machines at the Old Mill

The starting point for selecting and designing the exhibits was to identify specific engineering principles employed in the operation of the Old Mill, and then designing simple machines that reflected the selected engineering principles to fabricate for the NHA. These simple machines were developed using several lists of criteria that guided and shaped the designs

of these exhibits. These criteria were built from specifications from the Nantucket Historical Association, family-friendly exhibit PISEC standards, as well as criteria the team listed after reading the Old Mill operation manual. From these criteria were born the team's initial designs that were hand sketched (**Figure 21**) before being drafted in SolidWorks, a computer aided design package, to create detailed designs. From these designs, the team began to prototype the core concepts of exhibits to show proof of concept and correct any unforeseen errors from the detailed design phase. This prototyping phase revealed to the team an iterative process of engineering and how to account for the needs of the customers of a product, in this case being both the NHA and families visiting the Old Mill.

With the detailed design and prototyping phases complete, the project team worked to finalize the exhibits they designed. Ultimately, five exhibits were designed and four were created as a physical deliverable for the NHA. All five designs are accompanied by detailed SolidWorks drawings that are available for the NHA to manipulate and reproduce at their discretion. The final deliverables for the project include the exhibits detailed in this section, along with the recommendation that they be further tested, refined, and others be expanded to NHA sites.

4.2.1 Prototyping and Design Process

Through the fabrication process, the designs of the exhibit elements changed. These changes were due to means of fabrication, feasibility, and feedback from individuals in the workshop. Before committing to detailed designs, the project team utilized prototypes to test the designs. Prototypes took several forms before the ultimate design of each exhibit was developed, going through revisions in SolidWorks. The purpose of the SolidWorks models were to demonstrate the proof of concept for the exhibit designs, as well as initial dimensions and materials required to fabricate the physical elements. The image on the left in **Figure 22** shows the initial design of the assembly, while on the right shows a more detailed design that reflects design changes from sponsors and changes made when building the element.

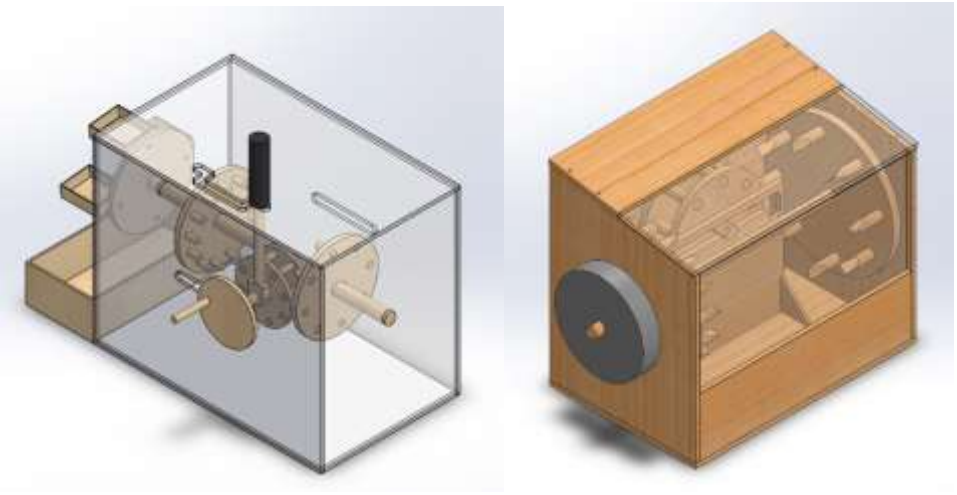

Figure 22. SolidWorks designs of gear ratio element

For example, one of these changes was modifying the teeth of the shifting gearbox from cylindrical dowels, to chamfered edges similar to the teeth in the Old Mill to improve smoothness of the system when the crank is turned (**Figure 23**). This adjustment would not have been made if the team did not prototype the assembly and test it before building the final design. Changing the profile of the teeth was made when the team built a prototype of the system and noticed the teeth would catch on each other. This new chamfered profile on each tooth reflected the appearance of the teeth inside the mill, and the team used the same profile geometry to create the smaller teeth that the millers use to machine new teeth for the Old Mill.

Figure 23. Prototype and final fitting of gears meshing

4.2.2 Shifting Gearbox

This machine at the Old Mill demonstrates how changing the gear ratio in a transmission will affect the speed of an end effector. By shifting a cage gear, like the one in the mill, the visitor spins a wheel modeled after a grindstone. The display in **Figure 24** contains a simple cage gear, two crown gears (with different number of teeth), and a handle that rotates the gears. The title of this machine proposes a question, “How Fast can you Spin the Grindstone?” This challenge encourages participation by drawing users in with a question, but also showing that the cage gears meshing with the crown gear moves the grindstone in the mill. The gears are enclosed in a Plexiglass and wood enclosure for safety and weather protection, while the grindstone wheel is removable for portability. Focus group testing done by a Nantucket Boy Scout troop provided the project team with insight into how users will interact with the exhibit after implementation. The testing demonstrated that the exhibit was simple enough that without instructional panels or guidance, children aged 10-12 understood the engineering concept of speed reduction with the change in gear teeth. The exhibit withstood rigorous play testing and adjustments to the durability were made after the testing.

Figure 24. How fast can you spin the grindstone?

4.2.3 Box of Rocks

One of the key elements in the Old Mill is the large box of rocks that acts as a brake to keep the crown gear assembly to rotate when not in operation. The project team reduced this large lever lifted by a series of pulleys to a simpler lever that demonstrates mechanical advantage, where the further the user pulls from the fulcrum point the easier it is to pull. This exhibit features a large lever weighed down by a box of rocks that users will have to lift using ropes attached to the large lever arm (**Figure 25**). Three ropes are strung from the lever arm at differing distances away from the pivot point. Each rope has a small grip at the bottom of the rope for users to pull on, each are a different color, corresponding to the difficulty of lifting the box of rocks. The title of the machine, "Can you lift the Box of Rocks?" poses a challenge to the visitor and allows them to solve the problem using exploration as they investigate the easiest way to lift the box. Focus group testing of this exhibit found that it was very durable and could withstand repetitive pulling. After the focus group testing, the project team made little changes to the design other than to add dampeners inside the slot of the beam to reduce force of the lever impacting the wood during use, as well as a hard stop to limit the height that the lever is allowed to move to. The children in the focus group easily recognized that the effort required to pull the differing ropes changed as the rope moved further away from the fulcrum point.

