Interactive Whaling Map

An Interactive Qualifying Project

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Abstract

The Nantucket Historical Association has been working to augment its in-person exhibits with digital content. We worked with the NHA to create an online interactive map of the voyage of Nantucket natives Charles and Susan Veeder aboard the whaleship *Nauticon* to be displayed on the website for the Nantucket Whaling Museum. We used the information from Susan Veeder's journal of the voyage to plot the journey and mark key events we thought were of interest. We recommend that the NHA continue to test the interactive map and solicit feedback about the map from its members.

Acknowledgements

We would like to thank the following individuals and organizations for making this project possible:

- **Mary and Al Novissimo** of Novation Media for helping us establish the goals and design criteria for our project, and for providing feedback on our work throughout the project.
- **James Russell and Amelia Holmes of the Nantucket Historical Association**, for giving us the opportunity to work on this project, as well as helping direct our project and providing us with the NHA's resources to assist with our work.
- **Dominic Golding, our Advisor,** for providing help and advice at all stages of our work.
- **Materialize,** the programming library we used to create the interface for our project.
- **MapBox,** the framework that allowed us to create the detailed map we used for our project.
- **Animate.css,** the library that allowed us to animate the different components of the program.
- **Fontawesome,** the library that provided us with icons to use in our program's interface.

Executive Summary

The Nantucket Historical Association is dedicated to preserving Nantucket's history through engaging visitor experiences. For most of its history, the NHA has focused primarily on physical exhibits, such as its Whaling Museum (History of the Whaling Museum) and tours of historic properties around Nantucket. While the NHA wants to continue providing these kinds of exhibits, the society also wants to move more towards creating interactive digital exhibits.

Since the 1970s and 80s, museums have shown a general shift towards using more interactive exhibits (Stillwell, 2017). Museums are attempting to use these interactive exhibits to increase visitor engagement (Hawkey, 2004), as many visitors now consider static, non-interactive exhibits to be too passive and thus uninteresting (Adams & Missouri, 2002).

The Nantucket Historical Association already hosts its own suite of interactives to better engage users in Nantucket's history. Some of these exhibits are more static in design, such as an exhibit on the NHA's website that shows petitions for and against the desegregation of Nantucket's schools; this exhibit only allows visitors to view a summary of each petition and an image of the original document. The NHA's digital exhibit on the whaleship *Edward Carey* provides more interactivity, as it provides users with a menu where they can view different videos detailing parts of the *Edward Carey's* voyages. Finally, the NHA also has an in-person interactive located on a kiosk in their Whaling Museum, which allows users to follow the voyages of different whaling ships and view key events along the ships' journeys.

To help build their repertoire of digital interactive exhibits, the Nantucket Historical Association tasked our team with building an interactive map of the four-year voyage of Nantucket natives Charles and Susan Veeder aboard the whaleship *Nauticon.* Susan Veeder kept a detailed journal of the voyage that the NHA had on file, and our goal was to use this journal to map out the path of the voyage and mark interesting events along the way that we discovered in Susan's journal entries.

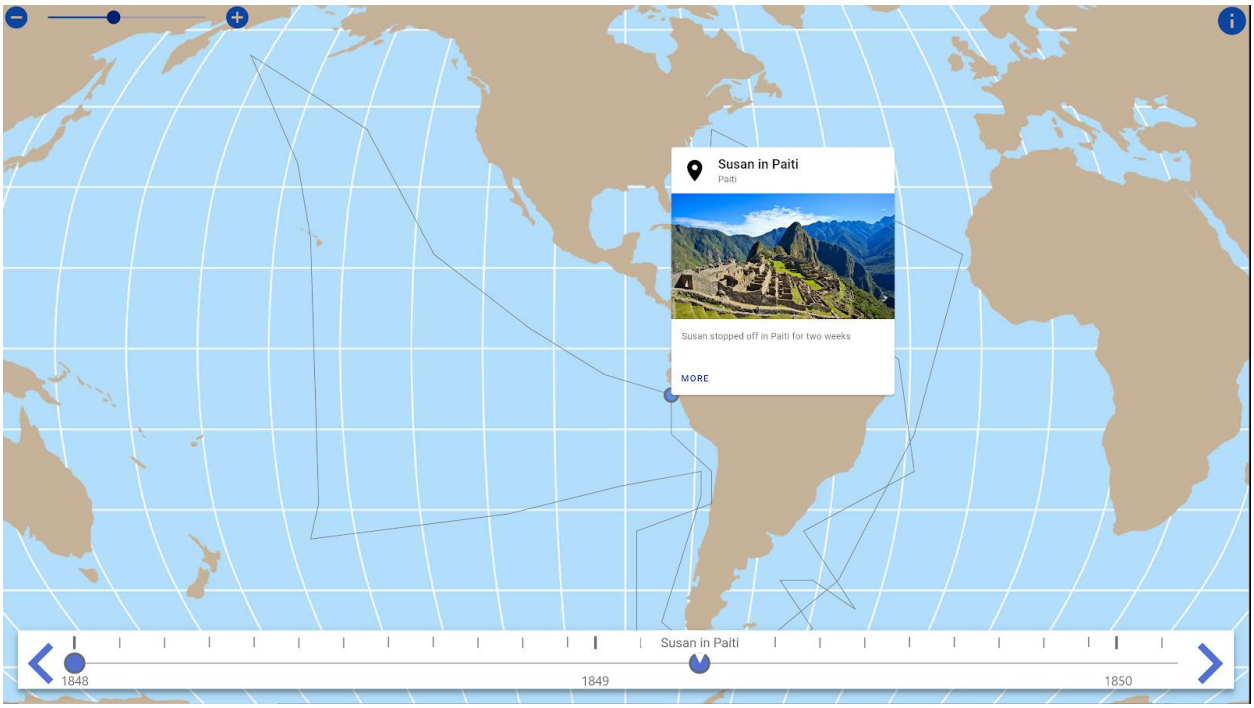
Historical Research and Data Collection

Our first task for this project was to extract data from Susan Veeder's journal that we would use to develop the map. The NHA helpfully provided us with a transcript of the journal,

and we took this journal and used it to create a spreadsheet of every journal entry, complete with their date, original text, and geographic latitude/longitude coordinates for entries that included them. Once we had compiled all the entries into this spreadsheet, we searched through them and pulled the 40 entries that we thought would be most compelling to highlight on the map.

Mockups and Visual Design

Once finished with our data collection, we set about making mockups for how we wanted the map program to look. Each of our group members individually drew up their own mockup; once that was complete, we met to compare our individual mockups and design a master mockup incorporating the features we thought were most compelling from each member's design that we would present to the NHA staff. Ultimately, our final mockup incorporated a map with the path of the voyage drawn on to it with a line, with the various major events marked on it as dots. Users would be able to click on each of these dots to bring up a popup with a description of the event, which could be expanded to show the original journal entry as well. Users could also click on the events on a timeline on the bottom of the screen. We also wanted users to be able to zoom and pan the map to see more detail.

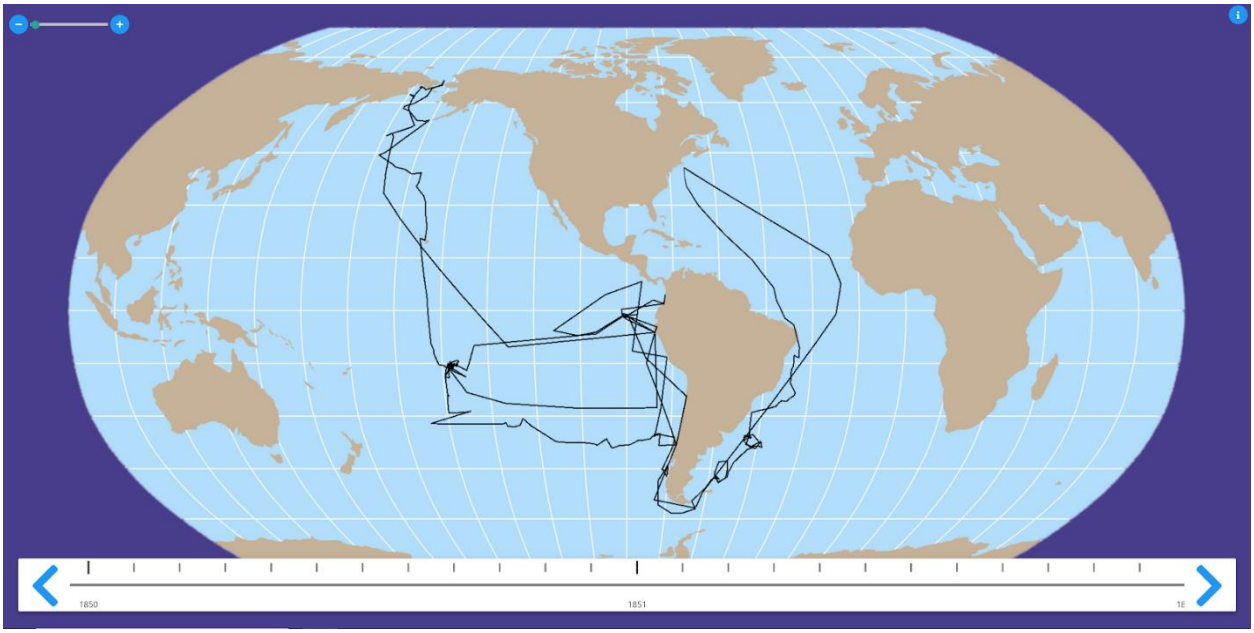


ES1: Mockup of main view

Development

We knew from the start that our program was meant to be a web application, so we needed to decide how to develop it for the web. We eventually settled on using vanilla HTML, CSS and JavaScript to develop our program, with the help of the libraries Materialize, Animate.css, Fontawesome, and Mapbox.

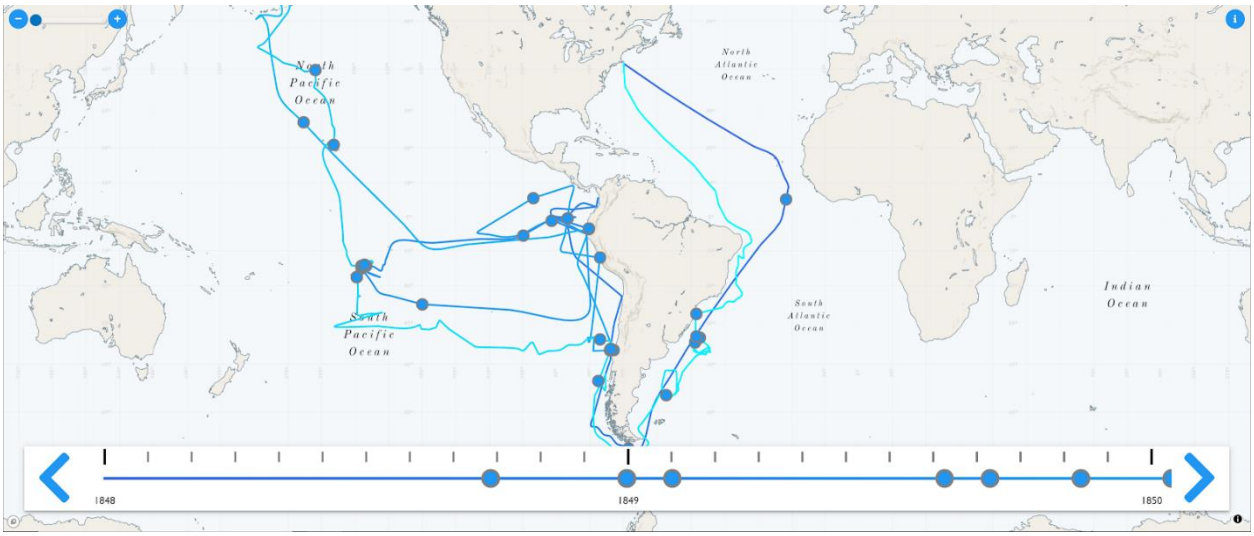
Our program was designed to display the voyage's path over a map of Earth, so naturally we began our work by implementing the map that would be used as a background later. The NHA provided us with a map image they had used in a previous interactive exhibit, which was a Robinson projection map centered on the Pacific Ocean. We initially inserted the map as a simple image that users could zoom in and out of with the mouse wheel or a zoom slider at the top left of the screen, as well as pan by clicking and dragging the mouse.



ES2: Early version with raster map

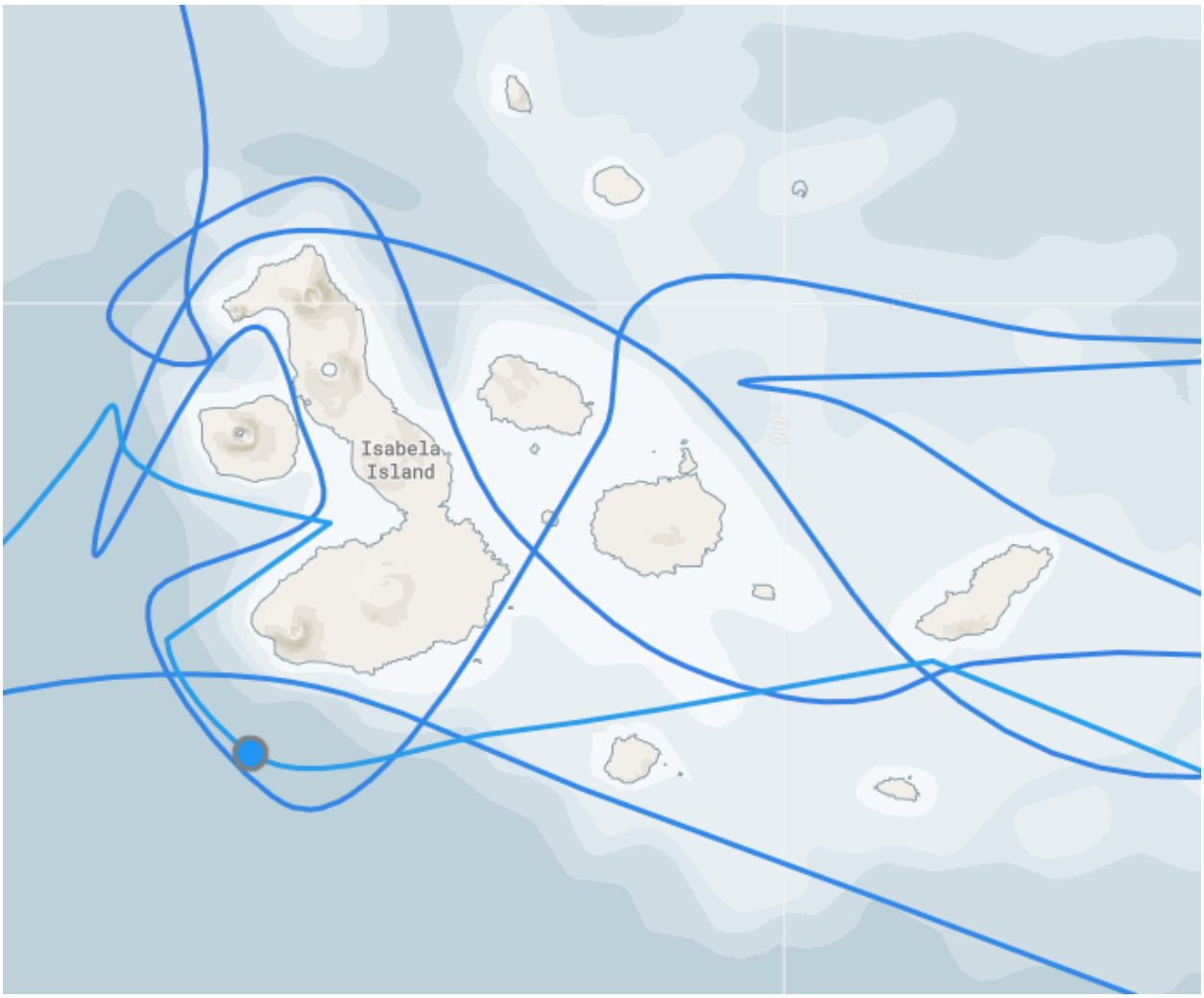
One of the first problems we ran into with this solution was that the image was too low-resolution, and thus looked blurry when a user zoomed in too far. We fixed this at first by converting the image into an SVG (Scalable Vector Graphics) image that gave it much greater visual fidelity, but this was a difficult and impractical solution that we later dropped in favor of converting the program to use the library Mapbox. Mapbox is a mapping framework that allows

us to display a much more detailed and visually appealing map, complete with labels on locations and bathymetric data.

