

Designing a Virtual Tour and Virtual Exhibit Room for El Caño Archaeological Museum and Park



By:
Cory Helmuth
Michael Reilly
Molly Sykes
Andrew Whitney



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Designing a Virtual Tour and Virtual Exhibit Room for El Caño Archaeological Museum and Park

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By
Cory Helmuth
Michael Reilly
Molly Sykes
Andrew Whitney

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Alexa Hancock
Fundación El Caño

Ricardo Montanari
Footprint Possibilities Inc.

Professors James Chiarelli and Robert Kinicki
Worcester Polytechnic Institute

Abstract

The El Caño Archaeological Site in the Gran Coclé Archaeological Culture complex is recognized for its discoveries that advanced knowledge of Pre-Columbian burial rituals and chiefdoms of the indigenous chiefdoms of what is now central Panama. The goal of the project, sponsored by Fundación El Caño and Footprint Possibilities Inc., was to increase the outreach and impact of the El Caño Archaeological Park and Museum by making the artifacts and park available through a virtual tour with text available for Spanish and English speakers. The team developed a historically impactful virtual tour application by conducting research, identifying virtual tour applications and their constraints, collecting images and relevant cultural facts, and refining the application based on survey responses.

Acknowledgments

We would like to acknowledge several sources who have provided support and resources which have contributed greatly to this project. We would like to express our gratitude to Ms. Alexa Hancock and Fundación El Caño for their continued assistance and cooperation throughout the project. Ms. Hancock's full support motivated our team, and the resources she provided influenced the development of the project. We are grateful for the organizational efforts of Ms. Hancock and other members of Fundación El Caño.

Furthermore, we would like to extend thanks to Ing. Ricardo Montanari of Footprint Possibilities Inc. for his continued dedication to guiding our project. Ing. Montanari's advice and contributions directed the development of our project. We are appreciative of the support and the opportunity which Ing. Montanari and his organization provided.

We would like to express our gratitude to Prof. James Chiarelli of Worcester Polytechnic Institute for his aid regarding our paper and presentation. His archaeological expertise, experiences and instruction helped make our project successful. We would also like to extend thanks to Prof. Robert Kinicki of Worcester Polytechnic Institute for his efforts and guidance during the process of developing our virtual tour application, paper, and presentation. His constant willingness to provide direction for our team assisted the progress of our project.

Finally, we would like to offer our gratitude to Worcester Polytechnic Institute for providing the opportunity to collaborate with Fundación El Caño and Footprint Possibilities Inc.

Executive Summary

Panama's Pre-Columbian history of native cultures in the modern-day Coclé province is essential nonexistent. Testimonials from Spanish invaders are the only documentation remaining regarding the indigenous people decimated by disease, infection, and warfare. Archaeological excavations in the Coclé province, specifically at the El Caño Archaeological Site, led to the discovery of seven tombs with over three dozen human burials buried with gold artifacts (Mayo et al, 2016). The archaeological discoveries at El Caño are the most significant discoveries in the Gran Coclé Archeological Culture complex and further the knowledge of Pre-Columbian burial rituals and chiefdoms of the indigenous people from an area that is now central Panama.



*Figure 1: Gold monkey discovered at the El Caño Archaeological site
Image Source: Fundación El Caño Repository, 2020*

Fundación El Caño converted the El Caño Archaeological Site into a park and founded a museum on the premises to display the gold artifacts discovered at the site (see Figure 1). Fundación El Caño funds all excavations at the archaeological site and maintains both the park and museum. Fundación El Caño's online artifact repository stores images and descriptions of all the artifacts discovered at the El Caño Archaeological site. The online repository along with

select images of the park on Fundación El Caño's website are the extent of the museum and park's online presence. To experience the El Caño Museum and Park and learn about the historical significance of the site, given the current online resources, can only be achieved through visiting the site. Fundación El Caño's website and the online repository do not capture the historical significance of the museum and park to the same extent as physically visiting the site.

The goal of the project, sponsored by Fundación El Caño and Footprint Possibilities Inc., was to create a virtual tour application that enables the user to experience both the archeological museum and park without traveling to the archaeological site. The team researched pre-existing virtual tours and examined the successful features of three museums: the Salvador Dalí Theater-Museum, the Van Gogh Museum in Amsterdam, and the Smithsonian National Museum of Natural History. After determining key elements to include in a virtual tour, the team researched four different applications to develop a virtual tour: Unity, Matterport, Google Tours, and JavaScript. Unity satisfies all the requirements of the sponsor and allows for the integration of all the key elements of a successful virtual tour, therefore the team selected Unity for development of the virtual tour application.

To guide the creation of the virtual tour, the team divided the development of the tour into four phases: gather resources, develop a virtual tour, review and refine the application, and develop a manual for the application. Due to the travel restrictions imposed by the COVID-19 pandemic, Ms. Alexa Hancock, our contact and sponsor from Fundación El Caño, established a Dropbox to upload textual information, 2D images, and 360-degree images for inclusion in the virtual tour application. Ms. Alexa Hancock captured all 360-degree images on the Insta360

Nano and the Samsung Gear 360 camera. The team selected the Insta360 Nano camera to take 360-degree photos of the museum and park due to its affordable price and ease of use. Through Ing. Rick Montanari's contacts, the International School of Panama loaned Fundación El Caño a Samsung Gear 360 camera to use in parallel with the Insta360 camera.