Figure 25. Can you lift the Box o' Rocks?

4.2.4 Sheets to the Wind

The project team worked with the NHA to learn how the sails on the Old Mill are raised and lowered when the mill is in operation. To simulate this experience, the team designed an exhibit allowing users to put smaller sails on a replica mill (**Figure 26**). The participants can place sheets on the vanes, made of canvas similar to the material the Old Mill's uses, and even turn the vanes into the wind by rotating the smock top. The exhibit's challenge poses the question, "How many sheets to the wind?". With the instructional panel that provides information on how many sheets the actual Old Mill uses depending on wind speed and air density, visitors can determine how many sheets they will place on the vanes.

Figure 26. How many sheets to the wind?

4.2.5 Corn on the Cart Race

Transporting corn and resources into the Old Mill was an engineering challenge when the mill operated regularly. Complex pulleys and rudimentary conveyer belts moved the corn through a door on the front of the mill. This simple machine simulates the engineering task to bring corn into the mill. The exhibit consists of two ramps with tracks built in them that carts fit into, pulleys, and weights (**Figure 27**). Users can fill their cart with corn, manipulate the angle that the ramp sits on between 3 angles, and add weights to the pulleys to change the rate the cart travels up the inclined plane. This exhibit is similar to common high school science experiments, but ties in the themes of the Old Mill and solving the puzzle of transporting products like corn in and out of the mill itself. With two ramps, multiple users can interact with the exhibit and there is an element of competition to try and race against your friends to get your cart to the top first. Our research found that giving the user the power to manipulate and "build" the settings of the exhibit enabled learning, as users can find the right combination of angles, corn, and weight to determine how fast the cart will move.

Figure 27. Race to the top!

4.2.6 Gear Puzzle

Gears are an easy way to teach how to transfer rotational energy to move something. The concept of rotational energy moving another element is essential in the function of the Old Mill. The title of the exhibit, “Who will make the mill turn first?” tasks the user to have a friendly competition with their friends or family to solve the puzzle. This interactive element is a three-sided structure where participants must place gears on pegs such that the gears fit together and spin the windmill at the top when they crank the gears (**Figure 28**). This activity promotes group-learning by allowing for multiple users. Due to time constraints, the team was not able to fabricate a full assembly of this exhibit, and recommends the NHA use the detailed drawings included to build and implement this exhibit.

Figure 28. Who can make the windmill turn first?

4.2.7 Exhibit Design Evaluation

As previously stated, there were three sets of design criteria, or constraints that both limited and guided the exhibits' designs. When designing, the team worked to incorporate as many of these constraints into consideration, however not every characteristic was achievable for each element. Our project team organized evaluations of the elements' designs into tables, with each characteristic also reflected. These evaluations were developed by the project team performing self-evaluations based on the external criteria set forth by the PISEC standards (from the Borun and Dritsas study), the Nantucket Historical Association, and the feasibility due to day-by-day operation at the Old Mill.

Criteria from Nantucket Historical Association

The criteria for the simple machine exhibits received from the Nantucket Historical Association were that they be Safe, Durable, Educational, Simple, Creative, Innovative, and Accessible and are used to evaluate the exhibits in **Table 1**. Overall, safety was a concern for all of the exhibit elements and safety measures were implemented into all of the exhibits, such as hard stops on the large lever beam to limit its swinging motion and rounded edges wherever possible. Educational was another category that was achieved at each display, as all museum exhibits should convey educational lessons. Durability is the criteria that the project team did not feel all the exhibits met, each display for different reasons. The team was not able to focus group test the three exhibits marked as not durable and recommends the NHA test these exhibits for their durability and adjust the construction accordingly.

Table 1. *Evaluation of Exhibit Elements by NHA Criteria*

NHA Design Criteria	**Safe**	**Durable**	**Educational**	**Simple**	**Creative**	**Innovative**	**Accessible**
Race to the top!							
How fast can spin the grindstone?							
Who can make the windmill turn first?							
Can you lift the box o' rocks?							
How many sheets to the wind?							

Criteria from Family-Friendly design

The criteria compiled from background research on family-friendly exhibit design provided strong guidance when designing the exhibit elements. Many of these constraints implied very similar design choices, such as Multi-Sided, Multi-User, Multi-Outcome, and Multi-Modal and are seen in **Table 2** in an evaluation of the exhibits. To accommodate these criteria, the design team chose to add as many sides, or possible opportunities for other users as possible into the designs. The lever and wind energy exhibits do not have multi-user capabilities, however, they both have multiple outcomes, so the lessons conveyed are dynamic. All of the exhibits were designed with multiple outcomes so that users can use the exhibit one way and interpet the results to try a different method and learn from their experience. Each of the exhibits have an instructional panel that utilizes both images and words so that it is readable and accessible for younger kids whose reading ability might not be as strong as older visitors. Lastly, all of the exhibit were designed to be directly related to principles inside the Old Mill to ensure that they are educational and relevant to the site.

Table 2. *Evaluation of Exhibit Elements by PISEC standards criteria*

PISEC Standards Criteria	**Multi-Sided**	**Multi-User**	**Accessible**	**Multi-Outcome**	**Multi-Modal**	**Readable**	**Relevant**
Race to the top!							
How fast can spin the grindstone?							
Who can make the windmill turn first?							
Can you lift the box o' rocks?							
How many sheets to the wind?							

Criteria from the Operation of the Old Mill

The project team performed onsite research at the Old Mill to develop a list of some criteria the exhibits should meet in conjunction with the two previous sets of criteria. Overall, each constraint is met by most elements, as seen in **Table 3**. A predominant element consideration was storage, making sure that the display could be stored either in the Old Mill, or the maintenance shed on the property. To work around this issue, the designs incorporated portability; for example, the lever has the ability to be easily taken apart for storage. A solution to the lack of storage at the Old Mill is utilizing space in Discovery Room at the Whaling Museum, a location in the museum used for interactive learning and arts and crafts. Displaying the exhibits in the Discovery Room makes portability a big consideration for the design. Overall, these exhibits do not interfere with the operation of the mill, and do not require the millers to supervise the users and are self-sufficient.