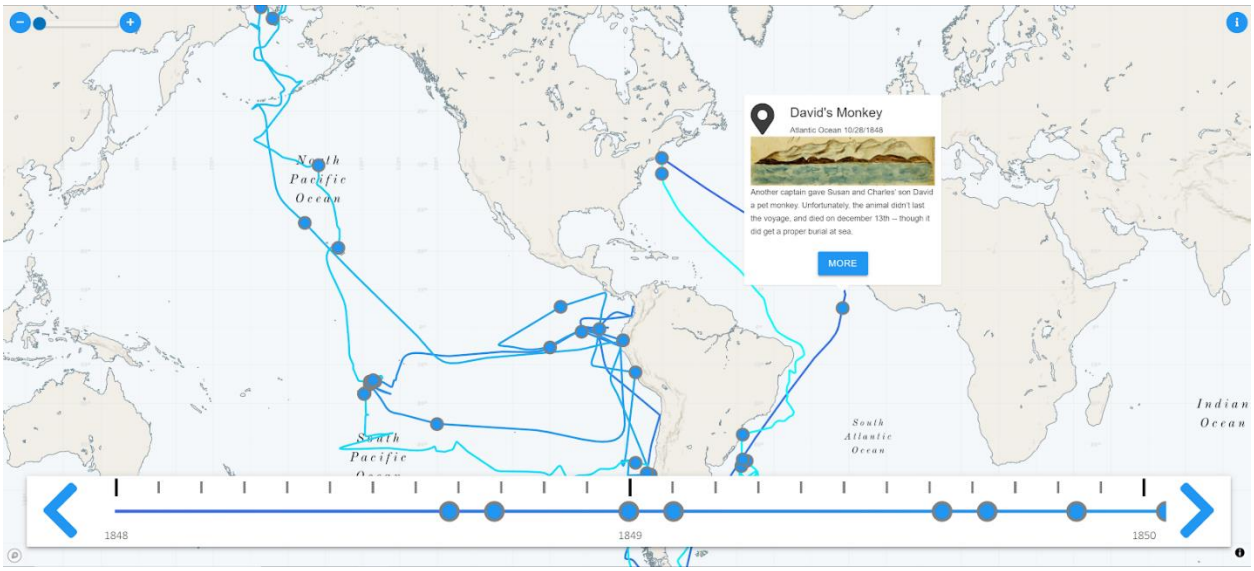


ES3: Final version with Mapbox map

After the map itself, the second most important part of the program was laying out the path of the voyage on the map. Susan Veeder's journal, despite not being a full ships' log, still had many records of latitude and longitude coordinates along the voyage; however, since these coordinates were not entirely complete, we used a Java program to estimate coordinates where we had no data. We placed the known and estimated data into a JSON file that our program would read in and use to draw lines between all the coordinates on an HTML canvas object. Our initial path looked mostly as we wanted, but it still had issues. The path looked jagged since we simply drew straight lines between the points, so we used Catmull-Rom splines to interpolate curves between the points, thus making the path look notably smoother. Additionally, the path was too low-resolution, making it look blurry when a user zoomed in too far. The switch to Mapbox fixed this issue, as Mapbox has built in functions that we used to draw much higher-resolution and detailed lines. Finally, the coordinates we had estimated occasionally were incorrect, having issues such as running into land masses. The higher detail allowed by Mapbox meant we could go in and edit the coordinates to move them to better estimates.



ES4: Zoomed in view of Mapbox map



ES5: Active event popup

The last part of development, along with the map and path, was placing markers for our chosen notable events and developing a system where users could click on the markers and bring up a descriptive view of the event. We were able to implement this feature much as we had wanted to in our mockup, with dots along the path that users could click on to show a small popup, shown in ES5, with the event's description that could then be expanded into a larger window which included the journal entry associated with the event.

Further Extensibility

We initially planned to perform our own period of testing and quality assurance; however, the Nantucket Historical Association decided to take over that role, as they wanted to handle testing and feedback themselves. We designed our program to be extensible and easily modifiable in the future, as our data files of coordinates and events can easily be added to. Additionally, the NHA staff discussed possibly using our design as a platform for future exhibits, so the design of our program allows a developer to easily replace our coordinates and events and draw the path for a different vessel than the *Nauticon* used in our exhibit.

Authorship

Our team's writing process consists of first creating a basic outline of a section, then dividing the drafting of the section up among each member of our team. After we had our initial draft, we would each make edits to the entire draft. We would then continue to make edits, and revisions such as adding or removing statements, paragraphs, and references. While the entire team was involved in the drafting, editing, and revising processes, Dyllan Cole and Billy Cross contributed more to the drafting process, while Evan Hatton and Ryan Stebe contributed more to editing.

Chapter	Primary Author	Primary Editor
Abstract	Billy Cross	All
Executive Summary	Billy Cross	Billy Cross, Evan Hatton
Authorship	Ryan Stebe	Ryan Stebe
Introduction	Billy Cross	All
Literature Review	All	All
Methods	All	Evan Hatton
Findings	All	Dyllan Cole
Conclusions and Recommendations	Dyllan Cole	Dyllan Cole, Billy Cross, Ryan Stebe

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Introduction

Increasingly, museums are using interactive exhibits to engage their audiences and foster learning among visitors with different experiences and learning styles. Interactivity is especially important in online exhibits where visitor attention is very difficult to maintain. Interactive exhibits, however, present many challenges that are simply not present in the design of standard exhibits. In particular, "visitors routinely ignore your favorite object … or expend enormous energy using an interactive exhibit in a way that, to you, does not appear to be particularly fruitful" (Hein 1998). Because it is impossible to predict how visitors will use an interactive exhibit, a very open-ended and iterative design approach must be taken to account for the myriad ways that visitors can interact with the exhibit. In particular, the exhibit must be readily accessible to all age groups and assume no prior knowledge regarding its technology; additionally, the exhibit must be designed so that it can be easily extended in the future.

The Nantucket Historical Association (NHA) currently hosts several online exhibits related to whaling. The NHA planned to expand these digital offerings with an interactive map of the voyages that two Nantucket residents, Charles and Susan Veeder, made between 1848 and 1853. In 2019 the NHA published a book titled *A Thousand Leagues of Blue,* which was one of the first detailed accounts of the Veeders' voyages and exploits. The NHA hopes to release an interactive exhibit to tie in with this book, showcasing the voyage of the Veeders aboard their first ship, the whaling vessel *Nauticon*. The map developed in this project shows the route the Veeders took, notable events along the way, and other interesting facets of the journey, such as details of life aboard a whaling ship. The interactive map features the watercolor drawings Susan Veeder made in her journal, excerpts from the ship logs, and images of other artifacts of interest from the NHA collections.

Our overarching goal in creating this interactive whaling map was to provide the Nantucket Historical Association with an interactive online exhibit that allows users to discover Charles & Susan Veeder's journeys on the whaling ship Nauticon. To that end, we identified three core objectives that delineate the required work:

1. Identifying design criteria for the interactive based on the NHA's requirements

2. Creating a testable prototype, to be refined through feedback
3. Finalizing the digital interactive while planning for future modifications and maintenance

We used Susan Veeder's journal as the primary sources for our interactive exhibit. We gathered feedback from NHA staff and consultants on the content and design of the exhibit, in order to ensure that it is fun, informative, and easy to use. Through this research and feedback, we developed a quality interactive digital exhibit that we hope will enhance the NHA's visitor experience.

Literature Review

The NHA's Approach to Attracting Visitors

The Nantucket Historical Society's mission is to preserve Nantucket's History. To do this, the society aims to provide a high-quality visitor experience through a combination of exhibits. The NHA originally only used physical exhibits in its initial historic properties and the Whaling Museum on its founding in 1930 (History of the Whaling Museum). The NHA continues to offer tours of its historic properties and display its collection of artifacts in the Whaling Museum but has also begun to expand its exhibits on the digital front. Moving towards more digital exhibits will allow the NHA to appeal to a much wider user base than just those visitors who can come to the island and visit their exhibits in person.

History of Interactive Exhibits

Museums have been collecting and preserving significant historical artifacts for centuries, however the way in which they display them to their visitors has changed drastically over the last few decades. Until the late 20th century, most museum exhibits were static displays of artifacts chosen by a curator and interpreted through text panels. "Since the 1970s and 1980s museums have increasingly included interactive exhibits to enhance visitors' experiences" (Stillwell, 2017). The switch away from the static, curated displays can be attributed to findings from visitor research that demonstrate interactive exhibits enhance engagement, learning, and visitor experience (Hawkey, 2004). Authors Adams and Moussouri describe a study in which visitors to museums were interviewed about their thoughts on interactive and non-interactive parts of museums; they found that many visitors viewed interactive exhibits as, among many qualities, exciting, enjoyable, and more educational, while non-interactive exhibits were considered uninteresting and passive (Adams &, Moussouri 2002).

Some challenges introduced by the switch from static to interactive exhibits are that not all interactives are created equally. For example, a basic question and answer with a pull up cover will not induce the same learning experience that a large touchscreen interface might (Hornecker 2006). This can be problematic for those museums that do not have the resources to

purchase an expensive touchscreen and all of the maintenance costs that go along with it, forcing them into a decision to use a lesser learning option.

Recently with the further availability of mobile computing, museums have been able to expand their reach by putting information on websites and apps. These online exhibits are not only a good way to advertise what is in store for visitors but can be used as a stand-alone learning tool. In fact, a study by Cheng-Wei Fan shows that learning often stops after a visitor leaves the museum. By employing online exhibits, visitors can instead continue to learn from the museum even when not in the museum itself (Fan, 2020). While exhibits at museums are very good at teaching those who go to see them with the very brief time spent at them it is difficult to retain all of the information that is being displayed, an online supplement furthers the retention of the information. Additionally, writers Parry and Arbach describe a form of "constructivist" learning facilitated by online museum environments, where users can learn at their own pace with a wide variety of entry points and paths (Parry & Arbach 2007). This shows another further benefit of the online approach for museums, as allowing learners to take their own path makes the museum's content more engaging by giving them options to work with.

Interactive Digital Exhibit Design

There is a wealth of knowledge on traditional museum exhibit design, but designing interactive digital exhibits comes with challenges that physical exhibits do not. Interactive digital exhibits are two degrees removed from traditional museum exhibits, which are both non-interactive and physical. As written by Wang-Shen (2013), the key problem in designing digital exhibits is in determining an accurate way to mirror the experience in a real exhibit so as to obtain a number of desirable qualities: usability, immersion, interactivity, and novelty, among others. As per Hein (1998), the interactivity factor is also key in information retention, especially among children; Hein argues that due to the interactive nature of the learning process in children, well-designed interactive exhibits are a highly effective way to convey information.

These goals are very similar to the goals of a physical interactive exhibit, and so many of the lessons learned from the design of in-person interactive exhibits are applicable; as written by Sandifer (2003) the key attributes to consider in an interactive exhibit are technological novelty and open-endedness. Achieving technological novelty can be difficult, as it requires coming up

with an approach that integrates cutting-edge technology with creative methods of presenting information while still being intuitive. Open-endedness, on the other hand, is much less difficult to attain. The NHA's current *Edward Cary* exhibit demonstrates a certain degree of open-endedness simply by virtue of allowing the user to pick and choose which videos to watch. Both are worth pursuing when designing an interactive exhibit, however, as according to Sandifer (2003) open-endedness and technological novelty respectively account for 33% and 38% of user holding time in an interactive exhibit.

Keeping the clear differences between traditional exhibits and digital interactives in mind, there are still lessons from the literature on traditional museum exhibit design that are applicable to designing interactive digital exhibits. According to Parman (2010), the key aspect in designing museum exhibits is romance. This may initially seem like an unusual quality for a museum exhibit, Parman argues that in order to truly get a rewarding experience out of a museum exhibit the visitor must fall in love with the subject matter; thus, in order to give the viewer a rewarding and educational experience the exhibit designer must first assure that the exhibit is appealing and exciting enough to draw the visitor in and make them want to learn more. Parman compares this to falling in love with a person and wanting to learn everything about them, with the understanding being that the visitor may feel the same sense of intense curiosity when they fall in love with the exhibit. Though there are unique challenges in drawing virtual visitors into a digital exhibit, by following Sandifer's guidelines on how to get the attention of users interacting with a virtual exhibit the same response can likely be elicited. Black (2005) broadly agrees with Parman's conclusions, and further notes that the exhibit must be positioned not only so that it is enjoyable to the visitor, but also so that the visitor feels it is a good use of their time both before and after interacting with the exhibit; Black argues that the feeling of the visitor being satisfied with spending their time viewing the exhibit is a key aspect in building an engaging museum.

Continuing on with the useful lessons from traditional exhibit design, Parman (2010) references three key initial components of an exhibit: the mission statement, storyline, and take-home messages. The mission statement refers to the initial goal of the exhibit, a general overview of what it or the museum it is part of seeks to accomplish. The storyline refers to simply the story the exhibit tells the viewer. Take-home messages are the information and other

parts of the exhibit that the visitor will remember most after leaving it. Taking Parman's lessons on exhibit design into account assists us on the learning front as well; as per Falk and Dierking (2000), the emotional factor is highly relevant to learning. Falk and Dierking argue, based on well-established prior research on memory formation and retention, that if a visitor finds joy in interacting with an exhibit they are far more likely to remember their experience than if they thought of the exhibit as mundane. Since human learning is highly dependent on the simple fact of whether someone finds something to be engaging and emotionally satisfying, we must strive for engagement first and foremost when we are considering how to design an educational exhibit. Returning to Parman (2010), we can achieve this level of engagement with the narrative portion of the exhibit that Parman's work describes; with a strong, clear narrative, visitors will be drawn in and remain engaged with the exhibit.

This engagement with exhibits can be generated not only with entirely new digital exhibits, but also with adaptations of existing physical exhibits. The New Bedford Whaling Museum has one such example, a digital version of their iconic "Grand Panorama" exhibit (Figure 1). The original Grand Panorama is a massive art piece depicting a voyage of a whaling ship, which was mounted on mechanical spools and would scroll across allowing visitors to view its entire surface in motion. The original panorama eventually began to suffer wear and tear, so the museum created a digital version of the exhibit available on their website. Besides just displaying pictures of the panorama, the digital exhibit also includes maps of the locations depicted on the panorama and extensive background information for the locations and events detailed ("Digital Grand Panorama", n.d.). As such, this is a prime example of why museums move to digital exhibits, as the New Bedford Whaling museum not only made a digital version to avoid further wear and tear on the original, but also took advantage of the digital medium to make the exhibit more engaging by adding new functionality.

