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Virtual Museum Tours of the de Saisset Museum

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Date: June 14, 2024

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

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ENTITLED

Virtual Museum Tours of the de Saisset Museum

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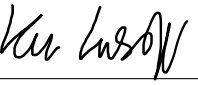
BACHELOR OF SCIENCE IN COMPUTER SCIENCE AND ENGINEERING



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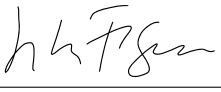

Department Chair

Virtual Museum Tours of the de Saisset Museum

by

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for the degree of
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ABSTRACT

Our project transforms the California Stories exhibit at the de Saisset Museum into an immersive virtual tour, integrating Matterport technology and Human-Computer-Interaction (HCI) principles. Matterport's high resolution 360 degree camera allows us to capture a physical space in high definition into a 3D virtual space while Matterport's software helps to facilitate the creation and editing for our physical space in a virtual environment. HCI principles focus on how systems should work when direct interaction with users is a key component. We apply the principles of HCI to create a virtual museum tour that offers visitors a culturally enriching, interactive experience, elevating the standard of virtual museum tours beyond simple walkthroughs to engage a wider audience.

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Chapter 1

Introduction

1.1 Problem Statement

Existing virtual tours generally only offer a virtual walkthrough of the museum, lacking accessibility for screen readers or other similar tools. We not only incorporate such accessibility features, but also design the virtual tours in ways that take advantage of the digital medium. The challenge before us is to significantly enhance the quality of user interactions and storytelling within museum tours, especially given the limited availability of virtual and accessible experiences. We aim to achieve this enhancement by seamlessly connecting individuals to these exhibits through the integration of Matterport technology and the application of Digital UX fundamentals. Our overarching goal is to create accessible, deeply immersive, and culturally enriching experiences for visitors as they explore museum exhibits in the virtual realm, providing them with a user-friendly interface to view and interact with artifacts.

1.2 Background or Related Work

There are numerous virtual tours that use technologies similar to Matterport, yet many of these tours are merely 3D renditions with limited or no accessibility features or UI elements that enhance a user's experience. As a team, we have viewed dozens of existing Matterport tours of museums and brainstormed how these tours could have been improved. We identified that some virtual tours could benefit significantly from the incorporation of interactive elements, such as videos, and the expansion of images and objects within the tour. For example, one of the museum tours we viewed was that of the Seinfeld apartment [1]. The Seinfeld tour was simply a basic walkthrough with no interactive elements at all; this was a missed opportunity to enrich the experience by adding videos of scenes from the show or pointing out important areas as visitors toured the home. Such additions could have made the tour more engaging and immersive, capturing the nostalgia associated with the house's history. Another tour we referenced was The Baha'i House of Worship [2]. This tour, like the Seinfeld tour, lacked any significant UI/UX elements. The House of Worship is a stunning architectural marvel, yet the virtual tour does not convey any of its history or importance. To improve the tour, nodes could be used to add educational videos, informative plaques in multiple languages, or