Table 3. *Evaluation of Exhibit Elements by Old Mill Operation Criteria*

Old Mill Operation Criteria	Does not Require Miller Supervision	Easily Stored	Easy Setup	Usable in High Winds	Low Maintenance Required	Easily Transported	Available at Whaling Museum
Race to the top!							
How fast can you spin the grindstone?							
Who can make the windmill turn first?							
Can you lift the box o' rocks?							
How many sheets to the wind?							

4.3 Supplemental Educational Resources

The interactive exhibits the project team fabricated serve as educational opportunities to learn about the engineering principles in the Old Mill, which the team supported with additional resources. These supplemental resources create a cohesive experience for visitors of the NHA's Old Mill exhibits, building an interactive story around STEM education. This section will detail the main deliverables the project team created for the NHA as supplemental resources to the simple machine exhibits at the Old Mill. These resources include a printable children's booklet, instructional panels to the exhibits, and a lesson plan for teachers.

4.3.1 Voyage Log

In order to build a cohesive experience for visitors at the Old Mill, the project team developed a system around the exhibits. An original site map created on Adobe Photoshop and Adobe InDesign will guide visitors through all of the exhibits in an open ended adventure. This guide is affectionately titled the "Voyage Log", tying in themes of Nantucket's history of sailing and exploration on their whaling ships. This resource is a document that the NHA can print and offer to visitors while visiting the Old Mill, as well as an online resource for guests to print at home and bring. The log includes a title page, a site map showing all of the exhibits to interact with, and a stamp page (**Figure 29**).

This map was purposefully designed to suggest no order to the exhibits. It is not likely that all five of the exhibits are displayed together at all times, and so there is no required order to interact with the exhibits. The stamp page of the Voyage Log has spots for five stamps, each corresponding to a different exhibit. Once a guest has interacted with the exhibit and completed the challenge, they can stamp their log. There is a final stamp spot reserved for the "Miller's Stamp of Approval", a stamp guests only receive after they have gone inside the mill and received a tour from an interpreter or miller. The last stamp encourages guests to receive the full experience of the Nantucket Old Mill and understand how the engineering principles of the exhibits directly correlate with those in the mill.

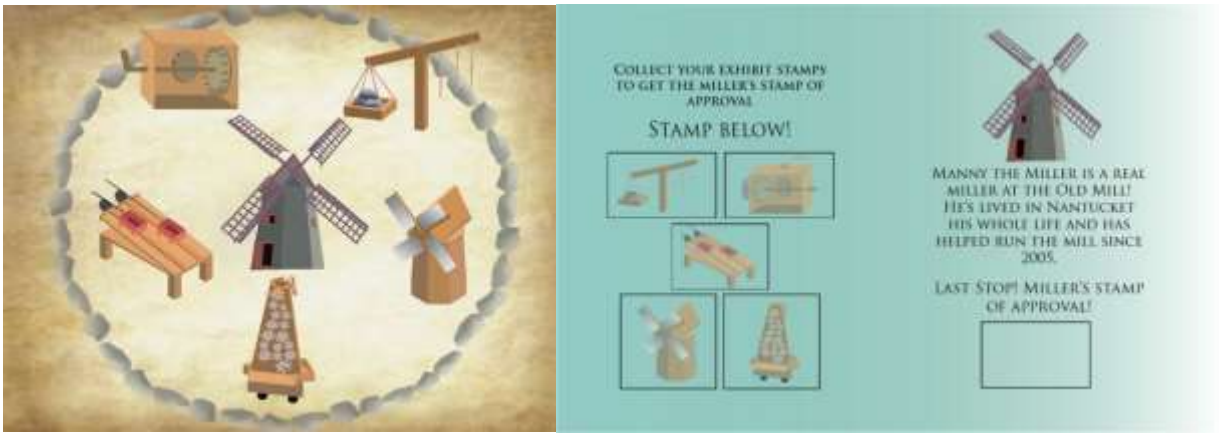

Figure 29. Voyage Log and stamp page of exhibit handout

4.3.2 Instructional Panels

In conjunction to the simple machine exhibits featured at the Old Mill, the project team created instructional panels to guide users. These instructional panels are resources to learn about the underlying engineering principles present in each exhibit, as well as challenges, instructions, and safety precautions. These panels are located at each exhibit for easy reference for visitors looking to see reference material or need a hint on how to use the simple machine. Each panel features a challenge for users to solve as they engage with the exhibits, an element that was noted during research on family-friendly exhibit design. The panel in **Figure 30** is for the Box of Rocks exhibit and features a simple graphic, similar to the image in the Voyage Log that shows the user they need to pull a rope to lift the rocks. The challenge of this exhibit asks the user if they can lift the box of rocks, and to see what happens if they pull on the different ropes spaced further from the fulcrum. While not every guest will understand the more detailed engineering concept of mechanical advantage, the instructional panel notes this lesson at the bottom of the poster.

The instructional panels designed by the project team are conceptual, and the team recommends that the NHA focus group and trial these panels to determine the final style and design before implementation.