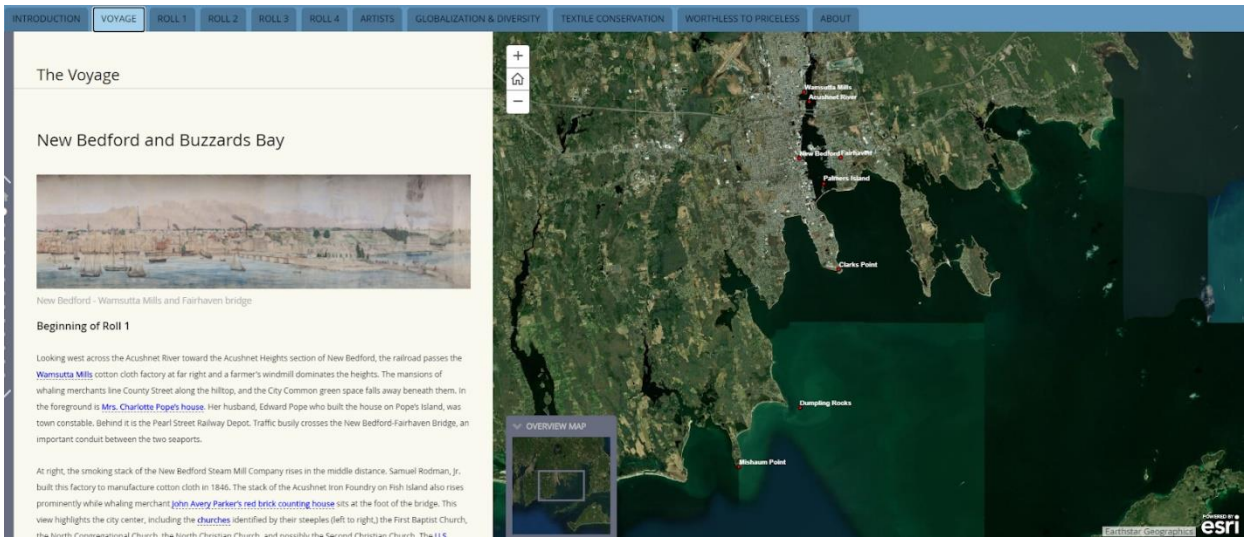

Figure 1. The Digital Grand Panorama at the New Bedford Whaling Museum.

When creating our interactive map, we will need to keep all of this information in mind in order to cultivate the best user experience. This experience should be enjoyable as stated by Parman, Falk, and Dierking in order to foster a learning environment. Further, in keeping with Parman's other findings, we must design our exhibit based on a clear mission statement and with a coherent narrative that draws users in and leaves them with lasting information that they will take home with them after leaving the exhibit. Finally, in order to keep the users engaged we must keep in mind Sandifer's findings, which determined that exhibits are more attractive when they are both open ended and novel. However, being technically novel means that the exhibit is inherently unlike other exhibits users have interacted with, thus making it difficult for the user to understand and use it. As a result, we need to balance novelty against efficient and user-friendly interface design.

Current Digital NHA Exhibits

The Nantucket Historical Society hosts a number of their own digital exhibits on their website at present, although the majority of their digital exhibits are only accessible in person at the whaling museum. Historically, the NHA has not prioritized web-based exhibits. Though there are highly interactive exhibits in the museum, their current web-based exhibits are largely static, with the goal of examining parts of their collection through text and images. The exhibits cover a wide range of subject matter, from an 1845 petition to integrate Nantucket's schools to a page on the Nantucket art colony, a collaborative exhibition that the NHA held in 2007. In the

petition exhibit, for example, the viewer can read a brief summary regarding the petition then see the NHA's digitized images of the original document. There is no variation in how users experience the petition exhibit, however; every user sees the same content in the same order.

In contrast to the other largely static digital exhibits, the Whaling Museum exhibit on the "The Whaleship *Edward Cary"* stands out for its relative interactivity; it provides a number of videos on the *Edward Cary*'s many voyages that the user can pick from by selecting one of 10 buttons at will (The Whaleship Edward Carey). This allows for a more free-form experience for the visitor to the digital museum, as not every experience with the exhibit is the same. By allowing for the users to pick and choose what information they want to see, a somewhat unique experience for every visitor is formed. Our project aims to build on this idea and create an interactive display that documents the movements and routes of whaleships as well as how they operate, but with an even more free-form experience than the *Edward Cary* exhibit.

Figure 2. Buttons for video selection in *Edward Cary* exhibit

Another aspect of the *Edward Cary* exhibit that is somewhat problematic is in how the way it was made makes it difficult to extend. Mary and Al Novissimo collated data on the voyages of the *Edward Cary* from the available sources then manually created videos on the ship in Adobe AfterEffects. The result is an appealing product that highlights some of the most interesting aspects of the *Edward Cary*'s journey. Unfortunately, the exhibit is not extensible -- there is little room for future additions. If the NHA were to choose to make another exhibit about a different whaling vessel, it would not be easy to build on the *Edward Cary* exhibit since it was created manually by integrating separately created videos. Because of this, any future exhibit on

a separate ship done in the same style would not be able to automate the production of videos to be displayed.

The NHA also has an existing logbook interactive on display in a physical museum kiosk that details the voyages of various whaling vessels during Nantucket's whaling trade as part of their Stove By A Whale exhibit (Figure 3). As demonstrated to us by Mary and Al Novissimo (personal communication, 9/17/2020), the exhibit allows users to pick one vessel and then explore a map marked with points indicating major events during the vessel's journey. Users can select each of these events to see more detail about what happened, including excerpts from the ship's log detailing the event. The excerpts from the ship's log are one of the more notable parts of the exhibit, as they include both a shot of the original text from the logbook and a translation alongside to enhance the user experience. Additionally, the descriptions of events are not just plain text; they feature rich content including many images. As aforementioned, there are other digital exhibits in the whaling museum, such as an exploration of petitions for and against integrating the Nantucket public schools, but the Stove By A Whale exhibit is the most relevant to our work.

In addition to the existing NHA interactives that we can draw inspiration from, the NHA has laid out their digital interactive development process in detail. First, they start with either an interesting story they want to tell or an educational goal, then they consider what content they want to cover in the exhibit, and finally they build the exhibit around that content (The Case for Technology-Based Interactive Exhibits, 2019). Though we have previously noted that technological novelty is important to visitor attention retainment, the NHA does not wish for the technology in their interactives to distract from the story that is being told; to that end, we must carefully consider how not to overwhelm the visitor such that their focus is on the technological logistics of the exhibit instead of the story. There is, however, still a balance to be found where our exhibit has sufficient technological novelty to hold the attention of visitors but not so much as to distract from the content. In order to find this balance, user feedback will likely be immensely helpful.

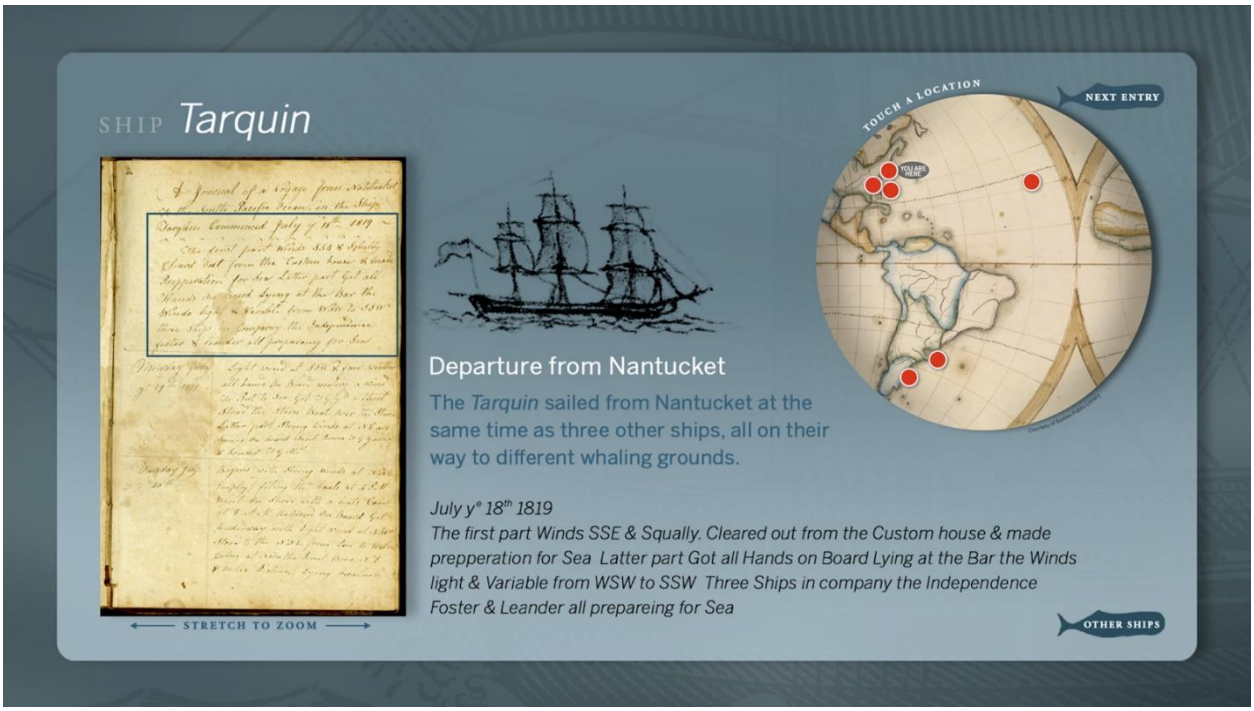

Figure 3. Logbook page view from Stove By A Whale exhibit

The Voyages of Charles and Susan Veeder

Building on the lessons learned in developing the Edward Cary and Stove By A Whale exhibits, the NHA has tasked us with adapting Betsy Tyler's *A Thousand Leagues of Blue* into an interactive online digital exhibit that details the pacific whaling voyages of Nantucket island residents Charles and Susan Veeder. The Veeders went on two significant whaling voyages throughout the mid-1800s. The first was aboard the *Nauticon* with the Veeders as a family, while the last was Charles Veeder's solo expedition aboard the *William Gifford,* as he left Nantucket after its whaling industry crashed (Tyler, 2019). Notably, *A Thousand Leagues of Blue* is the first definitive account of the Veeders' exploits and is extensively researched from historical documents such as logs and Susan Veeder's journals. The journals detail the voyages of the Veeders' journeys and are unique for their watercolor drawings of the locales they passed (Tyler, 2019, Veeder, 1852).

Figure 4. Example of Susan Veeder's watercolor work

Conclusion

Our proposed project ties in with *A Thousand Leagues of Blue* by adapting information from the book and its historical sources to create a digital map of the story of the Veeders for the Whaling Museum, tracing the routes they sailed and the events along the way. Because the Veeder's voyages were so obscure before the publication of *A Thousand Leagues of Blue,* our project will help to bring their story to new visitors who did not know of them. Additionally, since our exhibit will be freely available on the internet it has the potential to reach an even broader audience than *A Thousand Leagues of Blue*.

Our proposed project follows the components of story, mission statement, and take-home messages discussed earlier when addressing the development and design of interactive exhibits. The story in this exhibit is, of course, the story of the Veeders' voyages, with a specific focus on their time on the ship *Nauticon.* We will interpret this story through a map of the locales they visited, as well as enrich that story through the inclusion of Susan Veeder's watercolors.

The mission statement of the exhibit is the same as that of the NHA: to preserve and interpret the history of Nantucket. Finally, since the Veeders' voyages were so obscure, we want more visitors to learn about them and remember their story.

Methods

Introduction

Our goal was to provide the Nantucket Historical Association with an interactive online exhibit that allows users to discover Charles & Susan Veeder's journeys on the whaling ship *Nauticon*; to that end, we identified three core objectives that delineated the required work;

- identifying design criteria for the interactive;
- creating a testable prototype, to be refined through user feedback;
- finalizing the digital interactive while planning for future modifications and maintenance.

The bulk of the actual implementation work happened as part of our second objective, with the other two objectives being largely supporting work; that is not to say, however, that the first and third objectives were any less important than the second. In fact, the third objective was the most important in that the NHA cares deeply about having an exhibit that can be maintained and extended easily in the future.

In Figure 5., we provide an outline of the chronological progression of our objectives. This was not a concrete representation of when tasks began, as it can be quite difficult to estimate how long software projects will take. In particular, the second and third objectives blended together somewhat; after all, we needed to keep extensibility and maintainability in mind while we were implementing the exhibit. The order in which the tasks are placed is accurate however, though the time it took us to complete them varied.

Figure 5. Planned progression of project objectives by week

Objective 1: Design Criteria

Storyboarding

Our exhibit details one 4-year journey of the Veeders aboard the *Nauticon* through events that happened along the voyage. We made a storyboard for the journey to make sure it told a coherent and interesting story, was educational, and that it meshed with the NHA's goals. We accomplished this by writing out the events we wanted to highlight for that journey in the order they took place, and using that outline to determine if the chosen events told an engaging story. Since we were creating a visual exhibit, we needed to focus heavily on our user interface design. To assist with this, we made user experience storyboards by visually detailing the design for our interface, and how the user would navigate it. We discussed our possible designs as a group, and then used Adobe XD to make a mockup based on our initial designs. This further allowed us to solidify the design for our interface early, meaning that building our program entailed simply translating that design into the program instead of having to work out the details of the visuals along the way.

Additionally, our sponsor sent us the map we used as a backdrop on which to display the Veeders' voyages, which we used in our user interface mockups. The goal that we established together with the NHA's contractors, Mary and Al Novissimo, was to design an exhibit primarily around a large interactive map, unlike the existing digital NHA exhibits. As such, it was imperative for us to choose a sufficiently detailed and visually pleasing map to allow for high resolution at various zoom levels. Throughout our storyboarding process, we worked to design a user experience that showed as much useful information as possible while still maintaining the focus on the map, and not overwhelming users. We aimed for the exhibit to never completely switch away from the map or obscure it, but rather to always present information in a manner which was consistently centered around the map itself.

Log / Journal Data Intake

The data for the interactive came from one core source: Susan Veeder's Journal. From this main source we needed to compile all data into a usable format. This began by reading through the journal and placing all of the events detailed into a spreadsheet for us to easily sift through. For each event, we listed the original journal entry and a shortened summary for longer

entries, as well as a list of images and other related sources for each entry. After we catalogued the events, we picked out the 40 events we thought were the most interesting and conferred with NHA staff to ensure that they were relevant and interesting. Additionally, we worked with the NHA to find other materials such as photos from the NHA archives that we could tie the events of the Veeders' voyages back to. Once we decided which events we wanted to include, we pulled the relevant data points out of our compiled list. From this, we reformatted these data into a JSON file so that our program could parse and use it as necessary. Additionally, to more easily map out the Veeders' journey, we compiled all of the latitude and longitude coordinates that Susan included in her journal into their own JSON, estimating and interpolating coordinates where there was no data initially.

Web Framework Selection

In our discussions with Mary and Al Novissimo, we decided that, to make our program more accessible to a wider audience, we would be making a web-based application hosted on the NHA website. Traditionally, we would also select a web framework to use to develop our exhibit, but we feel that would be an unwise option due to our lack of web design experience. Large frameworks, such as Bootstrap or React, can take a long time to learn on top of three of our group members having to learn HTML, CSS, and JavaScript; this would have occupied an inordinate amount of our time and as a result we stayed away from a large web framework. Additionally, since future maintainability and extensibility was of serious concern to our sponsor, vanilla HTML/CSS/JS was our best choice. We did, however, use a library for Material Design on the web called Materialize, which is free and open source and provides ready to go web implementations of Material Design components. We had experience with the Material Design philosophy from the software engineering course that three of us had taken, so we chose to go down the same route for this project.

Objective 2: Prototyping, Testing, and Feedback

Exhibit Prototype

Once a general user interface was designed and we chose the best tools to complete the application we began designing the software to best fit the necessary design criteria. With this first software design we began to code and produce our first prototype. We used a program

developed by JetBrains called WebStrom as our IDE (integrated development environment). This IDE was chosen because it is easy to integrate with Git and Github, the source control platforms we chose to use, as well as having fairly good autocomplete functionality, which significantly sped up our development. With this first prototype we looked for feedback from the NHA and the public. We then used this feedback to improve what has already been developed and used it when implementing new parts of the program. This process was repeated until the application was complete.

Testing & Feedback Solicitation

As we iterated on our prototypes, we planned to send them out for users to test. This process would have included sending a survey to the tester to be filled out after they have used the interactive. Ideally, we wanted to create a pool of testers representative of visitors to the whaling museum and/or those with knowledge of the whaling museum. Due to current circumstances, however, collecting feedback from visitors to the museum was not possible; to this end, the most obvious demographic we solicited feedback from were employees of the NHA. We would have also added NHA members to our pool of testers as the members were more representative of the average museum visitor than the NHA employees and we wanted to get a visitor's perspective, however due to the time constraints involved with the project we were unable to reach this step. We recognized that the age of testers would likely have an impact on their feedback but also did not expect to have a significant enough pool of testers to stratify by age. Additionally, we would have avoided individuals under the age of 13 in our testing / feedback solicitation so that we could steer clear of the restrictions imposed by the Children's Online Privacy Protection Act (COPPA), as the NHA agreed that young children were not a core part of the target audience for our exhibit.