The team developed the virtual tour application in two phases: the museum segment of the virtual tour and the park segment of the virtual tour. The museum segment development was first and took significantly more time than the park segment. During museum segment

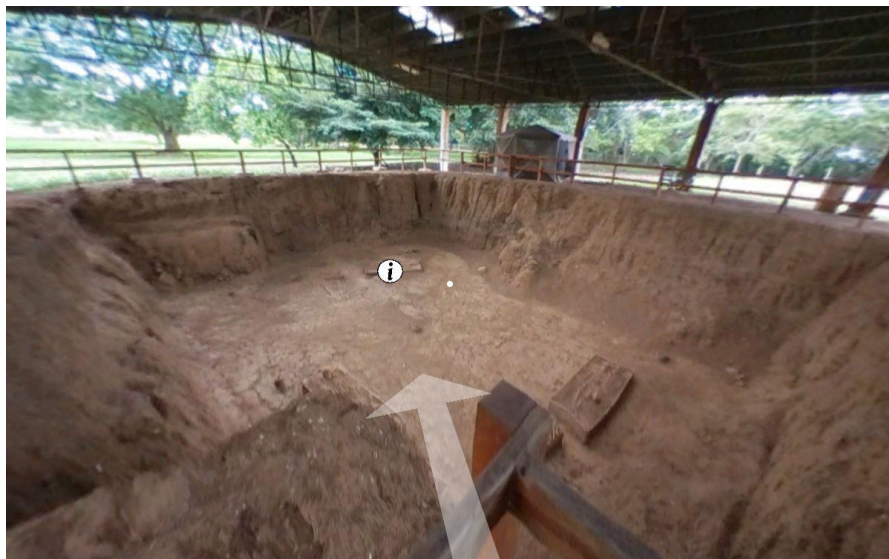


Figure 2: Example of an area of interest with a popup and arrow

development the team learned how to use Unity's development platform, and how to write scripts to create the navigational and informational features. The virtual tour utilizes the capabilities of Unity's Asset system to create popups to display the information and 2D visuals for the user, and arrows on the floor for navigation throughout the tour (see Figure 2). The museum tour includes twelve 360-degree image locations throughout the museum that give the user access to the eleven display cases and three informational panels in the museum. The eleven display cases provide details about the display case including additional popups of each artifact

with specific historical and scientific information. The park tour includes eight locations throughout the park with ten points of interest including additional images and text to give the user information about the points of interest.

After completing both segments of the virtual tour, the team released surveys to a diverse set of individuals to gain feedback and recommendations for the virtual tour application. The surveys collected information from both English and Spanish speakers as well as people with different levels of experience with technology. Based on the feedback the team received, 50% of

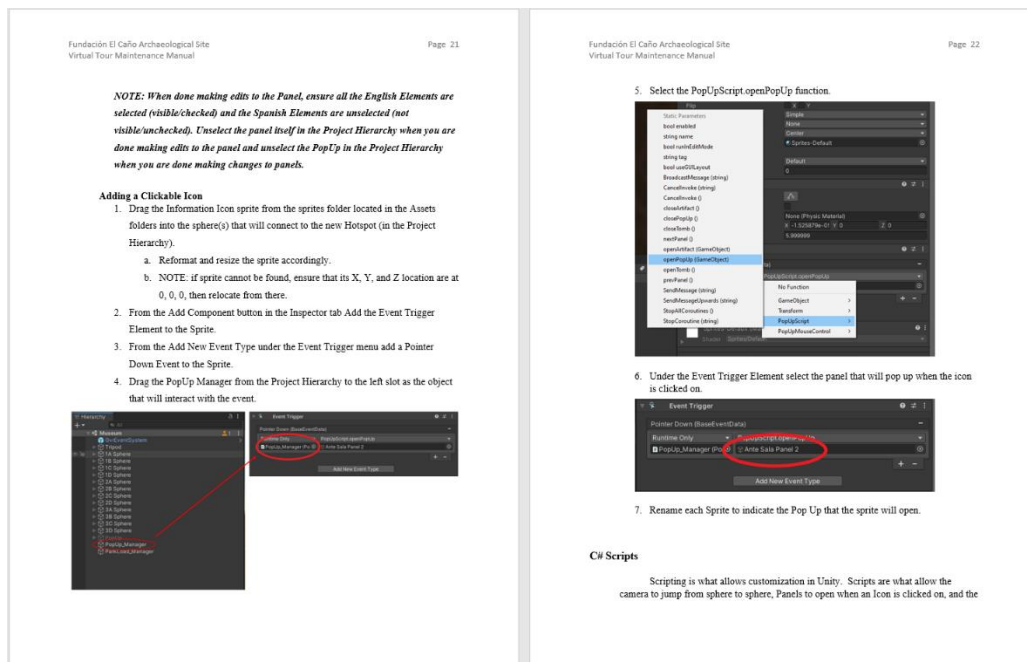


Figure 3: Screenshot of page 21 and 22 of the maintenance manual

survey respondents indicated that making the tour “more intuitive and easier to use” would improve the virtual tour application. The team enhanced the virtual tour application based on these responses by adding navigational instructions, integrating in redundancy, and streamlining the park tour path. In addition to navigational errors, the survey responses indicated that the load

times of the application were not satisfactory. The team reduced load times by decreasing image file sizes and reducing the project storage size to improve user retention.