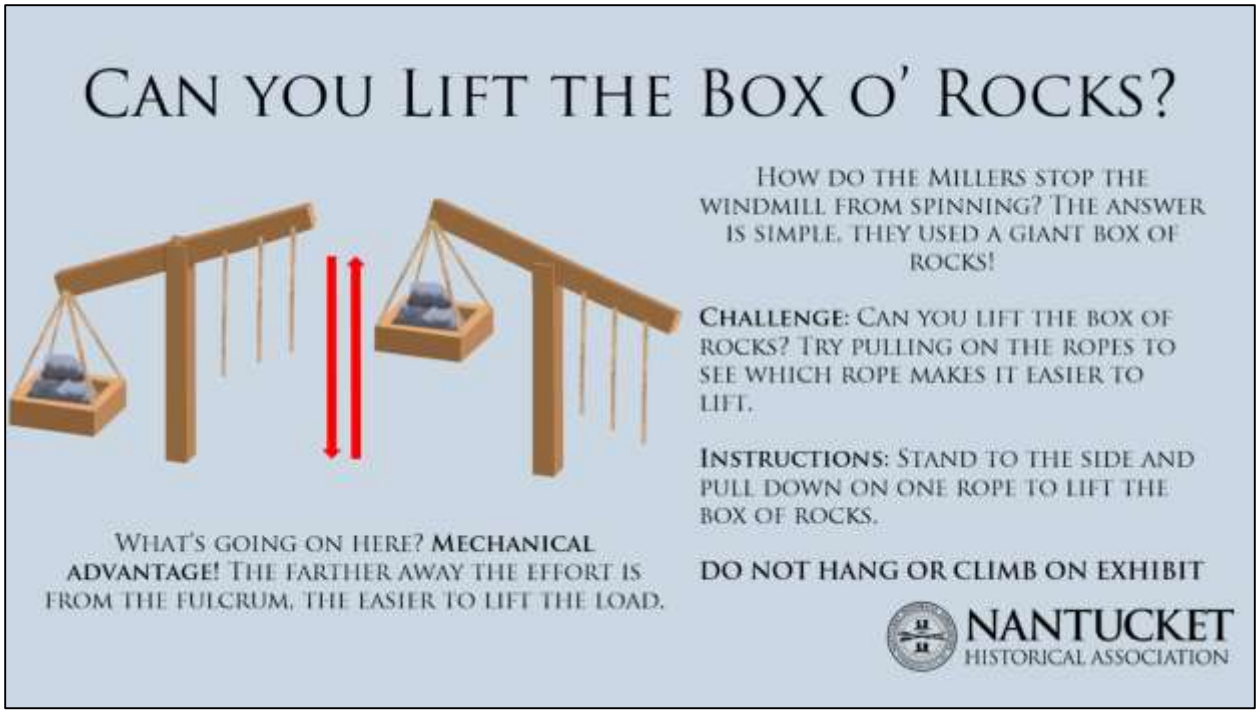

Figure 30. Instructional panel for Box of Rocks exhibit

4.3.3 Teacher's Guide

The exhibits at the Old Mill are also anticipated to be utilized by teachers and their classes. The exhibits at the site incorporate elements from the Massachusetts framework for STEM education, making them fitting for Nantucket community schools to bring their students to the site for interactive STEM lessons. A comprehensive teacher's guide assists educators who bring their students on field trips to the Old Mill. This guide serves as the framework for possible lesson plans that go over the engineering principles present in the Old Mill, as well as the interactive exhibits. By detailing pre-visit preparation material to cover in class, the teacher's guide outlines the necessary information educators may want to know about the Old Mill and its exhibits. Within the teacher's guide is material that covers all of the engineering principles in the Old Mill and where they are located. To summarize the guide, the team has included an activity worksheet for students to fill out after their visit. While this activity sheet does not cover all of the engineering lessons that are present at the Old Mill, it serves as a starting point for educators to assess their student's comprehension.

4.4 Further Site Recommendations

4.4.1 Recommendations Regarding Future Old Mill Exhibits

The project team recommends that the NHA conduct focus group testing on all of the exhibits that the team created to refine, or validate the designs before actual implementation to the summer tourists in the summer of 2019. These focus groups should consist of the targeted age range (7-12) and potentially children from outside of the Nantucket community who might

not be familiar with the Old Mill. A sample questionnaire that can be used to collect feedback from focus groups in the future is included in Appendix C. Focus Group Questionnaire. The team conducted small focus groups with some Boy Scout troops on Nantucket, but this group of Scouts does not represent the full demographic of users the exhibits will interact with, and so further testing is required. The project team provided the NHA with the SolidWorks drawings so they can reproduce or change any of the designs if beta test feedback calls for major revisions.

As these exhibits are the first interactive exhibits to feature simple machines at the Old Mill, the project team recommends that the NHA continue this project moving forward. As the term of the project lasted for only seven weeks, there are other opportunities for simple machines at the Old Mill that the NHA can explore in the future. The team recommends that these opportunities continue to be explored, as well as other interactive exhibits be developed at NHA sites. In addition to the instructional panels discussed in §4.3.2 Instructional Panels, the project team also has suggested recommendations on using the simple machine exhibits in a Frequently Asked Questions (FAQ) document in Appendix D. Frequently Asked Questions (FAQ).

4.4.2 Recommendations Regarding Signage at the Old Mill

In addition to the educational exhibits on the outside of the Old Mill property, the project team recommends the NHA update the signs and labels inside the building. A need for improved signage was identified for both the inside and outside of the Old Mill. These signs include the labels on different elements of the mill or artifacts displayed there, captions explaining photos, and existing signage that needs to be updated.

Figure 31. Locations inside the Old Mill for signs

Inside the Old Mill

The project team recommends that the NHA implement small signs throughout the Old Mill calling out important items/machine elements so that visitors can identify elements themselves. Through speaking with experts and millers, the team prepared a list of all the important elements in the Old Mill that need an identification label (**Table 4**). Additionally, there were several interesting pictures hung that showcased the history of the Old Mill and the other

Nantucket grist mills that previously stood across the landscape.

Table 4. *Signage Inside the Old Mill*

Labels		Photo Captions	Signage updating
Stone Lever	Grinding Shaft (Round Top Mill)	Running Stone	"Please Do Not Touch Corn"
Mill Box	Tun	Nether Stone	"Do Not Go Beyond This Point"
Grain Chute	Grinding Shaft	East Mill	
Sifter (Tintering)	Shoe	West Mill	
Nether Stone	Hopper	Spider Mill	
Running Stone	Corn Planter	Round Top Mill	
Eccentric Gear	Box of Rocks	Bunker Mill	
Corn Bin	Stone Puller	Tidal Mills	
Teeth	Sand Mold	Old Mill section Views	
Grain Table	Saddle Bearing		

Exterior of Old Mill

The team recommends that the NHA improve the signage outside of the Old Mill as well as the aforementioned interior. There are old worn down running and nether stones (top and bottom of the grinding stones) that are on the ground surrounding the property with no identification, as well as an old wind shaft on display. Important artifacts like these merit labels to denote what they are, and their place in the history of the Old Mill. Additionally, the team recommends that the NHA implement large signs near the streets adjacent to the Old Mill so it can be identified like other NHA sites seen in **Figure 32**.