Given the time to do so we would have given the testers identified above access to the exhibit without priming them in any way so that we could get unbiased feedback on its usability. See Appendix A for a draft of the preamble that we would have provided to testers. No time limit would be imposed, only an estimate of overall time to interact with the exhibit and complete the survey, as we wanted the experience to mimic that of an in-person interaction with an interactive exhibit as closely as possible. Once they took the time to explore the exhibit and completed all of their tasks, we would have asked them for feedback through Google Surveys regarding the

design and general usability, and additionally took any open-ended feedback that they would be willing to provide. Appendix B contains the questions that we would have asked. All feedback would be collected anonymously. This user feedback would have been used to inform later revisions to the overarching design and functionality of the exhibit. Feedback would have been collected more than once; after significant changes to the exhibit we would through the process again, with the same participants to gauge whether or not the exhibit is being improved by our further iterations.

Instead of the process above we had weekly meetings with Mary and Al Novissimo, occasionally joined by James Russel and Amelia Holmes, where we received feedback on our progress for the week by demoing the map's functionality. We then took this feedback and created a list of items that needed work for the following week. This process was repeated until we reached the conclusion of the project. The NHA decided to take control of the formal testing and user feedback process, and thus had us include an NHA feedback email in the map for users to send comments directly to the NHA.

Objective 3: Finalize

Deliverables and Maintenance

Over the course of our project, we presented prototypes of the exhibit to the NHA. Our final deliverable was the finished exhibit that the NHA displays on their website as well as detailed documentation of the program to allow for further development and extension by the NHA, as their needs change. The documentation included both the technical details of the exhibit's implementation and a guide to all the user-facing features. We aimed to document the exhibit to a sufficiently high standard so as to allow the NHA's digital exhibit contractors, Mary and Al Novissimo, to be able to easily extend it in any manner which the NHA may require in the future. Additionally, the documentation included detailed notes on our processes for taking in data on the ship's position and events so that more position / event data can be easily added without any changes to the programming of the exhibit.

Findings

Introduction

Our project work was divided into three phases, starting with data collection & design mockups, leading into development, and finishing with the production of our deliverables. In our data collection and design phase, we mocked up what we wanted the exhibit's user interface to look like then began gathering events to populate the actual content of our exhibit. In our development phase, we went through an iterative development process, which was somewhat convoluted at times, in which we implemented features, got feedback on said features, then tweaked the exhibit accordingly. Finally, we produced deliverables to hand off to the NHA both in the form of the actual website to publish and supplementary materials to maintain and expand on the exhibit for the future.

Design Mockups

Our first step in designing the exhibit was to mockup some initial design concepts. Each group member created a basic mockup of what they wanted the exhibit to look like, as shown in Figures 6 - 9. We did not collaborate or discuss these concepts with each other at this stage, as we wanted to generate a diverse set of ideas from which to develop our final mockup. These mockups were created using a variety of tools: Dyllan and Ryan used Google Drawings, Evan used Adobe XD, and Billy used paper.

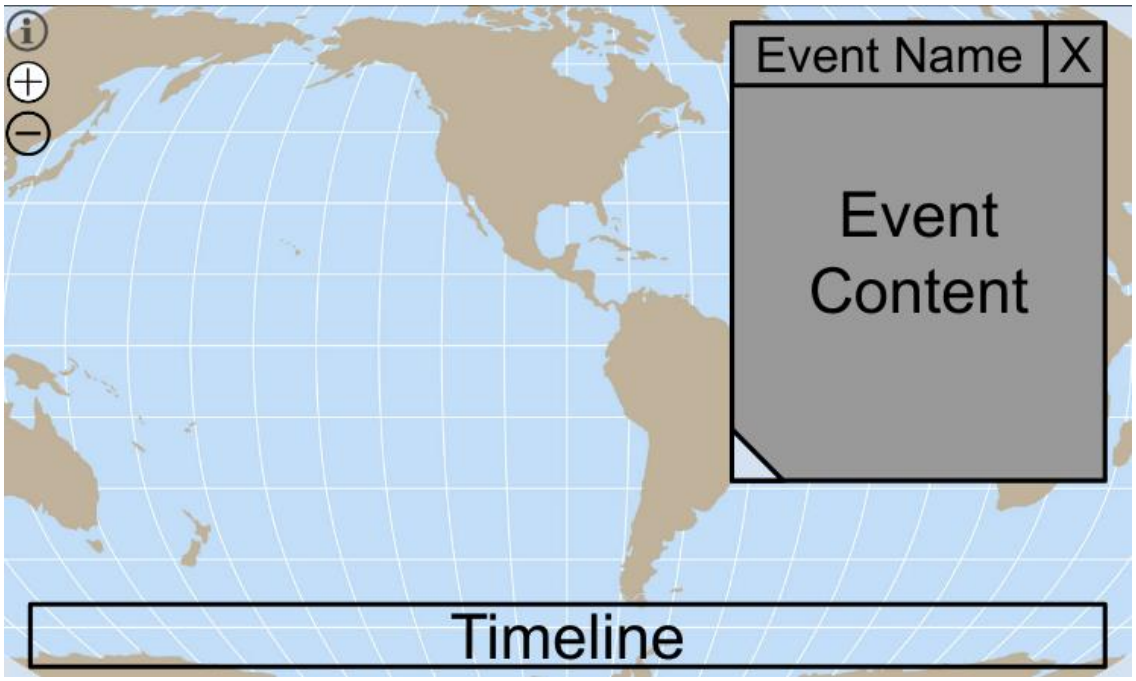

Figure 6. Dyllan's initial mockup

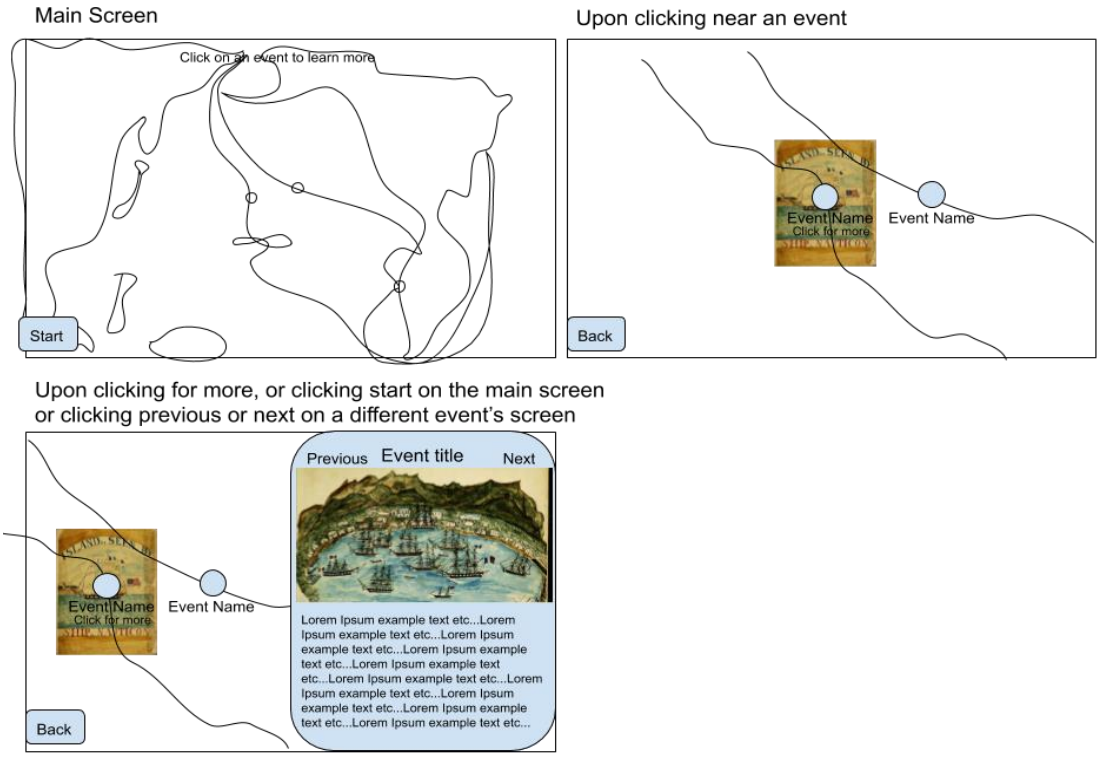

Figure 7. Ryan's initial mockup

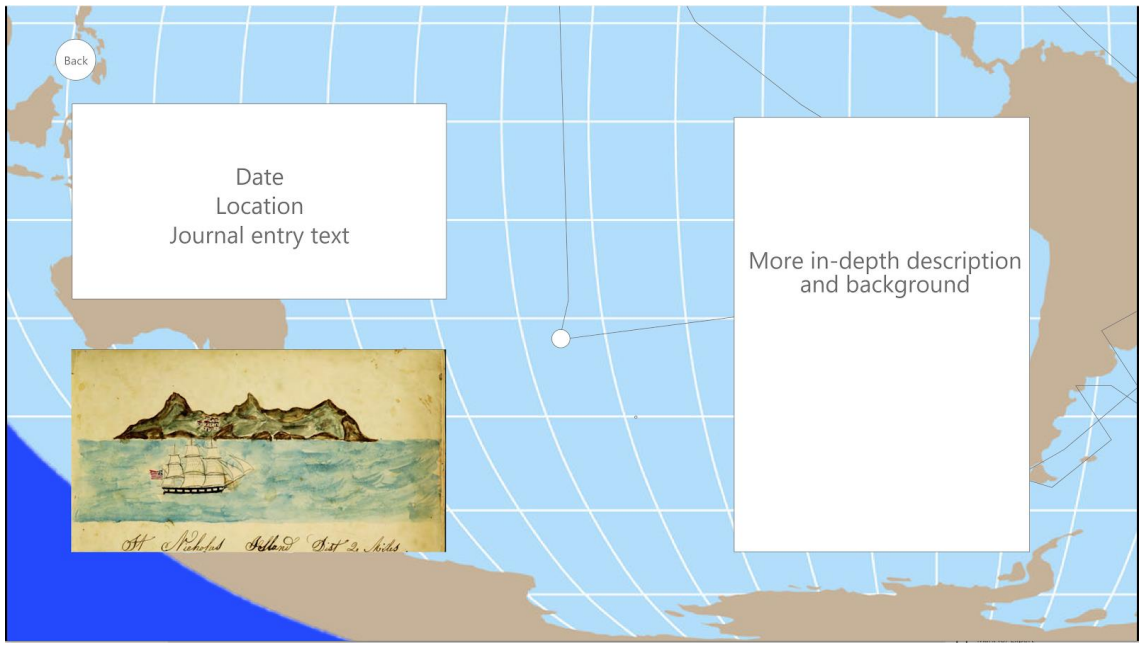

Figure 8. Evan's initial mockup

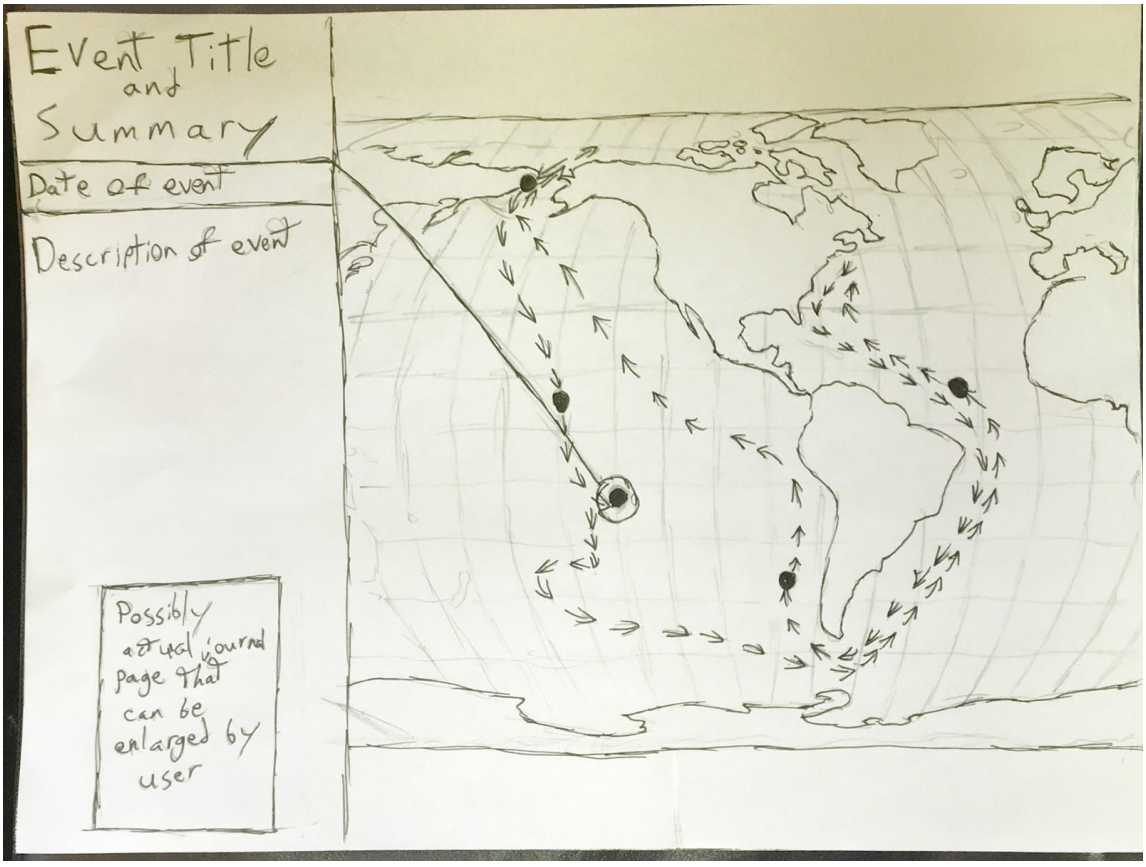

Figure 9. Billy's initial mockup

Once we had completed these separate mockups, we convened the first of our collaborative design meetings. Each person shared their mockup and discussed their broad ideas. Collectively, we discussed what we thought of each other's mockups and noted what we felt were some of the features from the individual mockups that we wished to incorporate into our final mockup. Over the course of our next four meetings, we collaboratively built the final mockups. Dyllan and Evan switched off using Adobe XD while sharing their screen for the others to see and comment on. We used Google's Material Design component library for Adobe XD and attempted to follow Google's Material Design guidelines. The end result of this process is shown in Figures 10 through 12.