In addition to the deliverable of a virtual tour application for our sponsors, Fundación El Caño and Footprint Possibilities Inc., the team wrote a manual detailing the steps for maintenance and future development of the virtual tour application (see Figure 3). The maintenance manual discusses several of the processes that are essential to the tour, such as adding new spheres to create new “environments” using the 360-degree images, populating those spheres with popups and navigational elements, and filling those popups with information and visuals. In addition, the manual contains information relevant to loading of the project and uploading the newest version of the project. The maintenance manual allows Fundación El Caño to update and modify the tour to include more artifacts or information as excavations continue at the archaeological site.

A virtual tour expands the global presence of Fundación El Caño, and the discoveries of the archaeological site. According to our survey over 75 percent of users agree that the virtual tour application successfully promotes the El Caño Archaeological Museum and Park. Through a virtual tour application more of Panama’s history and culture is accessible globally, through the display of artifacts found at the El Caño Archaeological site. The increased virtual presence of the El Caño Archaeological Museum and Park is important in promoting and funding excavations at the archaeological site, while also providing a greater global audience for the information at the museum and park. The team hopes that the virtual tour deliverable continues to aid Fundación El Caño by providing the outreach and notoriety that other museums enjoy.

Authorship

Cory Helmuth, Michael Reilly, Molly Sykes, and Andrew Whitney all contributed to the research, writing, and development of this project. All team members contributed to editing the paper and revising sections. The following is a breakdown of how the team contributed on the project.

Cory Helmuth was a co-author for the Introduction, Background Information, and Methodology sections of the paper. Mr. Helmuth was the primary author for the Recommendations and Conclusion chapter and was the primary photo editor for the images used in the deliverable. Mr. Helmuth was the primary author of the surveys used for the application feedback and was the primary author for Appendices B, C and D.

Michael Reilly was a co-author of the Executive Summary, Background, Methodology, and Results and Analysis. Mr. Reilly was a secondary developer for the virtual tour application. Mr. Reilly was also a co-author of the Maintenance Manual and collected all the images for the Maintenance Manual.

Molly Sykes was the primary author of the Abstract and Introduction, and the co-author of the Executive Summary, Background, and Methodology. Ms. Sykes was also the primary author of Appendix A. Ms. Sykes served as the primary contact between the team and sponsors. Ms. Sykes was the primary developer of the popup formatting and content integration. Ms. Sykes was a co-author of the Maintenance Manual and primary editor. In addition, Ms. Sykes was the primary editor for the entirety of the paper and compiled all sections into a cohesive document.

Andrew Whitney was a co-author of the Introduction, Background, and Methodology. Mr. Whitney was the primary author of the Implementation and Analysis. Mr. Whitney was also

the primary author of the Maintenance Manual. Mr. Whitney was the Lead Developer and Project Manager for the deliverable. Mr. Whitney also facilitated the transfer of the virtual tour application from the team to the sponsors.

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Chapter 1: Introduction

Archaeology is the study of past human behavior and culture through the recovery and analysis of artifacts and human activities as preserved in the archaeological record. Excavation of artifacts and structures serve as a historical reference for undocumented and pre-literate civilizations, providing understanding of how and why cultures change and evolve over time (“Value of Archaeology”, 2015). Documentation of native cultures prior to the discovery of Panama in the 1500s in the modern-day Coclé Province is almost nonexistent. The Gran Coclé Culture Area, the civilization discovered through archaeological digs in the Coclé Province, is a



*Figure 4: Gold pectoral with design of bipedal figures
Image Source: Fundación El Caño Artifact Repository, 2020*

collection of smaller archaeological digs that archaeologists connected through their similar pottery styles. However, this archaeological area lacks funding from the government to display and share the artifacts that organizations have excavated while also continuing excavations (“Pre-Columbian Coclé Pottery”, n.d.).

One of the most monumental archaeological digs in the Gran Coclé Culture Area is the excavation of El Caño's seven tombs led by Dr. Julia Mayo, which revealed the human remains of three dozen individuals of varying age, sex, and status (Mayo et al, 2016). Dr. Mayo's team found human remains placed next to valuable objects made of gold such as ear ornaments, pendants, belts, bracelets and pectorals (see Figure 4 and 5) as well as other objects such as perishable goods and ceramics (Kaal et al, 2019).