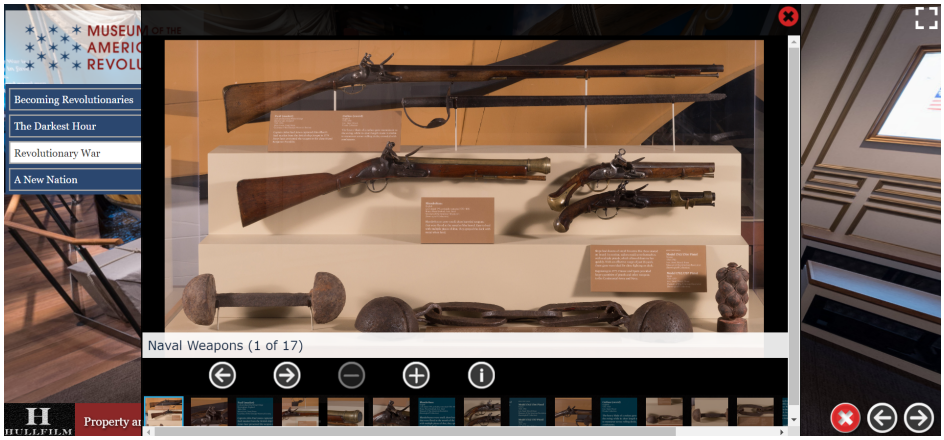


Figure 1.1: American Revolutionary War Museum Carousel

even quizzes to test the user's knowledge, providing a more informative and interactive experience. The third tour we referenced was the American Revolutionary War museum [3] in Philadelphia. Unlike the first two tours, this one included additional UI/UX elements such as text nodes and image carousels. Each item of interest within the tour had a node that allowed the image to be "blown-up" and provided a short summary of the item and its relevance to the time period. An interesting feature of this tour was the image carousel; the image carousel node was placed over display cases containing multiple items, such as musket balls, bayonets, musket wadding, and powder horns. Rather than requiring users to click on separate items, the image carousel allowed users to "highlight" and view one item at a time, making the experience more streamlined and user-friendly. All of these tours, some being done within Matterport, helped us generate ideas about how our tour looks. We aim to incorporate interactive elements, educational content, and user-friendly UI/UX features to create a more engaging and informative virtual tour experience. By learning from the strengths and weaknesses of these existing tours, we plan to develop a virtual tour that not only showcases the space but also enriches the visitor's understanding and interaction with the content.

1.3 Objectives

Our primary objective for this project is to enhance accessibility by making the first room of the California Stories Exhibit at the de Saisset Museum virtually accessible, thus allowing it to be viewed by a wider audience. To complete this objective, we conducted a scan of the location with the Matterport camera made available to us through the HCI Lab at Santa Clara University. This scan captured the intricate details and layout of the room, ensuring a comprehensive digital representation. Once the room scan was complete, we uploaded the tour to the Matterport Cloud, where it is be stored for future use and reference. Following the upload, the next phase involved enhancing the virtual tour by adding interactive "nodes" using Treedis. These nodes are strategically placed throughout the exhibit to ensure that all aspects and areas are visible to virtual tourists. The nodes serve as interactive points that provide additional layers of

information and engagement. For instance, exhibit items, pieces, and works are augmented with UI elements that can be expanded on the user's screen. Users have an array of interactive options to choose from, such as:

- Viewing Summaries: Brief descriptions and historical context for each piece are available, offering deeper insights into the exhibit.
- Listening to Introductions: Audio guides introduce certain areas, providing a narrated experience similar to in-person tours.
- Interacting with 3D Models: Users can select and manipulate 3D models of certain exhibit pieces, allowing for a more hands-on exploration.
- Watching Videos: Supplementary videos related to the pieces are available, offering visual and contextual enrichment.

These interactive elements ensure that the virtual tour is not only more educational but also more engaging than a traditional in-person tour. By providing diverse media and interaction methods, we aim to cater to different learning preferences and enhance the overall user experience. The virtual tour stands out in terms of accessibility and interactivity compared to existing tours. The integration of multimedia and interactive features creates a dynamic and immersive experience, making the California Stories Exhibit at the de Saisset Museum accessible to a broader audience and offering a richer, more engaging exploration of the museum's offerings.

1.4 Our approach

Our efforts kick off with the California Stories exhibit at the de Saisset Museum at Santa Clara University, which serves as a crucial initiative to preserve cultural heritage and commemorate historical significance. Our team met with Dr. Ciara Ennis, Director at the de Saisset Museum, Lauren Baines, Assistant Director at the de Saisset Museum, and Samantha Hull, Engagement and Operations Coordinator at the de Saisset Museum to build a framework for our final vision. This partnership will help us create this enhanced and accessible virtual tour of the exhibit. This endeavor holds great importance as it enables more people who cannot visit the museum in person, or may be visually or otherwise impaired, to learn about and engage with this museum, contributing to the preservation of Native American history that is often marginalized or erased by colonial powers. It also promises to develop general design principles for accessibility that can inform the design of thousands of virtual museum tours that currently lack support for users with visual impairments. We used an agile software development approach (rather than a waterfall development approach). This means that we developed the system iteratively and respond to user feedback. Since this was built from a previous system, developing new or different features were easier as well.