Figure 10. Mockup of the introduction screen

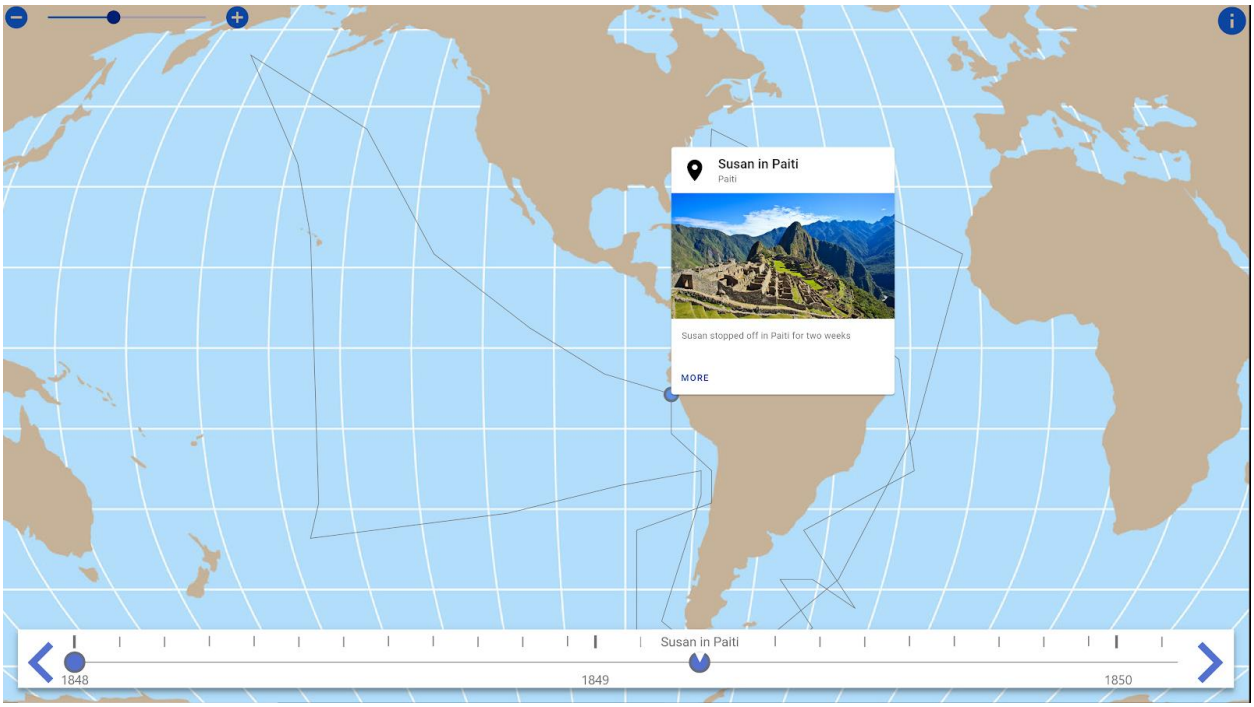

Figure 11. Mockup of the main view of the map

Figure 12. Mockup of the main event view

We included the timeline from Dyllan's design as it allowed the user to navigate easily in chronological order, and clearly demonstrated the amount of time passing between events. Also,

we used an event popup laid out in a similar manner to that of Billy and Ryan's designs. From these original designs we then edited them to fit a mobile device, as can be seen in Figures 13 through 15. We did this by first removing all user interface elements that made the map more cluttered on a smaller screen such as the timeline and enlarging graphics to make them readable.

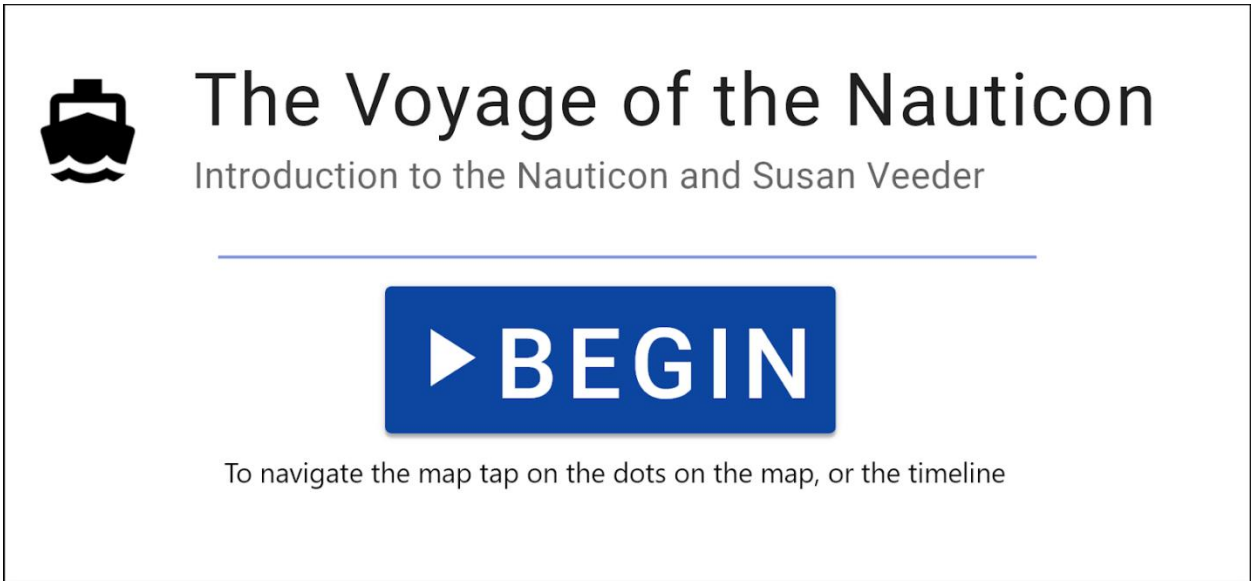

Figure 13. Mobile mockup of the introduction screen

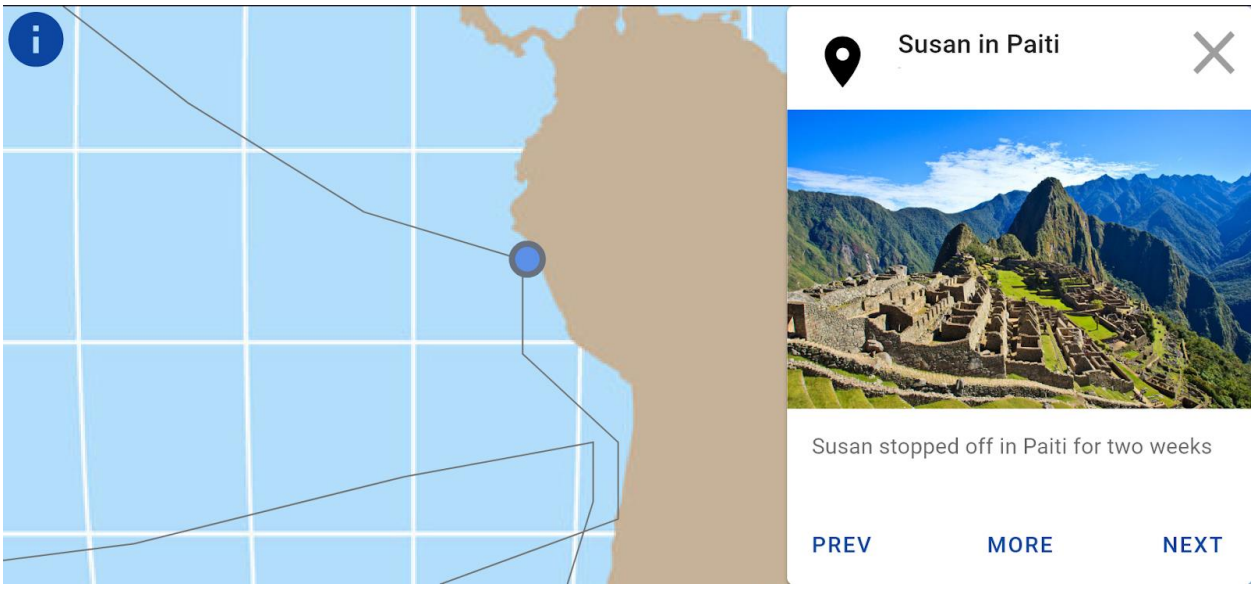

Figure 14. Mobile mockup of the main map view

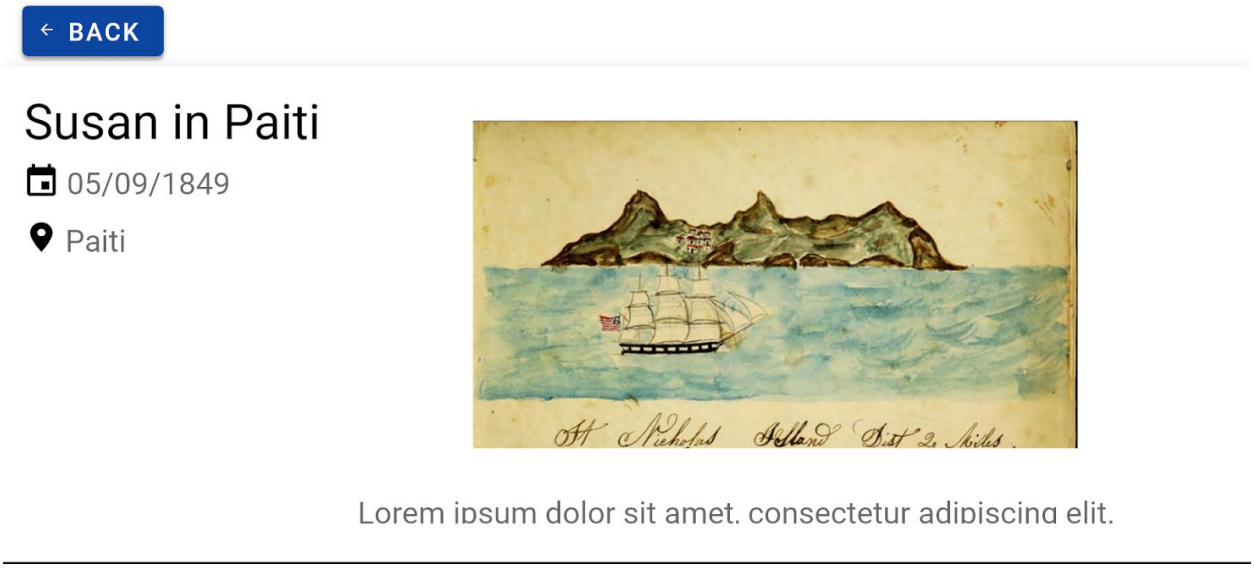

Figure 15. Mobile mockup of the main event view

Content Curation

To determine the events of the *Nauticon*'s journey that we would display in the exhibit, each member of the team identified the ten most interesting events from the section of the journal that they were responsible for tabulating into a spreadsheet. We focused on events such as the crew's several long stays at ports, as well as other important or interesting events such as the death of the ship's third mate James Roberts, the attempted desertion of two crew members, the Nauticon becoming trapped in the arctic ice. We thought these more dramatic events might pique the interest of users. We also highlighted some of the more mundane events, such as the crew repairing damage to the ship, to demonstrate what life was like aboard a whaling vessel.

Converting from Human Readable to Computer Readable

After we decided on which events we would like to use and tabulated them in a spreadsheet, Evan created a Java program that would convert the spreadsheet into a JSON file that the computer can read. We choose to use a JSON file because one of the main parts of the website is in JavaScript and JSON is the easiest file type for JavaScript to read. We wrote a conversion program because we had already manually copied a large number of journal entries into a spreadsheet and it would take much longer to write an entire JSON file by hand and update it each time we made a change to the event data. This way, we only needed to run the converter

program with an updated version of the spreadsheet. Additionally, this will make it easier for the NHA to amend the exhibit content in the future.

Development

With the completion of our design mockups, our development began in earnest, with all of us setting up our development environments. The exhibit was developed in WebStorm and hosted on a GitHub repository. Additionally, the NHA provided us with a web server that we could periodically upload the latest version of our application to in order to test it. Our workflow was based on GitHub Flow, with a new branch being created for each feature and then merged back into our development branch when complete. In order to assign work, we organized ourselves using Trello. In each of our daily meetings, we made sure that everyone had a task assigned to them and then worked through our assigned tasks separately, while communicating whenever a task was completed.

We used several libraries to aid in development: Materialize, Animate.css, FontAwesome, and Mapbox. Materialize was used for its Material Design components and CSS utility classes, as we had planned from the start to base our design off Material Design. Animate.css was used for its simple CSS animations to make our transitions pleasant to the eyes. FontAwesome was used for its vast library of icons. Finally, Mapbox was used to provide us with a simple and easily customizable map. Initially, we had created our own map system based off a static image and a system to project coordinates onto it. We ran into a several issues with that system and found it visually unpleasing, so we decided to switch to Mapbox relatively late in development.

Maps

As our application is primarily an interactive map, its functionality and its appearance are two of the most important aspects of the project. Throughout the development of the application, the displayed map changed many times in its color, its background color, how it is loaded into the website, and the back-end API used for the map. We began by manually creating our own API for displaying, scrolling, and zooming around the map, and eventually switched to an outsourced, customizable map API called MapBox.

Original Map

From the start the plan was to use the map that was provided to us by the NHA in static image form, which was a Robinson Projection centered on the Pacific, as most of the *Nauticon's* voyage was in the Pacific. With this original map we implemented as many of our main features as we could, for example zooming and panning on the map, the timeline, and an info button. As development progressed, we tweaked the features for better functionality, as can be seen in Figure 16. We ran into a major complication with this map, however. When zoomed inwards, the map and the voyage's path would become very pixelated as can be seen in Figure 17. This was the first major comment we received from the NHA that we needed to address. There are a couple of ways that this could have been resolved, by redrawing the map everytime that it was zoomed in or out in order to keep its sleek appearance, or switch the image an paths to be scalable vector graphics (SVG) which do as their name implies and scale seamlessly when zoomed.

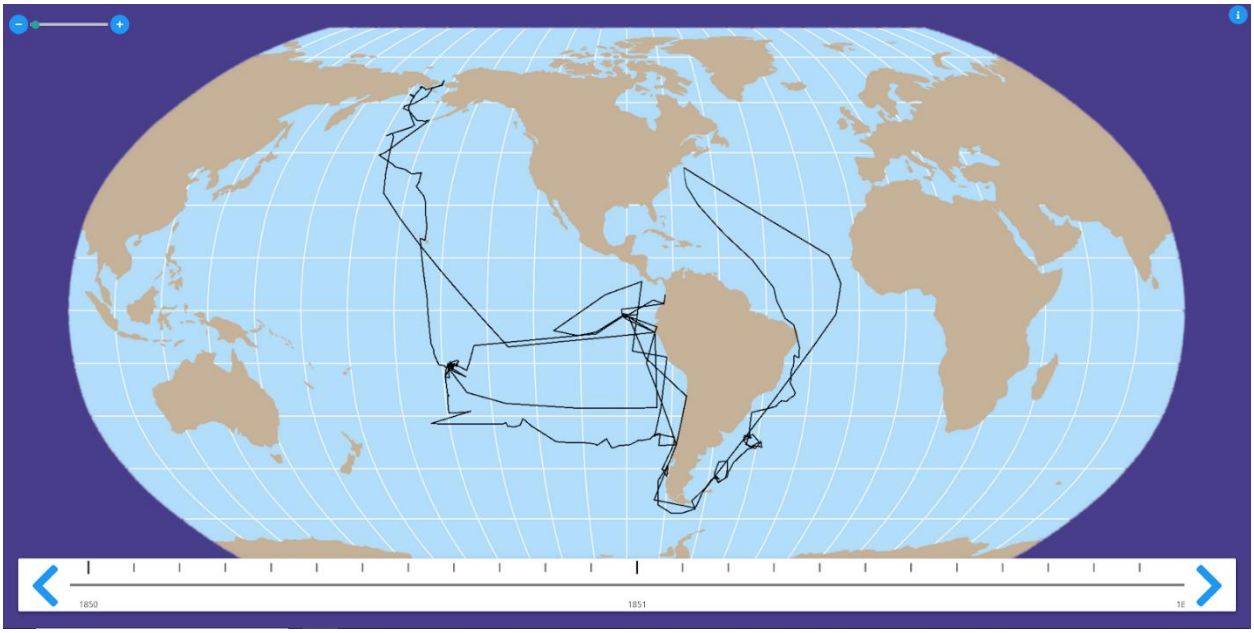

Figure 16. Initial Map with initial path of the *Nauticon*

Figure 17. Pixelation caused by zooming into map

Vector Map

After the original map we transitioned to an SVG version of the same map with a different color scheme. We made this decision knowing that having to redraw the map every time it was zoomed in or out would not only be extremely challenging, but would be potentially taxing on the browser, creating lag and detracting from the user experience. With this in mind, Dyllan went through the steps to convert the map into an SVG file which no longer pixelated when zoomed into as can be seen in Figure 18. In the process of implementing the new SVG map, Dyllan discovered that it was more performant to manually draw the SVG with appropriate transformations on an HTML canvas than to use CSS transformations on an actual SVG element; the reasons for this performance difference was unclear. The end result, however, was a map that actually performed better than the initial raster graphics map, even though it was more technically complicated.