The archaeological discoveries at El Caño are significant for the Gran Coclé Cultural Area because they provide knowledge regarding burial rituals and suggest that the civilizations were chiefdoms, characterized by the presence of a chief, social hierarchy, and economic



*Figure 5: Cast gold earring figurine
Image Source: Fundación El Caño Artifact Repository, 2020*

interdependence (Williams, 2013). The social hierarchy is an important factor when classifying civilizations because burial practices provide insight into the political and economic structure of its people. Fundación El Caño, the organization that manages the excavation site of El Caño, established a park and opened a museum on its grounds in April 2019 to display a portion of the artifacts from the excavation of the seven tombs. Fundación El Caño is a non-profit organization

committed to the conservation and investigation of the archaeological heritage of Panama (“Fundación El Caño”, 2020). To further the outreach of the El Caño museum and park, Fundación El Caño aims to create a virtual tour of the museum and park in collaboration with Footprint Possibilities Inc. and Worcester Polytechnic Institute IQP Students. A virtual tour allows the global public to experience the museum and park while learning about Panamanian culture. In addition, the creation and documentation of a virtual tour for a small foundation like Fundación El Caño serves as an example of a multi-media tool that other small museums, parks and historic sites like Sitio Conte and Monagrillo in Panama can also employ to share Panamanian culture with a greater audience.

Fundación El Caño currently has a mobile application that enables users to take a self-guided tour of the archaeological park (Baez, Kandaras, Louis & White, 2019). It utilizes a map of the site, along with pictures and captions, to provide information on various features of the park for visitors in English and French. The self-guided tour application allows a greater audience to experience the park while in El Caño, Panama. A virtual tour expands accessibility to the global public to experience the museum without traveling to the El Caño Archaeological Museum and Park in Panama. The virtual tour would simulate the experience of visiting El Caño and walking through the park and museum. In addition, a virtual tour gives the park an avenue in the future to expand and change their exhibits.

The goal of this project was to develop a virtual tour of the El Caño Archaeological Park that is more accessible to people around the globe. By creating a framework for this virtual tour, the project set the groundwork for other archaeological sites and parks in Panama. Through researching preexisting museum virtual tour applications, collecting pictures and graphics, designing the virtual tour application, conducting user surveys, refining the virtual tour

application and creating a cohesive maintenance manual, the team created a virtual tour for the El Caño Archaeological Park and Museum.

Creating a virtual tour application for El Caño Archaeological Park provided a unique opportunity to display the cultural significance of the El Caño Archaeological Park and Museum, and the importance of the artifacts for Panama's history with a global audience. The main stakeholders of the project who will benefit from the virtual access to the museum and park are students, academics, the museum staff and the members of the general public who are not able to visit the site. The virtual tour application allows the visitor to walk around the site with 360-degree images displaying the museum and park. Arrows act as the means of navigation to allow the user to move between the different images and areas. Inside each 360-degree image, information icons allow the user to inspect display cases, artifacts, excavation sites and display panels that provide the user with textual information and visuals.

Chapter 2: Background and Literature Review



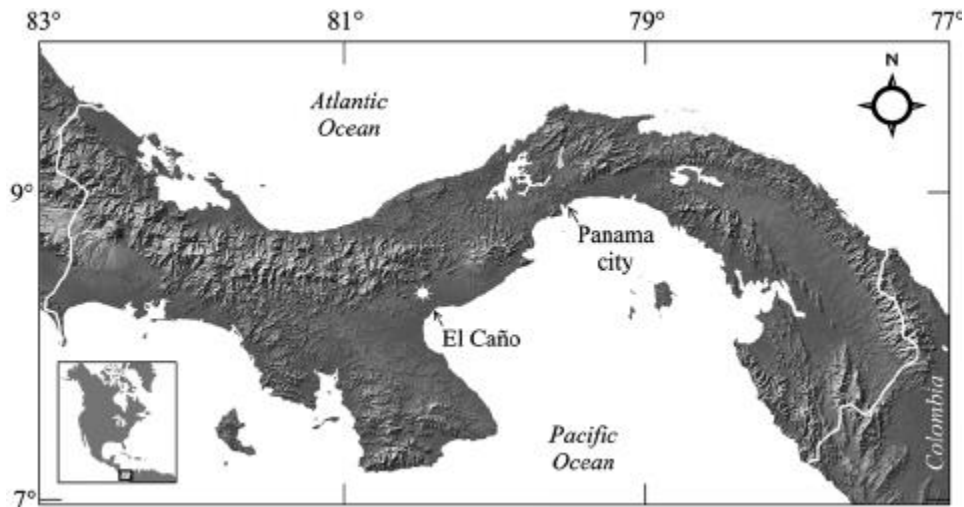
*Figure 6: El Caño Archaeological Park
Image Source: Hancock, 2020*

The creation of a virtual tour application for the El Caño Archaeological Museum and Park (see Figure 6) connects the globe with Panama’s culture discovered through the excavations at the El Caño Archaeological site. The background chapter presents research conducted on the history of the museum and park at El Caño, and on pre-existing museum virtual tour applications. In addition, this chapter explores the impact of a virtual tour application. Research conducted on published literature provides information regarding the topics stated above.