Figure 32. Exterior Signage at the Old Gaol

Table 5 outlines basic labels, signage to be added, and existing signage that the team

recommends be updated to create a more uniform image at the Old Mill.

Table 5. *Signage Exterior of Old Mill*

Labels	New Signs	Needs updating
Running Stone Tail Pole Sweeps Stone Track Deadmen (Capston) Former Wind Shaft Worn Out Running Stone	Welcome Sign Street signage	"Warning: Keep Outside Ropes"

The project team recommends that the signage the NHA implement match the style of graphics done across the other NHA sites, such as the Oldest House and the Old Gaol, where there are uniform graphic design templates for any text panel at the site. These uniform text panels are absent at the Old Mill, and the addition of signs, labels, and photo captions using a template would increase visitor's ability and inclination to read about the Old Mill while they visit.

4.4.3 Recommendations Regarding Social Media at the Old Mill

The project team found that social media is frequently used by the Nantucket Historical Association in promoting the NHA's events and properties. However, with only a few posts about the Old Mill in the year proceeding this project, and the site being a landmark of Nantucket, the project team recommends a series of improvements to the existing NHA social media posts to boost visibility of the Old Mill.

Instagram

The project team recommends that greater exposure of the mill using Instagram posts, stories, and hashtags can improve visibility. The Nantucket Historical Association runs an active Instagram account @ackhistory where they post about events hosted by the organization, as well as to promote the various sites the NHA maintains. In the year leading up to this project, there was only one post on the NHA's Instagram account advertising the Old Mill, and only 5 posts overall about the landmark. Instagram stories posted the morning of a day the Old Mill is being run (**Figure 33**) would improve the public's image of the site as well as attendance.

Figure 33. Instagram Story

Additionally, featured hashtags on Instagram posts from the NHA would encourage visitors of the Old Mill to reuse the hashtags, further promoting the mill's visibility. Adding some of these example hashtags would improve people's perception of the Old Mill, and allows the mill to be viewed as a fun place to go to learn and enjoy the Nantucket historical community.

#ACKhistory	#ACKcornmeal
#OldMill	#MannytheMiller
#BoxoRocks	#windmillsofACK
#MillHillACK	#onthatgrind

Facebook

In conjunction with the NHA Instagram, the organization uses Facebook as another social media tool to advertise their historic sites and events. The project team found this page to be very useful and informative when communicating about events.

Figure 34. Nantucket Historical Association Facebook page

However, the project team found that there is a public Facebook page for the Old Mill that does not reflect the level of communication and visibility that is seen in **Figure 34** of the NHA's Facebook page. The team saw opportunity to transform this page into a location for information about the Old Mill, when it is running, and for visitors to post pictures of their visits. The previous page (**Figure 35**) has no profile picture, no relevant cover photo and is visually unappealing to look at.

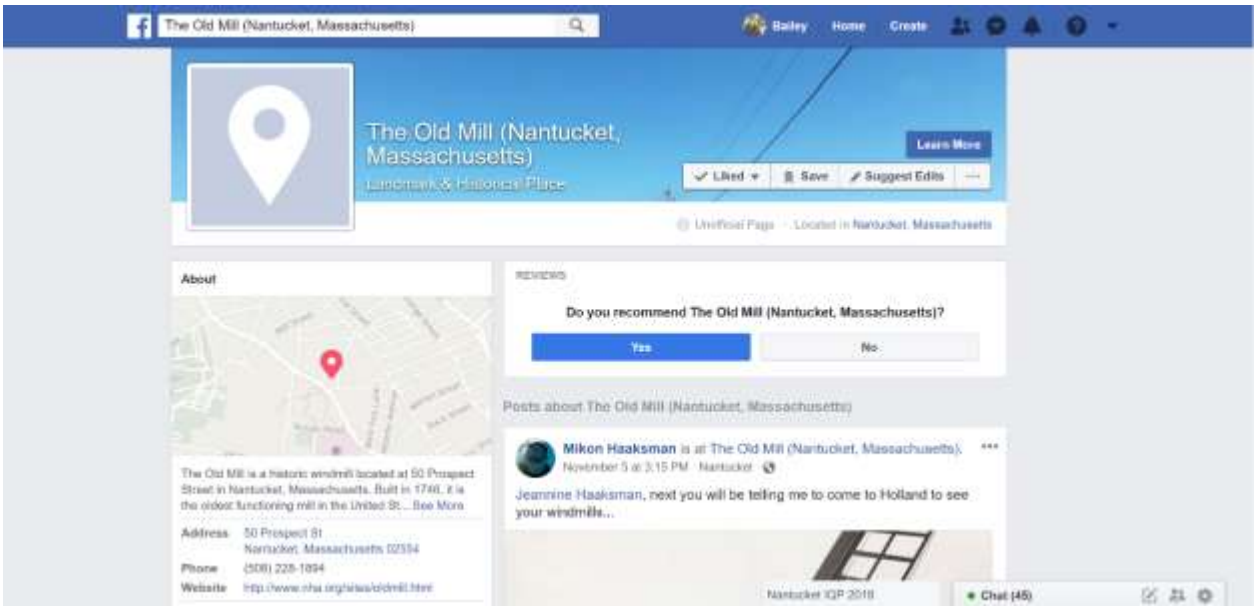

Figure 35. Previous Old Mill Facebook page

The project team recommends that the NHA revamp the page's look to fit into the NHA style and brand. **Figure 36** shows a sample of what a remodeled version of this page could look like.

With a photo of the Old Mill as the profile picture, visitors to the Facebook page instantly recognize the classic Nantucket icon. Using this Facebook page, the NHA can communicate regularly about when the Old Mill is running, when there is souvenir corn meal available, and post about events like the Harvest Fair.