Chapter 2

User Research

2.1 Methods

To achieve our objective of making the first room of the California Stories Exhibit at the de Saisset Museum virtually accessible, we employed a multi-faceted approach that included secondary research, competitor testing, and co-design with museum staff.

Secondary Research:

- We conducted extensive secondary research to understand the current landscape of virtual museum tours. This involved reviewing academic papers, industry reports, and case studies on virtual reality (VR) and augmented reality (AR) in museum settings.
- We analyzed existing Matterport tours and other similar virtual tours to identify best practices and common shortcomings. This provided us with insights into what makes a virtual tour engaging and educational.

Competitor Testing:

- We explored and tested numerous virtual tours available online, focusing on those created using Matterport and other similar technologies. Notable examples included the Amityville murder house, The Temple of Venus, and the American Revolutionary War museum in Boston.
- Through these tests, we evaluated the user experience, interactivity, and educational value of these tours. We documented features that stood out and those that could be improved upon, which informed our design and development process.

Co-Design with Museum Staff:

- Collaboration with the de Saisset Museum staff was integral to the project. We held co-design sessions with curators, educators, and exhibit designers to ensure the virtual tour accurately represented the physical exhibit and met the museum's educational goals.

Figure 2.1: Co-Design Process with the Museum

- The museum staff provided valuable insights into the historical and cultural significance of the exhibit pieces, which we incorporated into the interactive content of the virtual tour.

By combining these methods, we were able to develop a comprehensive and user-centric virtual tour for the California Stories Exhibit. This approach ensured that the tour not only showcased the exhibit effectively but also provided an engaging and educational experience for virtual visitors.

2.2 Stakeholder needs

The stakeholders for this project include the developers, museum staff, students, and the Muwekma-Ohlone tribe. As developers and Santa Clara University engineering students, we hold a significant stake in this project because completion of a Senior Design project is a graduation requirement, and we chose this project to fulfill that requirement. Our goal is to apply our technical skills and knowledge to create a meaningful and impactful virtual tour that benefits the museum and its audience. Successfully delivering this project not only contributes to our academic achievements but also to our professional growth and portfolio. The museum staff are critical stakeholders as they seek to increase the visibility and accessibility of the de Saisset Museum. By making the exhibit virtually accessible, they aim to attract a broader audience and provide educational resources that extend beyond the physical boundaries of the museum. The virtual tour helps them engage more visitors, enhance educational outreach, and showcase the museum's collections and narratives more effectively. Students, ranging from Santa Clara University attendees to younger learners such as 4th graders working on their Mission projects, are also important stakeholders. They stand to benefit from the accessible educational resources provided by the virtual tour. By making the history of Santa Clara and the exhibits at the de Saisset Museum accessible to a diverse age group, we ensure that both university students and younger students can conduct research and learn in an engaging, interactive manner. Finally, the Muwekma-Ohlone tribe are perhaps the most crucial stakeholders. They are entrusting the museum, and by extension, us as developers, to accurately and

respectfully tell their story and preserve their culture. This project involves representing the rich heritage and traditions of the Muwekma-Ohlone people, and it is vital to honor their trust by ensuring the virtual tour is culturally sensitive, accurate, and educational.

2.3 User stories

One important and likely user of our virtual tour would be a 4th-grade student. In California, 4th-grade students are required to complete a research project on one of the 21 historical Spanish missions. The California Stories Exhibit provides valuable context and supplementary information that can enhance their understanding of this period. By offering a virtual tour, we allow these students to interact with educational elements that they might not have access to in other museums. This includes interactive nodes that can provide detailed information about artifacts, historical videos, and audio narrations. Such features make the learning experience more engaging and accessible, helping to bring the history of the missions to life for young learners.

Another likely user would be an aspiring or admitted SCU Bronco. Prospective students often research the campus and its surrounding historical sites to get a sense of the university's heritage and cultural environment. The virtual tour of the California Stories Exhibit can serve as a valuable resource for these students, offering them insights into the rich history of Santa Clara and its significance. This interactive experience can help prospective students feel more connected to the university community and its legacy, potentially influencing their decision to attend Santa Clara University. Additionally, admitted students can use the tour as a way to familiarize themselves with the campus and its cultural offerings before they arrive, enriching their overall educational experience.