2.1 Culture and Geographical Location

The city of El Caño, located in the Coclé Province of Panama (see Figure 7), has a population of approximately 265,000 people (“Instituto Nacional de Estadística y Censo”, 2019). The province is primarily an agricultural area, supported by its tropical rainforest biome. The Tabasará mountain range begins near the Coclé province and runs east/west through the middle of the province, splitting the province into two distinct areas. The majority of the population and

development in the Coclé province is in the lower half. The mountain range continues to grow as it runs west through Panama toward the Costa Rica border range.



*Figure 7: Geological Map of El Caño and its Surroundings
Image Source: Tabbagh, 2014*

Due to the violent nature in which the control of Panama shifted from indigenous chiefdoms to the Spanish conquistadors, archaeologists have sparse knowledge of Panama's pre-Columbian history. Archaeologists have identified the chiefdoms in the area around El Caño as the Cueva and Coclé chiefdoms ("History of Panama (to 1821)", 2020). The Spanish invaders brought disease, infection and warfare to the Cueva and Coclé chiefdoms, decimating the population, and causing the migration and dispersal of the indigenous peoples. The only documentation remaining from this period are testimonials from European explorers with basic observations of the indigenous chiefdoms. Archaeological findings, such as the tomb discoveries at the El Caño archaeological site, supply much of the evidence to provide a history for the Cueva and Coclé chiefdoms and the Pre-Columbian era in what is now central Panama.

2.2 El Caño Archaeological Park and Museum

Hyatt Verrill discovered the El Caño Archaeological site in 1925 and excavated three human burials. Archaeologists in the United States largely ignored Verrill's findings and consequently the archaeological community overlooked them (Araúz, 1982). In the 1970s the National Directorate of the Historical Heritage of Panama restarted excavations as the



Figure 8: El Caño Archaeological Museum Façade
Image Source: Hancock, 2020

archaeological site regained global interest. However, the combination of political unrest as well as diminishing results led scientists to abandon the site again. Archaeologist Dr. Julia Mayo, equipped with more advanced surveying equipment, determined the El Caño site warranted another excavation in the early 2000s (Owen, 2011). Led by Dr. Julia Mayo, the most significant excavations began in 2008 and continued past 2011, resulting in the discovery of seven tombs and over three dozen human burials.

Fundación El Caño converted the excavation sites at El Caño into the El Caño Archaeological Park in 1979 following their rediscovery (see Figure 6). During the founding of

the park, the organization constructed a building (see Figure 8) on the premises of the newly formed park mirroring the architecture style of local homes. Fundación El Caño converted the building into the El Caño Archaeological Museum (see Figure 9) in 2019 to display the gold artifacts discovered in the tombs of El Caño (“Fundación El Caño”, 2020). The size of the original building restricts the museum space, limiting the exhibit area to one room and eleven display cases. The El Caño Archaeological Museum and Park provides an abundance of information regarding Panama’s historical and cultural background through the display of artifacts and excavations sites.

2.2.1 Significance of El Caño Archaeological Park and Museum

Excavations of the El Caño archaeological site revealed seven tombs with over three dozen human burials (Mayo et al, 2016). Archaeological crews discovered male skeletal remains with gold artifacts that symbolize high status in two of the excavated graves. The gold artifacts are objects such as pectorals, ear ornaments, pendants, belts, figurines, and bracelets (Kall et al,



*Figure 9: El Caño Archaeological Museum Main Exhibit Room
Image Source: Hancock, 2020*

2019). All the tombs at El Caño contain multiple simultaneous burials but vary in the number of burials in each tomb. The practice of multiple burials suggests a hierarchical burial system in which graves of high-status individuals contained the bodies of lower ranking citizens

(“Fundación El Caño”, 2020). Excavations at the El Caño Archaeological Park are very important to Panamanian culture as the discoveries further public knowledge of Pre-Columbian burial rituals of the Cueva and Coclé chiefdoms.

In addition to the significant historical developments for pre-Columbian Panamanian culture that the discoveries at the El Caño Archaeological Park provides, the artifacts detail the beauty and intricacy of the culture. The gold artifacts from the pre-Columbian indigenous chiefdoms are awe inspiring due to the intricacy of the patterns and details inscribed in them (see Figure 4 and 5). The opulence of the gold artifacts of El Caño draws attention to the discoveries made at the site, while also indicating individuals with high-status in the chiefdoms were most likely buried there. Exhibition of these gold artifacts promotes the continued study and excavation of the archaeological site critical to the understanding of the Pre-Columbian history of Panama.

2.3 Stakeholders

The creation of a virtual tour application for the El Caño Archaeological Museum and Park provides the ability to display and share the cultural significance of the artifacts and excavation sites found at the park. Although our team is working with Fundación El Caño, the people that benefit from the application are more than just the foundation’s staff. Academics, park visitors, students, and others who are not able to visit the site, benefit from the creation of this application and are the major stakeholders for the creation of the virtual tour. The sponsors assisting with the creation of a virtual tour application are Footprint Possibilities Inc. and Fundación El Caño. Footprint Possibilities Inc. is a United States-based group that acts as an intermediate between student organizations from the United States and foreign organizations

who are seeking to collaborate (“Footprint Possibilities Inc.”, 2020). Fundación El Caño is the primary organization responsible for the excavations, research, and display of the artifacts located at the El Caño Archaeological Site (“Fundación El Caño”, 2020). With a virtual tour application, Fundación El Caño will be able to share the archaeological site, museum and artifacts with students, academics, and the general public.