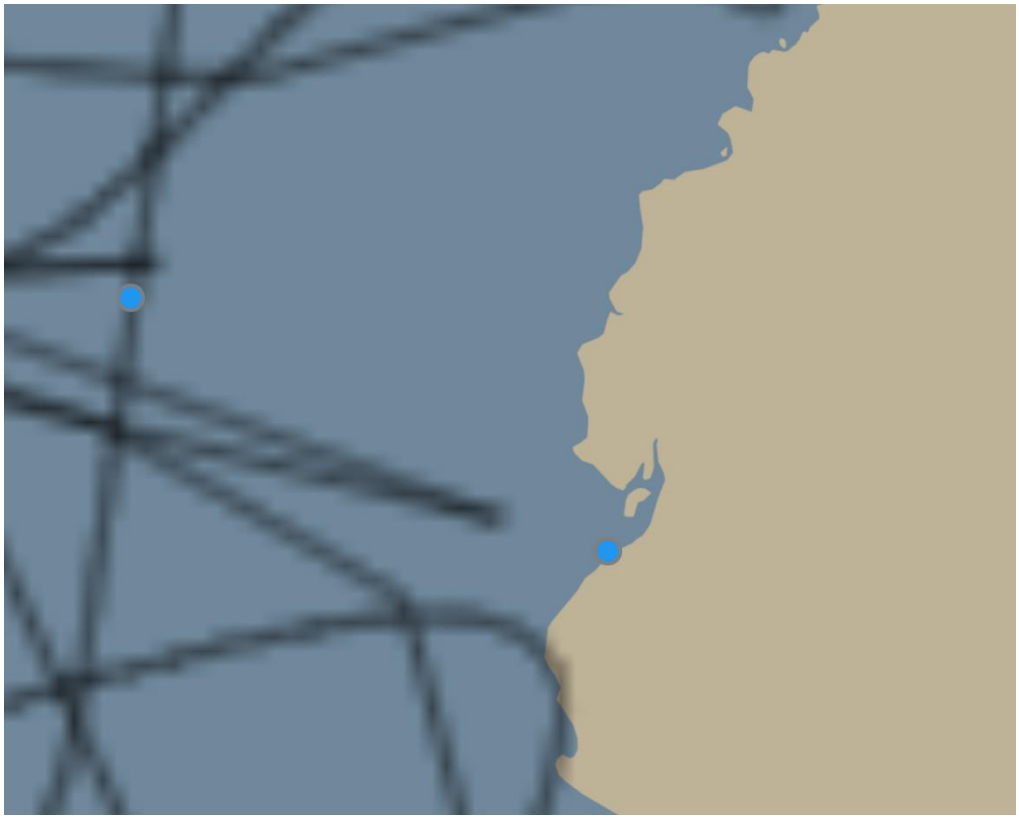

Figure 18. SVG map eliminates pixelation of coastline

By the time that we had implemented the new map we had also made much progress on adding the content to the map, thanks to our use of the version control tool, Git. For example by this time we had already added all of the markers of the events to the map and timeline, and connected them with their respective popups and main event card, as can be seen in Figures 19 and 20. However we had not completely finished the content curation part of our project and left placeholders in for information that was to be added later in development.

Figure 19. Event popup for the ‘Susan in Tumbes’ event

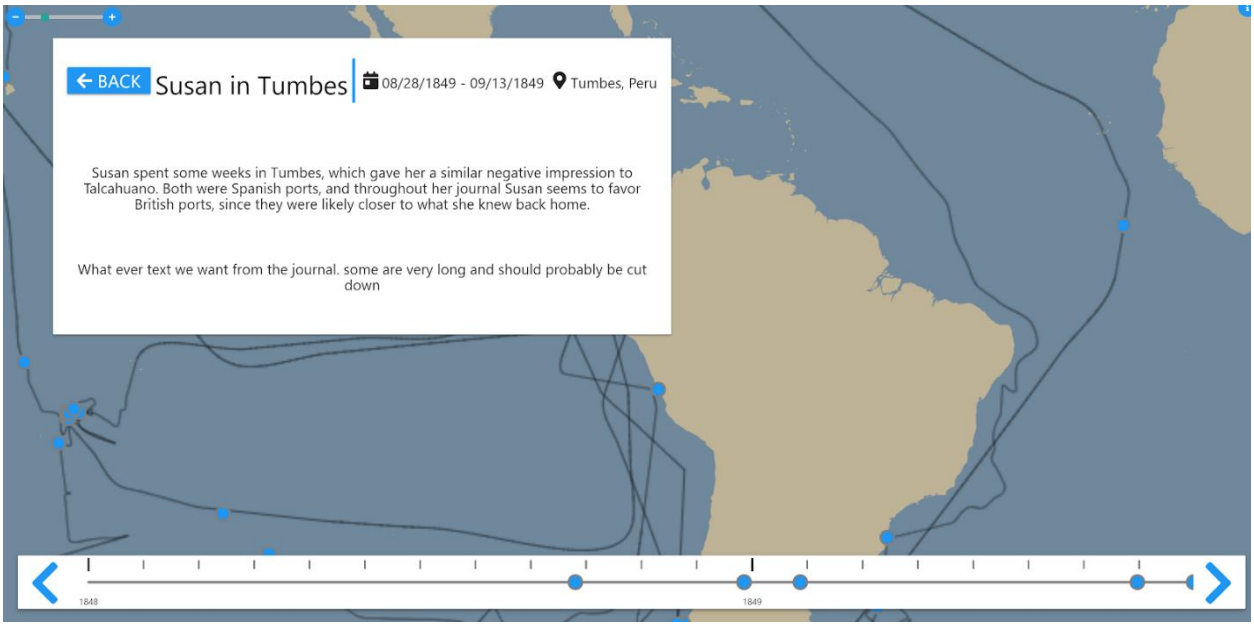

Figure 20. Main event card for the ‘Susan in Tumbes’ event.

While the NHA, Mary, and Al thought that the map was a significant improvement from the original there was still room for improvement in some details, like naming of locations, the path, and topographical details. The solution to many of our issues required a major reworking of our application to incorporate the MapBox API.

Mapbox

The idea we had to accommodate the recommendations above was to use an outside mapping software called Mapbox. The only challenge we had was that if the site was to get enough traffic on a monthly basis there would be a charge to use the API, however when we discussed the possibility with the NHA, they were willing to pay for the use of MapBox, allowing us to make an extremely customizable user friendly map. Mapbox is free to use if the site using it receives less than 50,000 hits per month, and the NHA did not anticipate that they would ever exceed that number of page views per month on this exhibit. Additionally, if they did pass the threshold, they were willing to pay for its continued use. This allowed us to quickly and easily use the API to add new details like the names of coastal cities, changing the color scheme, and zooming in to reveal topographic and bathymetric details, as can be seen in Figures 21 and 22. We also switched from a Robinson to a Mercator Projection, as it is a rectangular projection, so that we could continuously pan left or right.

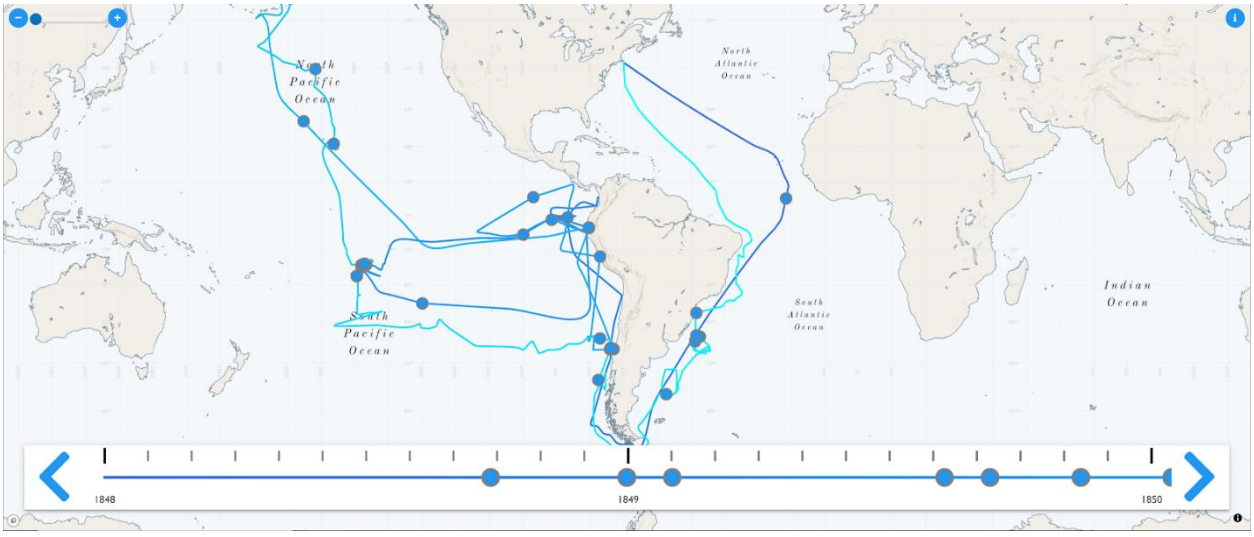

Figure 21. Full view of the Mapbox implementation

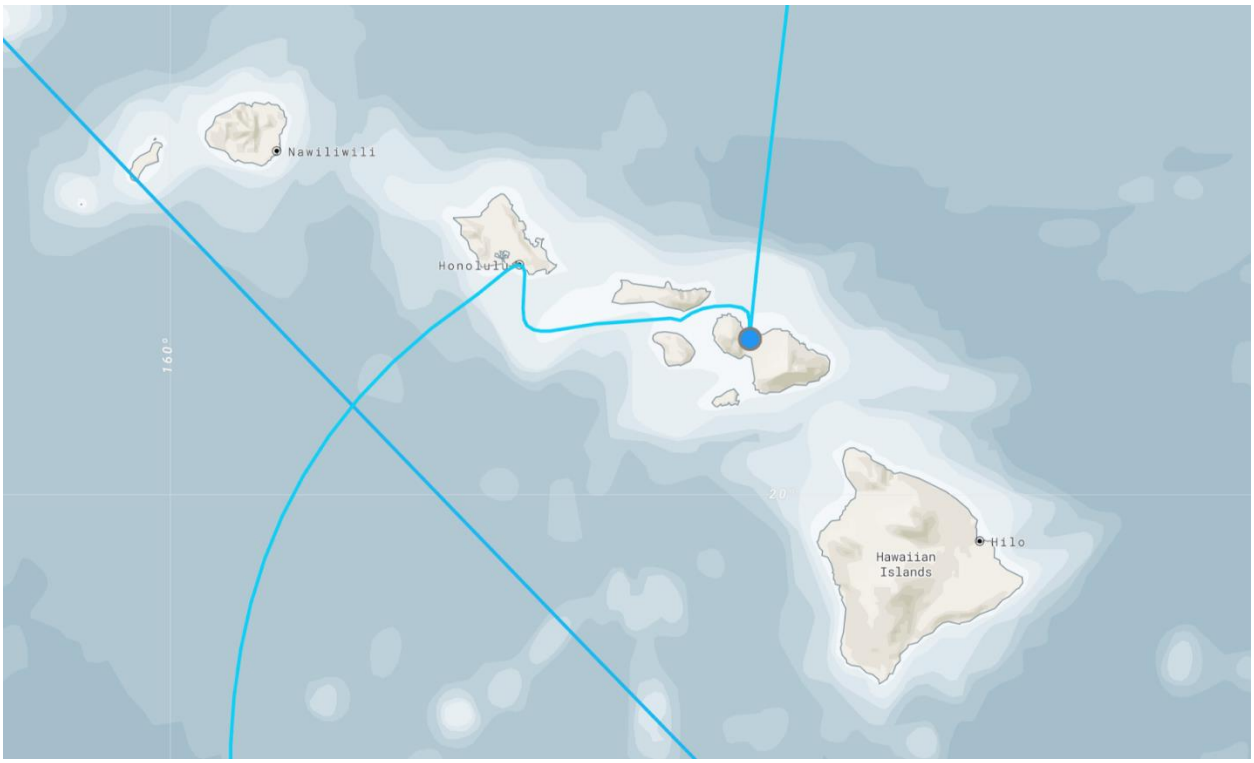

Figure 22. Zooming on Mapbox reveals topographic and bathymetric details

Mapbox allows for custom styles using an online editor, Mapbox Studio, and the style we use is based on an edited default Mapbox style titled *North Star*, with a nautical theme. In order to make the style fit our purposes better, we stripped out most features on the map; buildings, land use markers, roads, train tracks, ferry routes, country labels, country borders, and anything else that would not have been present in the 1840s and 1850s. Mapbox allowed us to do this in a very simple manner, as you can easily enable and disable layers of the map as you see fit, with the layers being based on data that Mapbox themselves provides. The resultant map provides a zooming and panning experience just like Google Maps or other similar applications but only shows terrain contours with elevation shading, bathymetric data, ports, and the names of geographic locations such as islands.

Along with the improved map, Mapbox allowed us to better integrate our event markers and the initial popup for each event. While this initially led to some challenges with formatting the popup into the Mapbox popup it better connected the popup with the marker it is associated with. This means that we did not have to worry about drawing the popup in the correct location with the marker as we had in the past with the SVG map. Instead Mapbox would keep track of

all of the event markers and their location and the team only needed to insert the correct event's information.

The Path

One of the main goals of the project was to display the path the Veeders took on their voyage over the map of the world. We were able to determine most of the path using the latitude and longitude coordinates that Susan Veeder recorded in her journal. However, her journal was not as extensive as an actual ships' log, and as a result we needed to estimate the coordinates we did not have. Initially, we solved this issue using a Java program listed in Appendix C that took our spreadsheet of coordinates and interpolated a straight line of coordinates for the days we did not have data for. We then used another Java program listed in Appendix E to convert the spreadsheet of known and estimated coordinates into a JSON file that our program would read in. We used an HTML canvas object to draw lines on the map between all the coordinates along the voyage. The initial path simply drew straight lines directly between the points, making the path look jagged in many places, so we implemented a function to interpolate curves between the points using Catmull-Rom splines, which took a series of four points at a time and used the two outer points to draw a curve between the two middle points. The Catmull-Rom interpolation made the path much smoother and more visually appealing. Our initial solution worked for the most part, but we did run into some major issues. Since the map was a Robinson projection, we needed to transform the points on the path to match the Robinson projection's distortion and shape, which we did by using a free-use library that would perform the necessary calculations -- though we eventually abandoned this process when we switched to Mapbox, and a Mercator projection. Next, we found that the estimated coordinates did occasionally run into land masses since they were drawn in a direct line between known coordinates, and as such required manual editing to place them in the right locations. Additionally, the HTML canvas was not a high enough resolution, so zooming in too far would make the path look very blurry, as seen previously in Figure 18.

The Mapbox Path

The switch to the Mapbox framework greatly improved the path and fixed many of the issues we were encountering. Mapbox has functions that allow developers to draw lines directly on to the map using a list of coordinates, which made it much easier to draw the path and made

the path much higher resolution. This higher resolution also simplified the process of editing the path, allowing us to easily move the points on the path to correct errors. Additionally, Mapbox's use of the Mercator map projection eliminated the previous need to transform the points to fit on a Robinson projection. Finally, to convey the progression of the journey over time, we implemented a gradient that made the path fade from dark to light blue over its course from setting out from Nantucket to the return 5 years later. The gradient, the higher resolution of mapbox, and the previously mentioned Catmull-Rom interpolation to smooth the curves made the final path substantially more visually appealing (Figure 23).