Nick Figs

4th-grader

Created with DALLE.3

Age: 10 years

Sex: Male

Major: TBD

Passion: Roblox

ABOUT

Nicholas Figs is a 4th-grader at Santa Clara Elementary School; his teacher, like all 4th-grade teachers, has assigned their class their California Mission project and Nicholas has been assigned to Mission Santa Clara de Asis.

Nicholas wants to do more research about the native peoples of the area to include in his mission project.

ISSUES

Nicholas is excited about his project, but he doesn't want to read books or some online articles, he wants to visit the mission and the de Saisset museum, but his parents are busy and aren't making the time to take him for a visit.

AR/VR

Nicholas could benefit from being able to visit the California Stories exhibit from the comfort of his home via the AR/VR realm; he would be able to take a tour of the first room of the California Stories exhibit where he would be able to interact with 3D objects, watch videos of how tule was used, and learn how the Muwekma-Ohlone people lived prior to the arrival of the Spanish.

Nicholas would have more than enough content to use on his project.

Figure 2.2: Nick Persona

Mike Poe

Aspiring Bronco

Created with DALLE.3

Age: 18 years

Sex: Male

Major: TBD

Passion: Hiking

ABOUT

Mike Poe is a recent high school graduate who aspires to be a Bronco in the School of Business at SCU.

While Mike wants to be a Bronco, he wants to learn more about SCU and the surrounding historical sites.

ISSUES

Mike wants to learn more about the SCU area, but he cannot travel to campus as he lives far away.

AR/VR

Mike can benefit from coming across a virtual tour of the de Saisset museum; he will have the chance to learn more about the Santa Clara area and the peoples that once inhabited it, while also building a connection to SCU.

Figure 2.3: Mike Persona

Chapter 3

Design and Rationale

3.1 Design

Users can easily access the live link from the de Saisset Museum's homepage, which seamlessly directs them into the cloud-saved Matterport tour. This virtual tour offers an immersive experience, allowing users to "walk" around the museum by clicking on strategically placed nodes on the floor. These nodes guide the user through various parts of the museum, offering a fluid and intuitive navigation experience. Additionally, users can select other nodes located above or directly on the museum's designated "points-of-interest," ensuring they do not miss any significant details or exhibits. Upon entry into the virtual tour, users are greeted by the welcoming voice of the Assistant Director of the museum, Lauren Baines, who provides an engaging introduction to the exhibit. This personalized touch enhances the visitor's experience, making them feel as if they are receiving a guided tour from a knowledgeable museum curator. Throughout the tour, empty spaces on the walls, as well as the entry and exit points of the museum, serve as hosts for our informative and engaging videos. These videos provide additional context and enrich the overall experience by offering deeper insights into the exhibits and the museum's history.To create the interactive nodes and ensure a