2.3.1 Footprint Possibilities Inc.

Footprint Possibilities Inc. is a private charity based in Florida that seeks to organize and fund projects benefitting international communities. Footprint Possibilities Inc. states in their mission that they wish to serve as a point of contact for local agents of US-based student organizations wishing to work in Panama (“Footprint Possibilities Inc.”, 2020). They focus on programs that enhance the connection between a community and an aspect of that group, such as the environment around them or their culture. Footprint Possibilities Inc. served as a liaison for projects with Worcester Polytechnic Institute Interactive Qualifying Projects (IQP) in the past such as a project in San Lorenzo del Chagres which focused on the distribution of clean drinking water to the area, as well as Fundación El Caño to create a mobile application featuring a guided tour of the archaeological site (Baez, Kandaras, Louis & White, 2019).

2.3.2 Fundación El Caño

Fundación El Caño funds and leads most of the archaeological work undertaken at the El Caño archaeological site starting in 2008. Their mission includes working to increase the connection between Panama and its cultural heritage (“Fundación El Caño”, 2020). Fundación El Caño operates and maintains both the El Caño Archaeological Park and the El Caño Archaeological Museum. The park encompasses all seven excavated tombs as well as the

uncovered monoliths at the El Caño site. The museum displays a small portion of the hundreds of artifacts excavated from the tombs in eleven display cases. Built in 1972, the museum reflects the building architecture of the time and therefore limits the available exhibition space to one room. The artifacts and their associated descriptions provide information about the burial practices and hierarchical system of the indigenous peoples of El Caño. Fundación El Caño desires to increase the global impact of the discoveries at the El Caño Archaeological Park and Museum through a virtual tour application through a partnership with Footprint Possibilities Inc. and Worcester Polytechnic Institute IQP students.

2.4 Virtual Tours

In 2019, an estimated 4 billion people were using the Internet (“International Telecommunication Union”, 2019). Digital media accessed through the Internet has increased the potential for the spread of knowledge. The World Wide Web provides access to many sources readily available to the general public, and these sources utilize a variety of multimedia formats (images, videos, sound, etc.) to convey their information.

A virtual tour simulates the experience of being in a location using modern technology. Virtual tours have been growing in importance due to the impact they have on Search Engine Optimization (SEO), the process of making a site better for search engines. Search engines search for content aimed for users. When utilized correctly, SEO can increase potential site interactions (Google Search Quality Team, 2020). Google states that knowing how to utilize SEO is important, “if you own, manage, monetize, or promote online content via Google Search” (Google Search Quality Team, 2020). Creating the Virtual Tour with SEO in mind is important on drawing more users to the site and increasing the potential audience. A positive interaction

with the proposed virtual tour will lead to users staying on the website longer than usual and makes the website more effective at drawing an audience to the organization (Sherman, 2019).

Virtual tours are gaining popularity in 2020, especially since the outbreak of COVID-19. Searches such as “Virtual tour”, “San Diego zoo virtual tour”, or “Google arts and culture virtual tour” skyrocketed in popularity in March 2020. Google labels virtual tours as a breakout trend in 2020. “Virtual Tour” has gone from a peak interest of 17% in the past 12 months to 100% interest in March and maintaining an interest over 40% from March to August (Google Trends, 2020). This newfound interest, while seemingly the result of the COVID-19 pandemic, is making a larger audience more aware of the availability of virtual tours, which will have a lasting effect even after governments lift COVID-19 travel restrictions.

Implementing a virtual tour is a process of blending images, videos, and other multimedia to attempt to replicate the experience of being in a certain location. Successful virtual tour designs overlay images with captions and interactive features, as well as providing audio and videos of interesting experiences. Using visuals provides information quickly, so users stay longer as opposed to exiting a tour early (Audet & Wilson, 2009). An organization's website hosts a tour to allow users to access the virtual tour from anywhere they have a network connection to experience the tour remotely.

2.4.1 Outreach and Impact

Small museums, such as El Caño Archaeological Park and Museum, lack the same outreach as large, world renowned institutions. The addition of a virtual tour website component for museums can increase website traffic and retain website visitors. Visitors to a website that features a virtual tour stay generally three times longer on the website (Priolo et al, 2017). In

addition to increasing website views, a virtual tour can extend access to the benefits and education of a museum to a greater population. Virtual exhibitions enable additional audiences, including people with disabilities and students of all ages, to experience and interact with the vast collection of objects in a museum (Cellary, Walczak & White, 2006).

In addition to outreach, virtual tours benefit museums by providing additional virtual exhibition space. Museums, including the El Caño Archaeological Museum, must limit the number of physical exhibits due to the size of the museum buildings causing artifacts to remain in storage. In addition, following current COVID-19 distancing guidelines limits the number of visitors allowed inside the museum and requires dedensification of the area. Virtual tours offer the best solution for museums and cultural heritage sites to display the otherwise stored artifacts and account for COVID-19 restrictions (Cellary, Walczak & White, 2006). With the additional display of artifacts through virtual tours, museums produce a more informative, immersive, and engaging experience (Priolo et al 2017). A virtual tour fabricates a space to give users a more detailed and closer experience with each artifact and creates a virtual place for museums to display more artifacts without having to expand or rotate their exhibits as frequently.