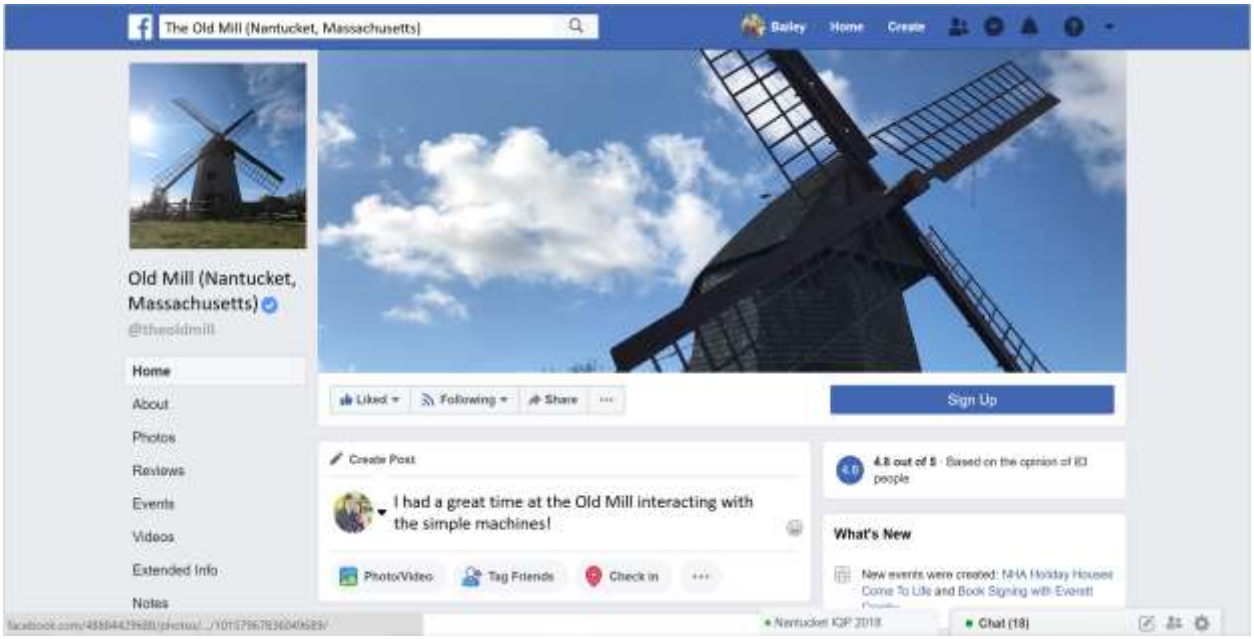

Figure 36. Updated Old Mill Facebook page

Snapchat

The last form of social media the project team recommends the NHA implement is the photo-sharing platform Snapchat. Snapchat is a common social media app most teens and young adults use with their friends. Not only can users create accounts to send pictures to their friends and post on the public Story, where photos are posted for 24 hours, but so can companies and organizations. With expansion into the Snapchat platform, the project team believes both the NHA and the Old Mill will have increased visibility.

Snapchat is simple to use and even subtle uses of the platform make a difference to users. The project team recommends that the NHA create Snapchat Geofilters for the Old Mill site, and even other notable locations like the Oldest House. Geofilters are graphics that get overlaid on top of the user's picture (**Figure 37**), allowing them to show to their friends where they are, propagating that location as a fun place to visit.

Figure 37. Snapchat Geofilter for the Old Mill

4.4.4 Recommendations Regarding Connecting NHA sites with the Old Mill

The fourth recommendation the project team has for the future of exhibits at the Old Mill concerns any connections between other NHA sites. Through linking the Old Mill interactive exhibits with other NHA locations, attendance is increased for all of the connected sites. The team's recommendations regarding association between the seven historic sites are a pretense to building a more interactive experience across all of the NHA's historic locations. The recommendations in this section will cover exhibiting the simple machines in the Whaling Museum in Downtown Nantucket and the expansion of interactive exhibits to other sites.

Simple Machine Exhibits in the Whaling Museum

The project team recommends that those exhibits that can be easily transportable; such as the shifting gearbox, the sails to the wind, and the race to the top exhibits all be displayed in the Discovery Room during the off season so that the NHA can continue to offer educational exhibits from the Old Mill. Offering the exhibits at the NHA's flagship location in the winter will draw visitors towards interactive learning and encourage them to visit the Old Mill to play with the other simple machines.

Expanding the Interactive Exhibits to other NHA sites

We recommend that the Nantucket Historical Association capture the thematic connections such as colonial architecture and sustainable farming through the NHA sites by using signage, activities, and site maps. The summer months are an asset to the NHA in order to link these sites together by hosting "Field-Days" between the Old Mill, the Oldest House, and the Old Gaol. Along with the similarities in each of the site's names, each of these sites are a testament to the Nantucket lifestyle of workers who made a living on-island, while the whaling industry boomed and after its decline. The Old Mill and the Oldest House are both examples of the agriculture that sustained the island's population, and we recommend implementing signs that show how the crops like grain or corn grown on Nantucket farms, like the Oldest House were brought to the Old Mill to be ground into cornmeal and other products for food. The interactive museum exhibits at the Old Mill focus on STEM learning and simple machines, while interactive exhibits at the Oldest House could focus on colonial architecture and sustainable farming on small plots of land. The outcomes from this project can be expanded in the future to encompass future exhibitions at the other NHA sites, all offering their own stamp books, challenges, and interactive games to encourage visitor's learning outside of what the interpreter conveys to them on their tours.

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Appendix A. Informed Consent Form

Project Name	Making the Old Mill New WPI Interactive Qualifying Project
Interviewers	
Interviewees	
Location	
Date	

This WPI IQP research project is sponsored by the Nantucket Historical Association and will work to expand the visibility of the Nantucket Old Mill to guests who visit the site.

The goals of our project include designing an educational exhibit, updating and standardizing signage, and proposing a system to promote interaction between NHA sites and visitors.