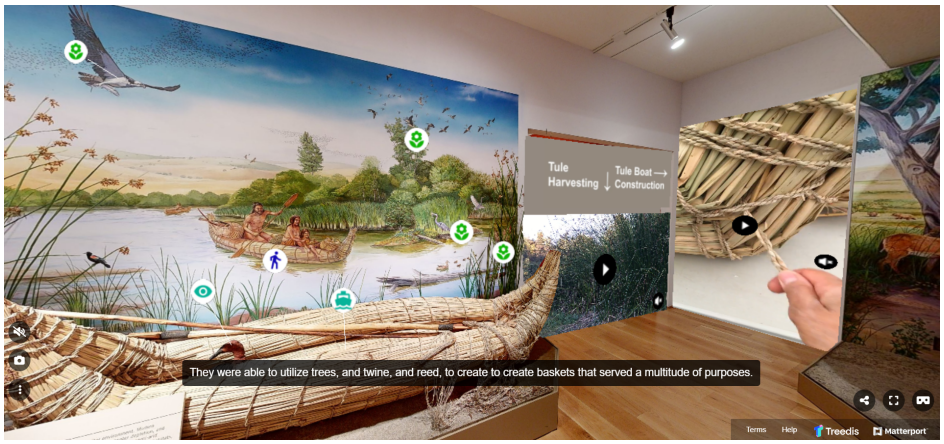


Figure 3.1: Final Museum Tour

user-friendly interface, we utilize the Treedis app. This innovative tool allows us to develop a sophisticated virtual tour without the need for extensive coding or the complexities of learning a new SDK. The Treedis app streamlines the process of adding interactive elements, ensuring that our virtual tour is both accessible and engaging for all users. By leveraging the capabilities of the Treedis app, we avoid the pitfalls of unnecessary coding of the UI/UX elements, allowing us to focus on creating a rich, interactive experience. This approach not only enhances the visual and interactive aspects of the tour but also ensures that users can easily navigate and fully appreciate the museum's offerings.

3.2 Functional requirements

Our first functional requirement was that he virtual tour must allow the user to navigate a virtual form of de Saisset exhibits. Users should have access to at least as much information as the physical exhibits contain. By scanning the exhibit, creating the tour, and crafting our information with the museum, we have met this requirement. Our second functional requirement was that the virtual tour must be accessible to hard of hearing and visually impaired users. These users should be able to navigate the tours as well as any other user could do. We unfortunately did not meet this requirement. Although accessibility was a part of the project at the outset, it became clear to us that figuring out the content of the tour as well as the basic functionality of the tour would take more time than would allow working on accessibility features as well. We did add captioning to our narration, but this was only one of many initial ideas planned for accessibility.

3.3 Non-functional requirements

Our first non-functional requirement is that the virtual tour shall be fast-to-load. That is, the tour itself and any embedded media in it should load quickly enough that it is not a major annoyance for our target users. We met this requirement by using the Matterport and Treedis platforms, which load fast. Our second non-functional requirement is that the virtual tour shall be easy to navigate. That is, the UI should be easy to use and intuitive to use. We met this requirement, by planning our scan locations and where to put media and annotations.

3.4 Rationale

We designed this system in this manner because it would facilitate the greatest number of people to access and use the tour, while displaying everything the physical version does as well.