2.4.2 Virtual Tour Programs

The project team considered the sponsor's desires, cost and ease of development, suggestions from Ms. Alexa Hancock of pre-existing museum virtual tour applications, and program knowledge from coding experience when examining the virtual tour research.

The team researched potential programs to create the virtual tour. The four main applications the team initially considered were Google Virtual Tour, Matterport, Unity, and a "Do It Yourself" method using JavaScript. The team created a table to show the pros and cons

between the various methods, along with a matrix chart to provide a two-dimensional examination of the tools. Table 3 (located in Appendix A) provides the detailed and tabulated research regarding potential virtual tour applications. The table lists the pros and cons for each application regarding the following categories: cost, ease of development, and sponsor desires (3D environment, addition of virtual exhibit rooms). The matrix chart (see Table 1) compares the different applications in the same four categories as Table 3 located in Appendix A in a concise format. An “x” denotes the existence of the listed feature. The application chosen for development of the virtual tour is Unity due to the platform's adaptability, the relative ease of development compared to the other options, and the low cost. As evidenced by the matrix, Unity satisfies all the categories. In addition, Unity was the appropriate platform to use to build Fundación El Caño’s virtual tour because Fundación El Caño’s staff will be able to modify the tour, where the other options don’t have the accessibility nor the simplicity for an individual who is unable to code to modify the virtual tour.

Table 1: Summarized Matrix of Virtual Tour Applications from Table 3 in Appendix A

Application	Free to Use	3D Environment	User Support	“Virtual Exhibit Room”
Matterport		x	x	
Google Tours	x	x	x	
Unity	x	x	x	x
JavaScript	x			x

2.5 Evaluation of Museum Virtual Tour Applications

The success of a virtual tour application centers on the target audience and the desired experience. A virtual tour is an ideal solution for those not able to visit a museum or those who only want to examine specific elements or exhibits of a museum. These users desire a seamless and intuitive navigational experience. Our evaluation of three different museum virtual tours

based on virtual reality experience, perception of presence, navigation, and learning aspects (Kabassi, Amelio, Komianos & Oikonomou, 2019) provide a basis for development of a virtual tour application for the El Caño Archaeological Park and Museum. The three museum virtual tours as seen in Figures 10 through 15 are: the Salvador Dalí Theater-Museum (“Salvador Dalí Theater-Museum Virtual Tour”, 2019); the Van Gogh Museum in Amsterdam (“Van Gogh Museum”, 2020); and the Smithsonian National Museum of Natural History (“Smithsonian National Museum of Natural History Virtual Tour”, 2020).

Virtual reality experience, perception of presence, and navigability of the museum virtual tour cater to a positive user experience. The evaluation of three virtual tours defined the key desirable characteristics for these topics. All three museum virtual tours use a panning feature to “look” around the 360-degree environment. A panning feature simulates the experience of standing in a museum. The Salvador Dalí Theater-Museum and the Smithsonian National Museum of Natural History offer overviews of the museum to assist with navigation. The Salvador Dalí Theater-Museum utilizes a dollhouse view of the museum (see Figure 12) while

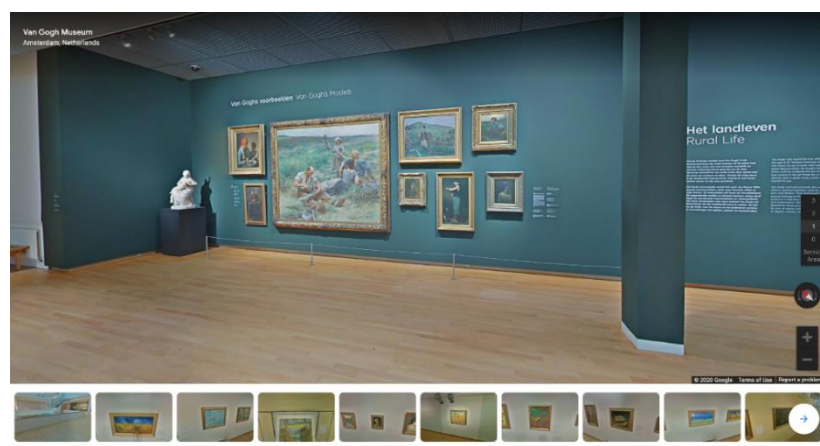


Figure 10: 3D Space view of the Van Gogh Museum in Amsterdam

Image Source: “Van Gogh Museum”, 2020

the Smithsonian National Museum of Natural History utilizes a map displayed in the upper right part of the screen (see Figure 11). The critical navigational feature of all three virtual museums tours is the navigational tool used to “walk” through the museum. The Smithsonian National Museum of Natural History (see Figure 11) uses arrows placed on the floor to “jump” ahead to