All information gained in this interview can be made anonymous at your request. All audio transcriptions will be retained as property of WPI unless otherwise noted below. A copy of the final report will be made available when completed and approved by WPI and the Nantucket Historical Association.

This interview is voluntary. Participants may decide not to participate at any time without consequences from the interviewer. The participant reserves the right not to answer any question that they are not comfortable with.

I give my permission for…	**Yes**	**No**
This interview to be (audio/video) taped		
My name to be used		
The tape/transcript to be archived		
The information to be made public		

_____ _____

Participant's Name (printed) Participant's Signature

Appendix B. Interview Plans

Appendix B.1 Educator Interview Plan

Methodological Note: Interviews conducted using this plan, or similar variant will be used to help our team gather valuable background information from Nantucket *experts on education* for targeted age groups.

Logistics: Interviews will be conducted at locations that convenience the interviewee, as these interviews will be organized beforehand in accordance to our interviewee

Team Member Assignments:

- Introducing:
- Note Taking:
- Question Asking:
- Summary/Information Review:

Sought out Information:

- What lessons are appropriate for each targeted age group?
- Ideas for interaction with targeted age groups

Introductions:
Hello, our names are Mackenzie, Bailey, Ben, and Mitch and we are from Worcester Polytechnic Institute in Massachusetts, conducting research to complete our Interactive Qualifying Project. We would like to gather feedback to help us build an interactive family friendly exhibit for the Nantucket Old Mill. This brief interview is completely voluntary. Would you be willing to answer some questions for us?

Order of Questions:
Leading Generalized Questions

- What is your role in the educational community?
- When did you start teaching at Nantucket?

Project Specific Questions

- What grade level introduces basic engineering (pulleys, gears, levers, etc.)?
    - How do other grade levels cover engineering?
    - Do you follow the Massachusetts Curriculum framework for STEM?
- When teaching simple machines do you use an interactive approach or more of a lecture style?
    - Which teaching style do students react to better?
- Are there any field trips to the NHA sites such as the Whaling Museum or the Old Mill?

    - Are the students engaged and generally interested touring the locations?
    - If not, what do you think would help engage students?
- What do you think of when you hear the words “interactive exhibit”?
- Based off your expertise what do you think makes up a good “interactive exhibit”?

Conclusion:

The information we gathered during this interview has provided us a better understanding of the educational standards on the island. It has also encouraged new ideas regarding our family friendly interactive exhibit and what types of lessons the exhibit should focus on.

Appendix B.2 Whaling Museum Visitor Interview Plan

Methodological Note: Interviews conducted using this plan, or similar variant will be used to help our team gather valuable background information from Nantucket visitors about their perceptions about the Nantucket Old Mill.

Logistics: Interviews will be conducted on-site, as in person interviews with the interviewee

Team Member Assignments:

- Introducing: IRB Consent statement
- Note Taking:
- Question Asking:
- Summary/Information Review:

Sought out Information:

- What is the public knowledge of the Mill? Do people know of the Old Mill?
- What is the public knowledge of the Other NHA sites?
- What are the reasons people are visiting the museum, and possibly the other sites? (History buffs, just an activity?)
- Are people planning to visit more of the sites?
- What are factors that attract people to a certain site?

Introductions:
Hello, our names are Mackenzie, Bailey, Ben, and Mitch and we are from Worcester Polytechnic Institute in Massachusetts, conducting research to complete our Interactive Qualifying Project. We would like to gather feedback to help us build an interactive family friendly exhibit for the Nantucket Old Mill. This brief interview is completely voluntary. Would you be willing to answer some questions for us?

Order of Questions:
Leading Generalized Questions

- How often do you visit Nantucket? Locals, often, first time?
- What brought you into the whaling museum today? Are you NHA or museum members?
- Is this your first time at the museum or any of the NHA historic sites?
    - Do you know of any of the other historic sites? If so, which is your favorite and why?

Project Specific Questions

- Do you have any knowledge of whaling or sailing?
- If any, what is your knowledge of the Old Mill? Have you ever attended it?
- What do you typically hope to get out of visiting one of the NHA historic sites?

- Could you tell us a few aspects of your visit to the NHA sites that could have made it better?
- Could you tell us an element of your visit to an NHA site that was particularly well done or memorable?

Notable Information

- Weather: to better understand information
- Interviewees: approximate age, students?
- With group or alone: understand the demographics visiting the sites

Conclusion:

The information we have gathered in this interview has provided us insight regarding the general public's knowledge of the Old Mill and the NHA sites. We also gained a better understanding of why museum goers are attending the sites and what their expectations are.

Appendix B.3 NHA experts Interview Plan

Methodological Note: Interviews conducted using this plan, or similar variant will be used to help our team gather valuable background information from Nantucket experts on the Old Mill and other related history.

Logistics: Interviews will be conducted on-site, as in person interviews with the interviewee

Team Member Assignments:

- Introducing:
- Note Taking:
- Question Asking:
- Summary/Information Review:

Sought out Information:

- Background information about the Old Mill
- What potential does the Old Mill have in the eyes of the interviewee?
    - Areas to improve

Introductions:
Hello, our names are Mackenzie, Bailey, Ben, and Mitch and we are from Worcester Polytechnic Institute in Massachusetts, conducting research to complete our Interactive Qualifying Project. We would like to gather feedback to help us build an interactive family friendly exhibit for the Nantucket Old Mill. This brief interview is completely voluntary. Would you be willing to answer some questions for us?

Order of Questions:
Leading Generalized Questions

- What is your background with Nantucket, and or the NHA like?
- What draws you to be interested in the Old Mill, is there anything that you think in particular that should be highlighted?
    - Could be something that currently is noted that should be promoted further, or something that is not currently noted.
- Is there anything that you think could be changed about the appearance of the Mill?

Project Description Specific Questions

- What is your opinion of the current signage at the Old Mill?
- If an outdoor exhibit/display/interaction was made for the Old Mill, what would you think would be useful lessons to teach to children/visitors?
- Melanie - what type of activities do students enjoy interacting with? What has and has not worked at the exploration station?

- Ed/James - Should the exhibit be something included in the admission price or an attraction that is free that draws people to the mill?