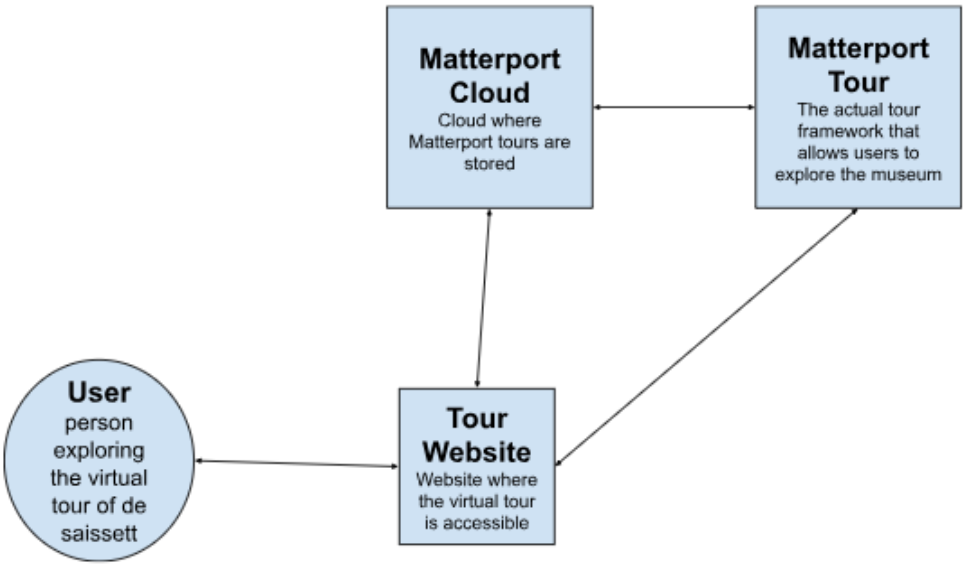


Figure 3.2: System Context Diagram

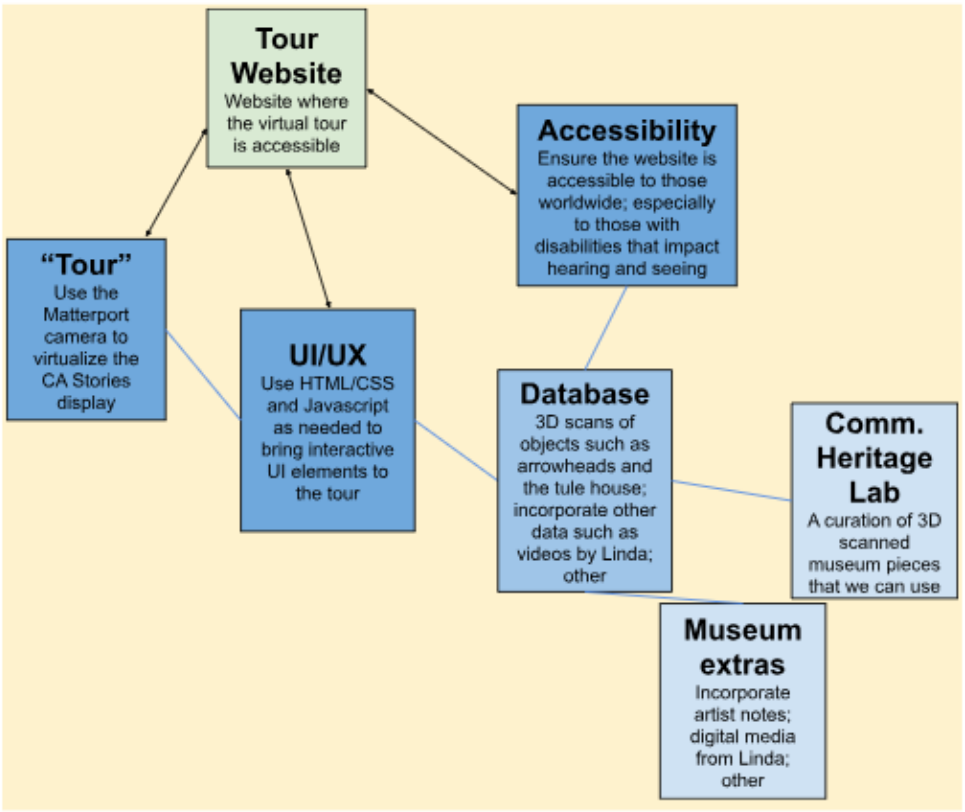


Figure 3.3: Container Diagram

Chapter 4

Technologies

This project used relatively few technologies, but we make extensive use of them.

The first technology that we made use of was the Matterport Pro3 3D Camera. We used this camera, and its associated software, to scan the room of our exhibit. We also made use of the Matterport Virtual Tour Software. This allowed us to convert our scan of the room into a digital model that can be edited as a tour. We had initially planned on also using the Matterport SDK to further modify the tour, but we opted not to use it. Instead, we used the Treedis Digital Twin Software. This is because, the steep learning curve of the SDK did not justify the minimal amount of flexibility and customizability it has over Treedis. Through Treedis, we added all of our features to the tour, which are described in further detail elsewhere in this report.

Figure 4.1: Matterport Pro3 Camera

Chapter 5

System Evaluation

5.1 Internal Testing

Our internal evaluation largely dealt with if the system:

- satisfies the criteria the de Saisset museum wants out of the virtual tour loads quickly
- features all the visual and audio accessibility features planned
- features improvements on current virtual tour technologies

We did this by frequently checking in with the museum to ensure our tour met their expectations and by comparing our tour with various other publicly available tours to see if our had a substantive improvement of features over the others. We did not end up succeeding with implementing all the visual and audio accessibility features planned, due to scoping and timing issues, so there was little testing involved for those aspects.

5.2 External Testing

We did usability tests. This allowed us to gather data on what parts of the system are most usable and need work, what problem points users have, and whether any technical issues arise. We also held several further meetings with the de Saisset Museum team who provided us with feedback on aspects of our work as well as other valuable suggestions.