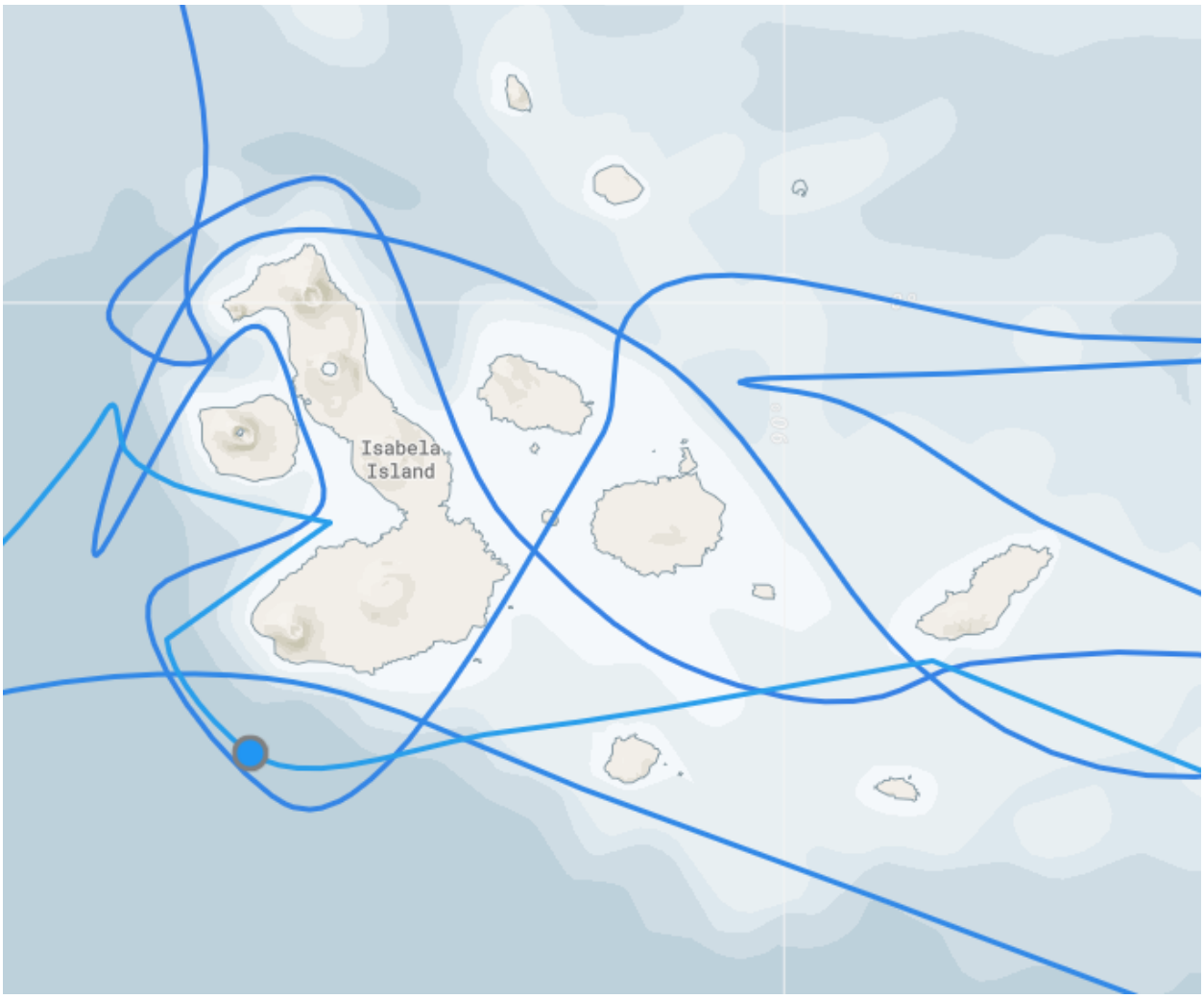

Figure 23: The greater detail allowed by the new path in Mapbox.

Deliverables

Our primary deliverable, of course, was our website that we produced. The final version of our website is shown in Figures 24 through 27. Currently, the website is residing on the NHA's temporary development server, with plans for it to be brought over onto the main NHA website later. Additionally, we provided the NHA with supplemental materials in the form of our helper programs and a user manual. The helper programs, listed in Appendices C, D, and E, were used in the data collection and development process to convert our data into the formats used by our website. The user manual details how the internals of the exhibit work and how they can maintain or expand the exhibit. This manual describes how to add our change events, how to tweak the path, how to add images, and even how to transition the exhibit to be about an entirely different ship if they wish to use the same framework for different Whaleship voyages.

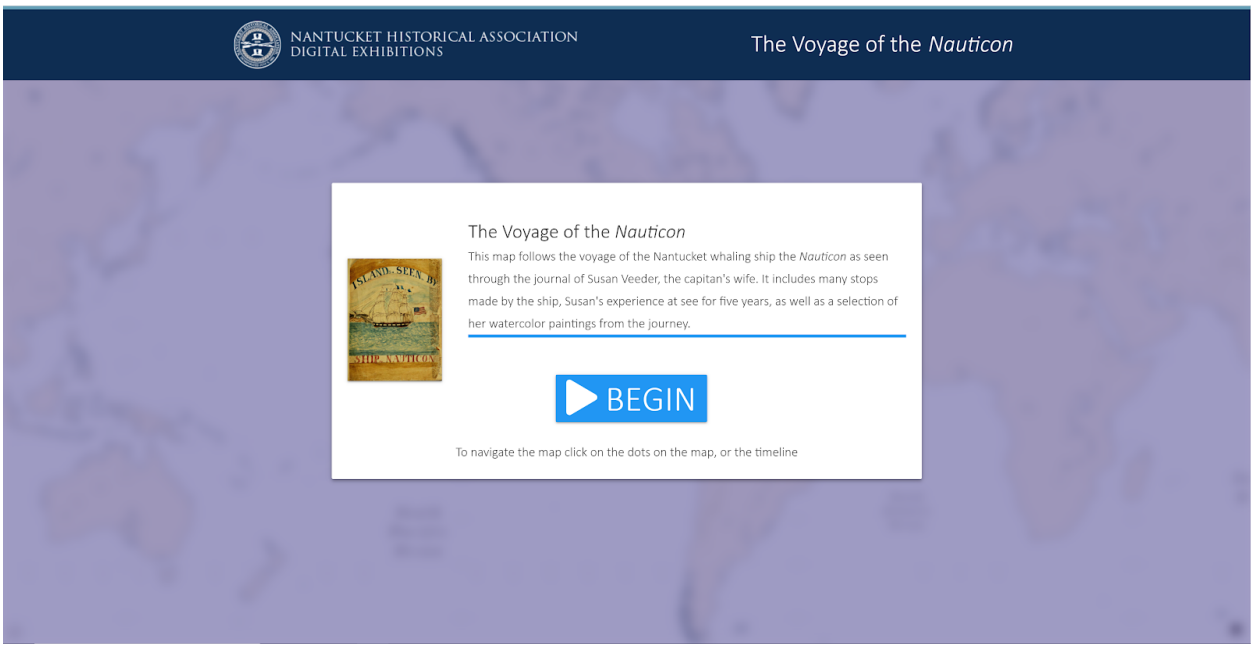

Figure 24. Final intro page

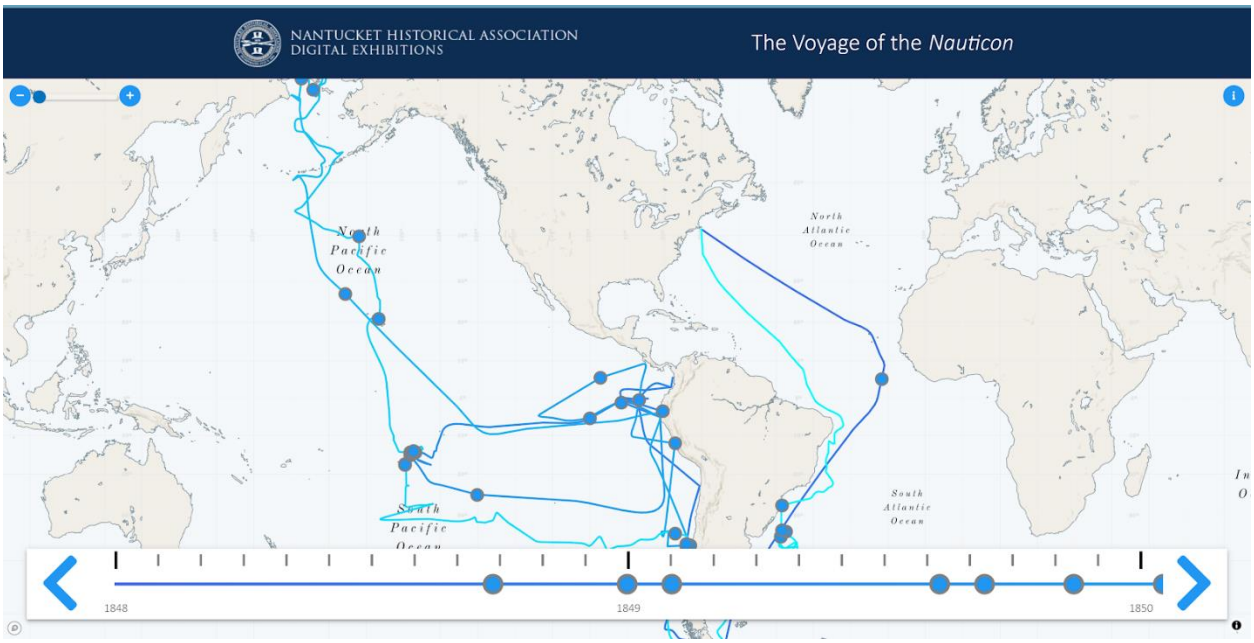

Figure 25. Final map screen

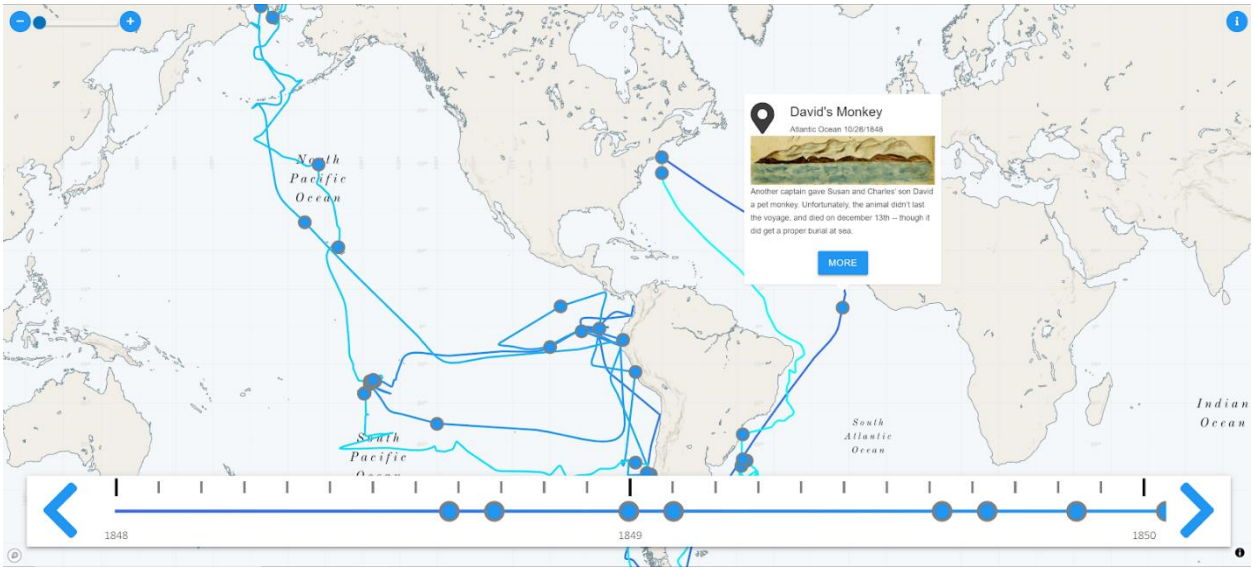

Figure 26. Final event popup

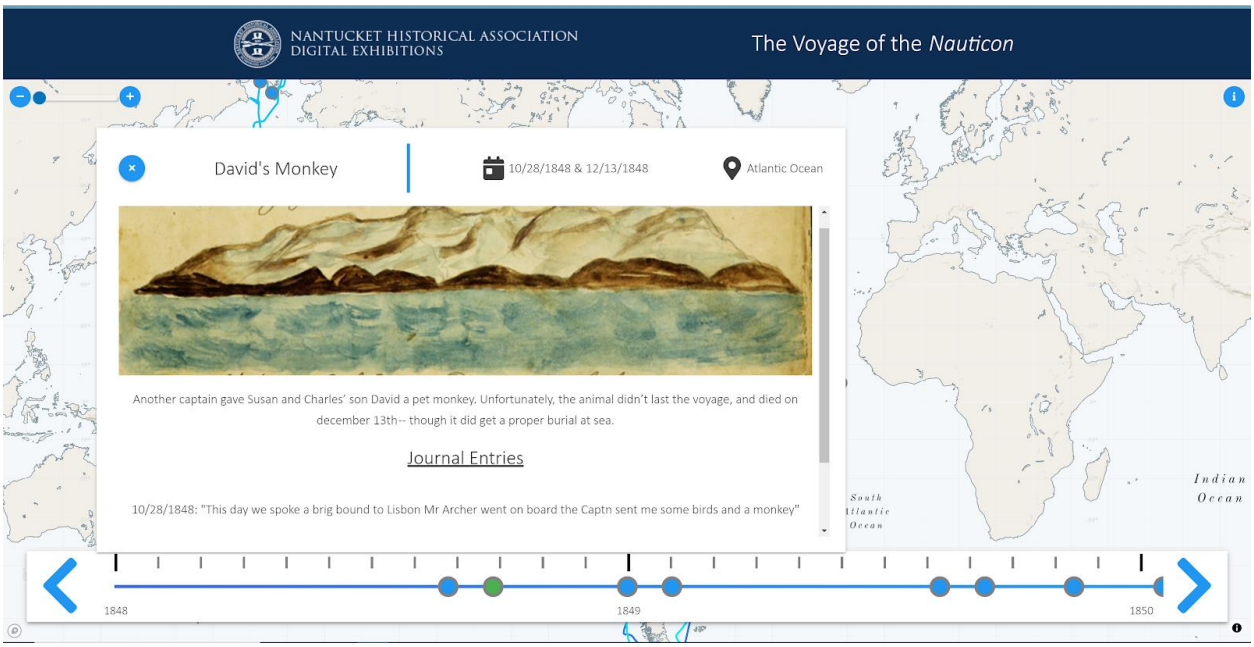

Figure 27. Final main event view

Conclusions & Recommendations

It is important to acknowledge that the NHA obviously cannot become complacent with their current exhibits; they must continuously look for new ways to both engage their audiences and provide for novel and interesting visitor experiences. We have discussed how the statistics indicate that novelty is a major component of exhibit design, but it is important to contextualize that by noting that it pertains to novelty regarding other exhibits. The most interesting exhibits are not only those that are unlike exhibits at other museums, but also those that stand out among the collection of exhibits at that same museum, in this case the NHA's whaling museum. By continuously providing their visitors with new and novelly designed exhibits, the NHA not only has the prospect of bringing in more visitors but also greatly enhances the museum experience for those visitors.

The NHA has several pre-existing interactives, such as the *Stove by a Whale* exhibit, and so we strove to design and exhibit that was unlike said pre-existing exhibits. We wished to provide a more holistic and unfiltered view on life aboard a whaleship, which is why we designed the exhibit to allow for a freeform experience and presented many events. By not restricting the visitor to a linear experience we allow for them to either step through the voyage of the whaleship sequentially or to experience the events in whichever order they may choose; regardless of their mode of interaction, however, they are still presented with a relatively unfiltered view of life aboard a whaleship. The *Stove by a Whale* exhibit had different aims and presented the visitor with a less free-form experience in that they could not freely navigate the map of the ship's voyage. Additionally, we included a much wider variety of events in our exhibit to present a broader view of life aboard a whaleship.

As noted, the original intention for the exhibit was to develop a comparatively more versatile viewer for a larger number of whaleship journeys, but we ended up focusing on the 4 year trip of the *Nauticon* because of the many unique qualities of Susan Veeder's journal. First and foremost, it provided a very novel perspective on the journey of a whaleship by being written from the perspective of a woman—we are unaware of any contemporaneous ships logs written by women, and other whaling journals written by women are very rare. Susan Veeder's journal thus provides an invaluable perspective, as the standard ships logs were much blander, written only by men, and did not typically cover events ashore when the ships were put into port

for long periods of time. Additionally, Susan Veeder illustrated the *Nauticon*'s voyages through watercolors, which no other ships logs or journals from the same time period have; this makes Susan Veeder's journals one of the most easily relatable accounts of life aboard a whaleship. Unfortunately, many of the watercolors are of relatively mundane scenes that are not tied to events, but they do provide visual interest and several offer unique perspectives on life at sea at that time.