Conclusion:
The information you have provided us with from these questions will help us to further optimize the educational value and overall experience at the Old Mill and the NHA.

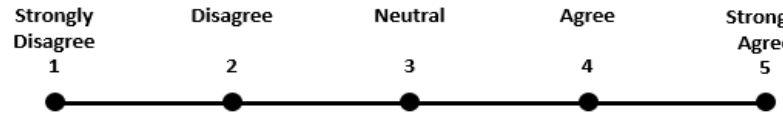
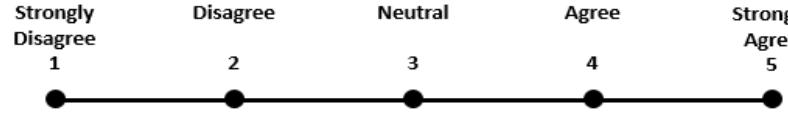
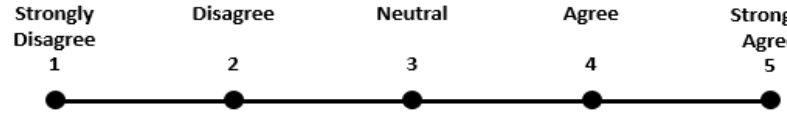
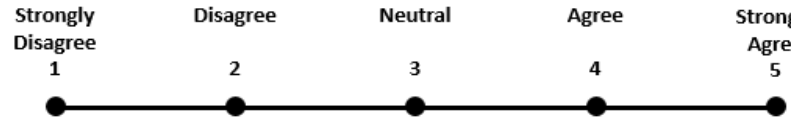
- Do you have any additional thoughts on what we've questioned you about?

Appendix C. Focus Group Questionnaire

Please answer the following questions about the "Making the Old Mill New" exhibit.

Are you willing to participate in a Focus Group about the Old Mill?	Yes	No
Were you familiar with the Old Mill before today?	Yes	No
Would you go to the Old Mill with your family?	Yes	No
Have you visited the Nantucket Whaling Museum?	Yes	No
Have you visited any other historic Nantucket locations?	Yes	No
Do you mind paying a fee to tour the Old Mill?	Yes	No

Please rate the exhibit presented on a scale of 1 to 5, where 1 = "Strongly Disagree" and 5 = "Strongly Agree" about the topics listed below.

Interactive	
Fun	
Educational	
Family-Friendly	

Do you have any questions or comments regarding our project or this exhibit?

Appendix D. Frequently Asked Questions (FAQ)

This Appendix of the Final Project Report outlines some Frequently Asked Questions regarding the use and operation of the simple machines exhibits featured at the Old Mill.

How do they work?

While the mechanics of each exhibit element differs between each simple machine. The exhibits are an open exploration space to learn about the simple machines in the Old Mill. Each exhibit has an instructional panel where it is located that will explain the relevance of the simple machine at the Old Mill and visual instructions on how to use it (**Figure 30**). The exhibits were designed to not require supervision of the millers attending to the Old Mill as it runs, so each machine is easy to operate and does not require guidance beyond what is provided on the panels. The project team additionally designed a small hand-out with a map of the location of the Old Mill site with spots for stamps when visitors have interacted with the element (**Figure 29**). For schools bringing their students to the Old Mill to learn about STEM, the project team created a Teacher's Guide that outlines the purpose of the exhibits, as well as the different engineering principles that underlie each of the exhibits. These descriptive lesson plans are tailored to the Massachusetts's framework for STEM education in grades 6 through 8.

When are the exhibits on display?

These exhibits should be on display at the Old Mill property site whenever the NHA determines their sites are open for the tourist summer season. The exhibits were designed to supplement and enhance a visitor's experience at the mill and should be offered especially when the Old Mill is open. During the summer tourist season is when the mill receives its most visitors so these exhibits should be available to these patrons upon their visit. In the off-season, the project team recommends that any number of exhibits be located and displayed in the Discovery Room at the Whaling Museum, an interactive learning space located off the main exhibition space of the museum. This secondary display space will allow for the continual offering of STEM learning when the mill is not in operation.

How many exhibits should be on display?

The exhibits were designed each to be individual and engineering to convey a different lesson. Because there is no strong tie between each element, besides being a simple machine in the Old Mill, not all of the elements need to be on display at the same time. At the minimum, the team recommends that there be 3 of the 5 exhibits on display, however it is up to the NHA's discretion which of these displays are brought out if all 5 are not on display. On the weekends during the busy season, there should be all 5 of the exhibits on the Old Mill property to benefit all visitors who are seeing the site, and will ease congestion if there are large groups of children. With any future expansion of the number of exhibits that are created for the Old Mill, these numbers are subject to change, however the principle can still be stated that there should always

be simple machine exhibits offered at the Old Mill or Discovery Room.

Where will they be stored?

When the exhibit elements are not being displayed however they will require a storage location, as they are not built to be left outside in the weather. The project team recommends that the millers and members of the NHA's maintenance team utilize the existing storage space on the Old Mill's property for these exhibit elements. There are two spaces are suitable for storage space at the Old Mill, the first being a storage shed slightly off Mill Hill affectionately named "Fred the Shed", and the second being the Old Mill itself. Both these storage locations will store these exhibit elements, as these elements are compact and some are collapsible to ease storage. In the off-season when the Old Mill is not open, storage will be simpler as the elements will not need to be displayed as often. In addition, one or two elements should be displayed in the Discovery Room at the Whaling Museum during the winter months to continue utilizing the educational benefits of these simple machine exhibit pieces as previously stated.

What is the cost?

While there is a small cost for families to visit the Old Mill and take a tour inside, the project team recommends that there be no fee to use the exhibit elements. The goal of these exhibits is to supplement a visit to the Old Mill by conveying lessons about simple machines and engineering, and that visitors can interact with them when they visit the mill. If visitors come to the site to play with the exhibits, there are questions inviting them to go inside the mill and see where the actual machines are inside the building, where they will incur the visitation cost. There is no need to double-charge visitors to learn about STEM and the rich history of agriculture on Nantucket.