We tested with five undergraduate students and asked them to open up the tour on their own device. The participants were asked to share their thoughts while we took notes. The participants explored the tour at their own pace, exploring the environment as they saw fit and remarking on whatever they were thinking at the time. We observed where the particpants went first, how they interacted with the space, and if they seemed confused at any time. At the end, we asked the partcipants if there was anything that felt good or bad about the experience, and marked these down as well.

What we found was that our initial version of the tours seemed a bit disorganized, that some of the icons were not representative or distinct enough, and that the swipe gesture was not doing what users expected it to do. By using this feedback, we were able to fix these issues and improve the user experience.

We also got feedback from Lauren Baines and the rest of the museum throughout the development and planning process. This involved not only planning meetings, but also which kinds of interactions and content would be ideal for the tour and the story the museum was trying to convery via this tour.

Chapter 6

Implementation Plan

6.1 Timeline

Figure 6.1 displays our tentative timeline for this project, using an Agile development framework with two-week sprints.

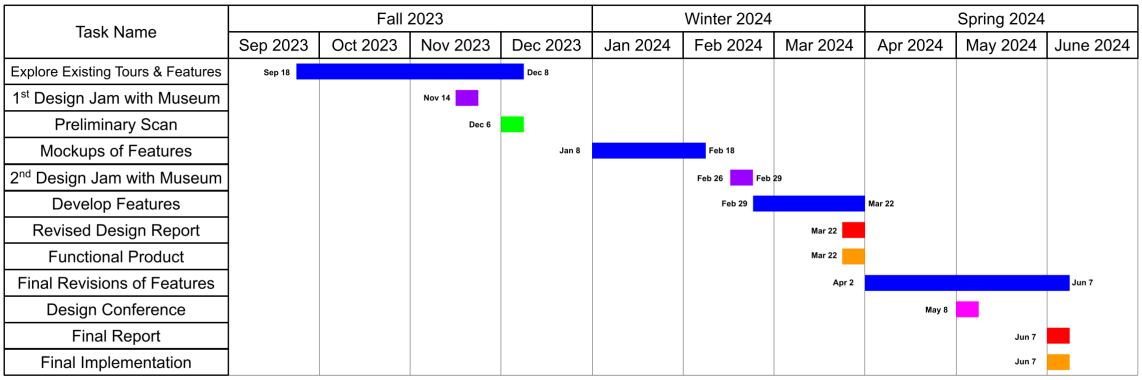
6.2 Agile software development

We used agile software development methods. This means that final system design changes in response to user feedback. We work in two week sprints, and assign a number of user stories for each sprint to tackle. For each of these stories, we come up with some tasks to accomplish them, and assign these to group members. This allowed us to stay organized and

6.3 Project Risks

The first and biggest risk of this project is time management. All three of the developers are Computer Science and Engineering seniors who have class obligations to fulfill to graduate in June of 2024; we needed to manage our time wisely, divide the work up evenly, and maintain responsibility. The second biggest risk of this project is not being able to deliver a well-polished tour; the Matterport tour looks nice for the most part, however, there are some areas where the museum's lighting is causing some of the pieces to blend in with the environment.

Scoping was a hurdle with this project. We initially had a far larger emphasis on accessibility, but did not have enough time or practical experience to make this a reality. Had we mitigated the first risk of time management, this would have made the second risk less concerning. We reduced the scope of this project, which made sure that we were able to provide a proper product.