Susan Veeder's journal was quite detailed and provided a wide selection of content to choose from, but ultimately, we chose to highlight the events that we thought would be of the most interest to a wide variety of audiences. We additionally aimed to include events that could highlight gaps missing in other NHA exhibits or tie back to the NHA's collections in interesting ways. It is important to recognize that viewer interest, our primary metric for including events, is highly subjective and we did not engage in any sort of formal process to gauge interest. Rather, we decided amongst ourselves on what events we thought seemed interesting and contained sufficient information from the Veeder journal. We thus ended up with an interesting mishmash of events; some pertaining to random occurrences such as the crew bringing a monkey that later died onboard and some pertaining to more standard whaleship events such as a chain holding a whale breaking or crew members deserting. We believe that this strategy was our best choice under the circumstances, since the pandemic prohibited us from soliciting feedback from museum visitors. We believe that the result incorporates a blend of events that will pique the interest of visitors and provide educational value.

One of our main design goals when we embarked on this project was to make it extensible, and to that end we have a number of recommendations on how the exhibit can be expanded in the future: implementing it in the form of a standalone kiosk, conducting evaluations while iterating based off of said feedback, developing ancillary educational materials, and developing other interactive whaling maps. The first recommendation is the most straightforward, as the web-based nature of our exhibit means that it can run in any environment with a web browser. The NHA uses a piece of third-party kiosk software, Intuiface, for their existing in-person interactives. Intuiface provides an integrated web browser based on Chromium 81, which as of writing is only 8 months behind the version currently used in Google Chrome. This version of chromium is more than new enough to support all of the features used in our

exhibit; the most significant feature we use is WebGL, which is required by Mapbox. WebGL has been supported since Chromium 9, released in 2010. Additionally, WebGL is supported in all versions of Firefox since March 2011, and all versions of Safari since July 2012. It is thus quite straightforward for the NHA to integrate our exhibit into a physical kiosk; Intuiface will essentially serve as a very thin wrapper over our web-based exhibit with only minor differences to sandbox the user.

As for evaluations, we had initially planned to conduct a formal evaluation process but then did not have the time to complete it as we previously explained due to our implementation of a new map and other factors, including the COVID-19 pandemic. We recommend that the NHA adopt a simpler system for implementing feedback into the design of the exhibit. We have included a link on the bottom of the page to email library@nha.org, monitored by Amelia Holmes. We are providing extensive documentation on how to add to and modify the exhibit. To that end, it should be easily possible for the NHA to modify and / or add to the exhibit as required. Especially when it comes to the event data and path of the ship, we have worked to make the exhibit very easily modifiable and it can be modified to some extent with no programming knowledge by following the guidelines in our documentation. Adding additional features would be more complicated and require some programming knowledge, though we believe that we are providing sufficient documentation that Mary and Al Novissimo, the NHA's digital exhibit contractors, could conceivably expand on the exhibit if required to do so. Bugs must also be considered; we recognize that our exhibit is not perfect and there will likely be issues that are discovered after the completion of our project that the NHA must handle.

Additionally, the extensible nature of our design means that the NHA can use it to develop other interactive whaling maps, including composites of multiple whaling voyages. James Russell, the executive director of the NHA, inquired as to the feasibility of this and we believe it to be relatively straightforward. The only parts of the exhibit that are specific to the *Nauticon*, and that cannot be changed by editing the program's config file, are the heading and footer, which could be relatively easily customized. Apart from that, the nature in which the data on events and the path of the ship is pulled in means that it would be relatively easy to replace them with different events and the path of a different ship. We think that this represents a significant opportunity for the NHA to expand on the exhibit in the future, as they could present

the journeys of other whaling ships in an interactive format with very little additional effort. The bulk of our time was spent designing and developing the interface, whereas realistically only two weeks of our project were spent on poring over the journal, refining the path, and picking out events. That interface work only must be done once, and so the only portion of our project that would need to be repeated in order to create additional whaling maps would be the data collection and curation. As for multiple whaling voyages, some additional development by someone with programming experience would be required, as the JavaScript internals of our exhibit do not consider support for multiple different paths. We estimate, however, that adding support for multiple voyages would take no more than one day's work for even a beginner at web development.

Finally, we recognize that there are opportunities for the NHA to further spread Susan Veeder's story outside of our exhibit. You can only go so far with a single interactive, and there are many possibilities for ancillary educational materials that the NHA could produce, especially for children, on Susan Veeder's voyage on the *Nauticon*. As we have previously explained, this exhibit was not targeted at children; rather, we aimed for it to provide a solid experience to those who are teenagers or older. Because we did not target children with our exhibit, the NHA would do well to present the same content, and possibly additional content, in a digestible format for children with limited attention spans and lower reading levels. We believe that any such resources should have the goal of encouraging children to further explore Susan Veeder's journal, Betsy Tyler's book, and any other related items in the NHA collection. Moreover, such additional content could not only target children but also target the same audience as our exhibit in order to build on our exhibit. We did not cover all the ins and outs of the *Nauticon*'s voyage, only thirty-six events that we believed would be interesting to the average museum visitor. By presenting additional content in other formats, the NHA can fill in the gaps that we missed in our exhibit.

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Appendices

Appendix A: Draft Testing Survey Preamble

We are a project group from Worcester Polytechnic Institute (WPI) working with the Nantucket Historical Association (NHA) to design a new interactive digital exhibit. The exhibit can be found at example.com. If you are willing to spend roughly fifteen minutes of your time simply use the exhibit and then answer a quick survey on your experience. Your feedback will be used by the WPI group to improve the exhibit's design and inform any possible future additions. No telemetry is collected by the exhibit and all answers to survey questions will be fully anonymized. To avoid biasing our results, we are not providing you any instruction on how to use the exhibit; simply interact with it as you see fit.

Appendix B: Draft Testing Survey Questions

Question 1: Rate (1-10) the usability of the exhibit's user interface.

Question 2: Describe any major technical issues you noticed while using the exhibit, such as features not functioning.

Question 3: Rate (1-10) the visual appeal of the exhibit.

Question 4: Describe any aspects of the exhibit that you found to be visually unappealing

Question 5: Rate (1-10) how well you felt the exhibit held your interest.

Question 6: Describe why or why not you were interested in the exhibit, and please specify any parts of the exhibit that you felt were boring and / or un-engaging.

Question 7: Rate (1-10) how much freedom you felt the exhibit offered you - as in, how open-ended or limiting you felt the exhibit was.

Question 8: Describe any parts of the exhibit that you felt were too limiting.

Question 9: Rate (1-10) how technologically novel interacting with the exhibit felt. To provide some further clarification, when we say “technologically novel” we are referring to how different interacting with our exhibit feels from any of your prior interactions with online exhibits. If you have never interacted with an online exhibit before, please skip this question.

Question 10: If applicable, please point out which specific parts of the exhibit impressed / disappointed you from a technical standpoint.

Appendix C: Coordinate Interpolation Program

```
package dev.dcole;

import java.io.BufferedReader;
import java.io.FileReader;
import java.util.ArrayList;

public class Main {

    public static void main(String[] args) {
     // Take in CSV to read from
        String fileName = args[0];

        ArrayList<Double> latitude = new ArrayList<>();
        ArrayList<Double> longitude = new ArrayList<>();

        // Read in latitude and longitude from file (decimal or deg/min/sec)
        try (BufferedReader br = new BufferedReader(new FileReader(fileName))) {
            String line;
            while ((line = br.readLine()) != null) {
                String[] val = line.split(",");

                double lat = 0.0;
                double lon = 0.0;

                // Handle degree - minute - second - direction notation
                if (val[0].contains("'")) {
                    double deg_lat = Double.parseDouble(val[0].substring(0,
val[0].indexOf("°")));
                    double deg_lon = Double.parseDouble(val[1].substring(0,
val[1].indexOf("°")));

                    double min_lat =
Double.parseDouble(val[0].substring(val[0].indexOf("°") + 1, val[0].indexOf("'")));
                    double min_lon =
Double.parseDouble(val[1].substring(val[1].indexOf("°") + 1, val[1].indexOf("'")));

                    double sec_lat =
Double.parseDouble(val[0].substring(val[0].indexOf("'") + 1, val[0].indexOf("\"")));
                    double sec_lon =
Double.parseDouble(val[1].substring(val[1].indexOf("'") + 1, val[1].indexOf("\"")));

                    lat = deg_lat + (min_lat / 60) + (sec_lat / 3600);
                    lon = deg_lon + (min_lon / 60) + (sec_lon / 3600);

                    // Negative if south
                    if (val[0].contains("S")) {
                        lat = -lat;
                    }

                    // Negative if west
                    if (val[1].contains("W")) {
                        lon = -lon;
```

```
                    }
                } else if (!val[0].contains("?")) {
                    lat = Double.parseDouble(val[0]);
                    lon = Double.parseDouble(val[1]);
                }

                if (val[0].contains("?")) {
                    latitude.add(null);
                    longitude.add(null);
                } else {
                    latitude.add(lat);
                    longitude.add(lon);
                }

            }
        } catch (Exception e) {
            e.printStackTrace();
        }

        // Interpolate missing data points (Can't interpolate missing initial
coordinate though!
        for (int i = 1; i < latitude.size(); i++) {
            if (latitude.get(i) == null) {
                // Get last latitude & longitude
                double last_lat = latitude.get(i - 1);
                double last_lon = longitude.get(i - 1);

                // Find length of gap, also get next lat & lon
                int gap_len = 0;

                double next_lat = 0.0;
                double next_lon = 0.0;

                for (int j = i; j < latitude.size(); j++) {
                    if (latitude.get(j) == null) {
                        gap_len++;
                    } else {
                        next_lat = latitude.get(j);
                        next_lon = longitude.get(j);
                        break;
                    }
                }

                // Skip gap if we would have to interpolate across the prime meridian
                if ((last_lon < 0 && next_lon > 0) || (last_lon > 0 && next_lon < 0))
{
                    i += (gap_len - 1);
                    continue;
                }

                // Fill in gap
                for (int j = i; j < (i + gap_len); j++) {
                    // Calculate interpolation scalar
                    double s = ((double) (j - i + 1)) / ((double) (gap_len + 1));
```

```
                    // Interpolate
                    double lat = last_lat + s * (next_lat - last_lat);
                    double lon = last_lon + s * (next_lon - last_lon);

                    latitude.set(j, lat);
                    longitude.set(j, lon);
                }

                // Skip loop to the end of the gap
                i += (gap_len - 1);
            }
        }

        // Print out coordinates
        for (int i = 0; i < latitude.size(); i++) {
            double lat = latitude.get(i);
            double lon = longitude.get(i);

// Shift longitudes > 0 to be < -180 to work with Mapbox
            if (lon > 0) {
                lon = -180.0 - (180 - lon);
            }

            // Print out latitude & longitude shifted back into proper range
            System.out.println(lat + ", " + lon);
        }
    }
}
```

Appendix D: Event Spreadsheet to JSON Converter

```
import java.io.BufferedReader;
import java.io.File;
import java.io.FileNotFoundException;
import java.io.FileReader;
import java.io.FileWriter;
import java.io.IOException;
import java.util.Arrays;
import java.util.Scanner;

public class Parser {

    public static void main(String[] args) {
        // TODO Auto-generated method stub
        try {
            File jsonFile = new File("C:\\Users\\eah89\\Documents\\Whaling
Map\\events.json");
            if(jsonFile.exists()) {
                jsonFile.delete();
                jsonFile.createNewFile();
            }
            File csvFile = new File("C:\\Users\\eah89\\Documents\\Whaling
Map\\events.csv");
            FileWriter jsonFileWriter = new FileWriter(jsonFile);
            BufferedReader myReader = new BufferedReader(new
FileReader("C:\\Users\\eah89\\Documents\\Whaling Map\\events.csv"));
            // Need to skip past the titles of the columns
            myReader.readLine();
            int eventNum = 0;
            String row;
            String jsonArray = "{\n\"events\": [\n";
            while ((row = myReader.readLine()) != null) {
                if(eventNum != 0) {
                    jsonArray += ",\n";
                }
                String[] fields = row.split(",");
                String newEvent = "{\n"
                        + "\"eid\" :" + eventNum + ",\n"
                        + " \"name\" :\"" + fields[0].replace("@", ",") + "\",\n"
                        + " \"date\" : [\n" ;
                if(fields[1].contains("&")) {
                    String[] dates = fields[1].split("&");
                    newEvent += "\"" + dates[0] + "\", \n\"" + dates[1] + "\"\n],\n"
+
                            "\"dateType\" : \"discrete\",\n";
                }
                else if(fields[1].contains("-")) {
                    String[] dates = fields[1].split("-");
                    newEvent += "\"" + dates[0] + "\", \n\"" + dates[1] + "\"\n],\n"
+
                            "\"dateType\" : \"continuous\",\n";
                }
                else {
```

```
                    newEvent += "\"" + fields[1] + "\"\n],\n" +
                            "\"dateType\" : \"discrete\",\n";
                }
                newEvent += " \"mainDescription\" :\"" + fields[2].replace("@", ",")
+ "\",\n"
                        + " \"shortDescription\" :\"" + fields[3].replace("@", ",") +
"\",\n"
                        + " \"text\" :[\n";
                String[] journalEntries = fields[4].replace("@", ",").split("%");
                for(int i = 0; i < journalEntries.length; i++) {
                    if(i != journalEntries.length-1) {
                        newEvent += "\"" + journalEntries[i] + "\",\n";
                    }
                    else {
                        newEvent += "\"" + journalEntries[i] + "\"\n],\n";
                    }
                }
                newEvent += " \"location\" :\"" + fields[5].replace("@", ",") +
"\"\n"
                        + "}";
                jsonArray += newEvent;
                eventNum++;
            }
            jsonFileWriter.write("" + jsonArray + "]}");
            jsonFileWriter.close();
            myReader.close();
        } catch (FileNotFoundException e) {
            System.out.println("An error occurred openning the file.");
            e.printStackTrace();
        }
        catch (IOException e) {
            System.out.println("An error occurred creating the file");
            e.printStackTrace();
        }
    }
}
```

Appendix E: Coordinate Spreadsheet to JSON Converter

```
import java.io.BufferedReader;
import java.io.FileReader;
import java.io.FileNotFoundException;
import java.io.IOException;

import java.io.FileWriter;
import org.json.simple.JSONArray;
import org.json.simple.JSONObject;

import java.util.Arrays;


public class CSVreader {

    public static void main (String[] args) {

        String csvFile = "C:/Users/Billy-Admin/Documents/Class docs/IQP
Nantucket/Coords/veederCoords.csv";
        BufferedReader br = null;
        String line = "";
        String csvSplit = ",";

        FileWriter file;

        try {
            br = new BufferedReader(new FileReader(csvFile));
            JSONArray points = new JSONArray();
            int id = 0;
            while ((line = br.readLine()) != null) {
                String[] rawPoint = line.split(csvSplit);

                JSONObject newPoint = new JSONObject();

                newPoint.put("id", id);
                newPoint.put("date", rawPoint[0]);
                newPoint.put("lat", rawPoint[3]);
                newPoint.put("long", rawPoint[4]);

                points.add(newPoint);

                id++;
            }

            JSONObject obj = new JSONObject();
            obj.put("points", points);

            file = new FileWriter("C:/Users/Billy-Admin/Documents/Class docs/IQP
Nantucket/Coords/formattedCoordsNoEdits.JSON");
            file.write(obj.toJSONString());
            file.close();
            System.out.print(obj);
        }
```

```
        catch (FileNotFoundException e) {
            e.printStackTrace();
        }
        catch (IOException e) {
            e.printStackTrace();
        }
    }
}
```