by Karthik Tamil, Justin Enciso-Anaya, Quoc Truong

Figure 6.1: Current Agile Timeline

Chapter 7

Constraints and Standards

7.1 Constraints

The main constraint to our project was time. We had to juggle the lengthy planning phase with the development, which did not leave us with as much time for development of features as we initially expected. This is mostly because being able to display a good amount of information within the virtual exhibit without overwhelming or confusing the user is an essential part of the tour. To do this well, and to do it for all exhibits within the museum room of the tour, requires time, which has limited our scope. Namely, it led us to reduce our focus on various accessibility features, so that the core functionality of the tour could be at its best. Another constraint was money. The only funding we spent on this project was for a subscription to a service, which provided the ability to create some features for our tour. This subscription will not be paid for after this school year, so these features may cease to work. Functionality also had some constraints. The Matterport Pro3 Camera, while excellent, struggled with glare from glass cases, as all cameras do. This meant that some shots had suboptimal viewing angles, and that in some the camera was visible in the reflection. This could be mitigated in the futre with manually controlled lighting within the room, but this was not feasible for us in this project. We also faces a constraint in the software we used. Matterport and Treedis' online editing had quite a lot of interactions that could be implemented, but some user interactions were not available. These could be implemented had we used the Matterport SDK, but as with the accessibility features, spending more time learning how to use this SDK was not worth the minimal bump in functionality it would have provided.

7.2 Standards

There are a few relevant standards for this project. One is the C4 software architecture model [4], described on the C4 website. We use this model as a standard to structure our software, as it uses a tiered system that is easy to modify and easy to understand. The C4 model separates a product into Context, Containers, Components, and Code, allowing for a hierarchical model to structure our software. Another is ISO 9241-110:2020 Ergonomics of human-system interaction Part 110: Interaction principles [5]. This standard covers how interactive systems should behave and operate when

being used by any user. We use this standard since it covers interactions between users and interactive systems, which is the core of our project. Using this standard, we can ensure users can interact effectively with our tours, and get the proper feedback and experience that they expect. We also use The Web Content Accessibility Guidelines (WCAG) 2.1 [6] from W3. This standard establishes how content on the web should be made accessible. Since our tour is intended to be hosted online, the standard is pertinent to us. We meet portions of this standard. Specifically, we provide captions to all audio content, and make color a nonessential part of the design. Unfortunately were not able to meet all of the standard in this version of the tour. Most notably, our tour cannot be easily processed by text readers, and does not have full support for text alternates of media, though some is available. This is something to be improved upon in future versions.

Chapter 8

Societal Issues

8.1 Ethical

Rather than raise ethical issues, our project comes close on solving some issues. By eliminating the need to be physically present in a museum, and by focusing on visual and aural accessibility features, we ensure access to those who would otherwise not have access to this museum, which is a success in terms of ethicality. We also ensure ethicality by working with the museum and by extension the Muwekma-Ohlone tribe in the content of the tour, so as to provide the story and message that the tribe wants in our tour.

8.2 Social

Our project impacts society, or at least the subset of society who interact with museum tours, positively. By eliminating the need to be physically present in a museum, and by focusing on visual and aural accessibility features, we ensure access to those who would otherwise not have access to this museum. This is a great social benefit. In addition, like the ethicality, the social impact of having greater awareness of the Muwekma-Ohlone tribe is a good for the community.

8.3 Usability

Our project is built from the ground up with usability in mind. The forms of interactions are as intuitive as possible in the digital space, while utilizing that space to the fullest. A central aspect of our project is the accessibility concerns it tackles. By allowing people to get the museum experience without having to travel, we ensure that the maximum number of people can access our tour with the minimal effort. The tour is not as accessible as it could be however, which raises a concern for the usability of the tour by some member of the community. This can be solved with future iterations of the project.

8.4 Compassion

A central aspect of our project is the accessibility concerns it tackles. By allowing people to get the museum experience without having to travel, and by having visual and aural accessibility features, we ensure that the maximum number of people can access our tour with the minimal effort

Chapter 9

Conclusions

We created a virtual tour of the first room of the museum, and have learned effective ways to plan and design displaying and conveying information and interfaces that are intuitive to users. This virtual tour of the de Saisset museum will definitely help increase access of the museum, while not negatively impacting much. However, we did not achieve all that we set out to. Primarily, accessibility features were not implemented. This was largely due to both scoping and timing issues. Our initial concept for this tour was too large to implement with the way we planned out our project. If we had spent more time in the beginning testing how feasible certain tasks were, we could have planned out our scope and timeline better. Other projects of a similar topic or scope should research early on what tools would work best, and should begin experimenting with these tools as early as possible. Now that our project has wrapped up, in the future the tour can be expanded to the rest of the museum, and our techniques for displaying and conveying information can be used by other tours as well.

Chapter 10

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