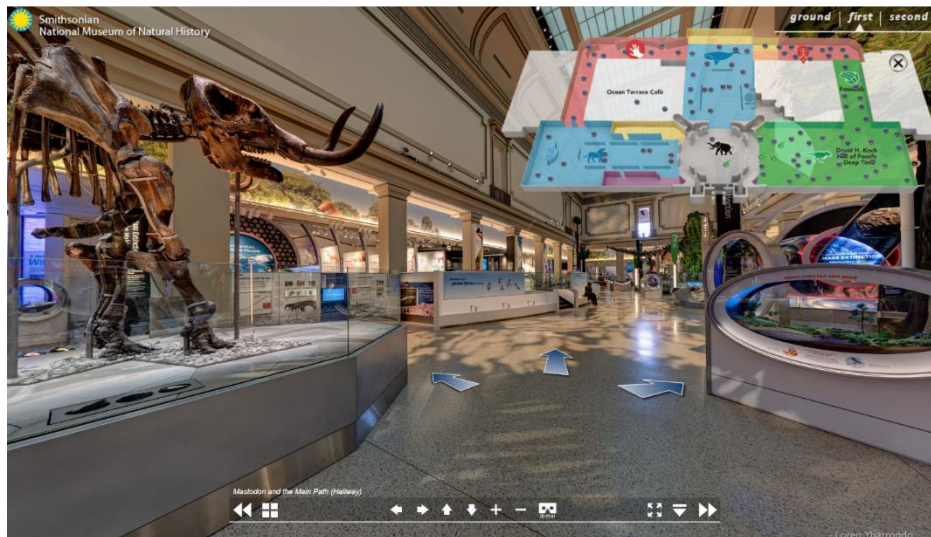


Figure 12: 3D Space view of the Smithsonian National Museum of Natural History Virtual Tour
Image Source: “Smithsonian National Museum of Natural History Virtual Tour”, 2020

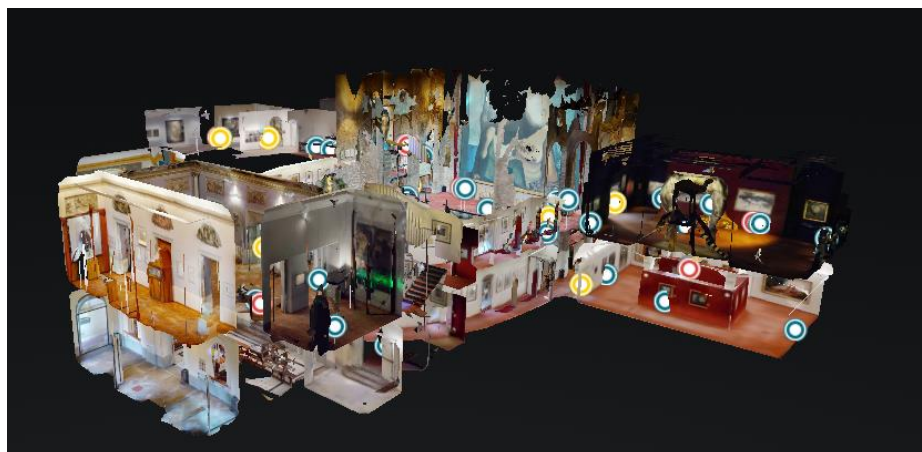


Figure 11: Dollhouse view of the Salvador Dali Theater-Museum Virtual Tour
Image Source: “Salvador Dali Theater-Museum Virtual Tour”, 2020

different exhibits and sections of the museum. The Salvador Dalí Theater-Museum (see Figure 13) and the Van Gogh Museum (see Figure 10) use a ‘click and travel’ method to navigate the museum, similar to Google Maps. The ‘click and travel’ method produces the effect of “walking” from place to place rather than the “jump” effect that the arrows engender.



Figure 13: 3D Space View of the Salvador Dalí Theater-Museum Virtual Tour
Image Source: “Salvador Dalí Theater-Museum Virtual Tour”, 2020

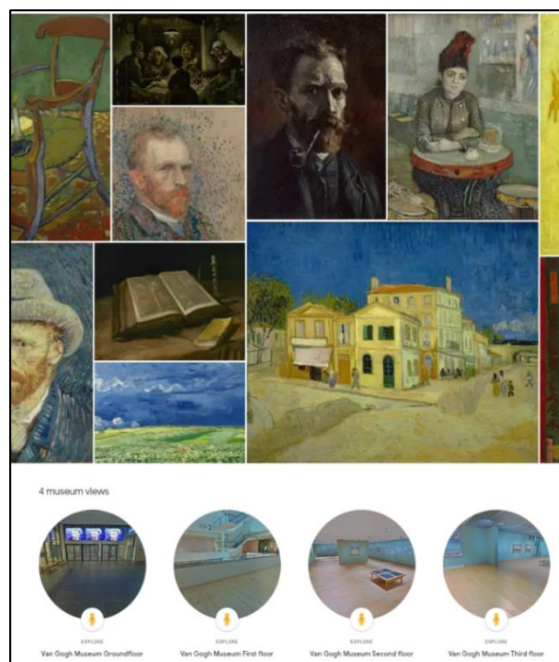


Figure 14: Launch page of the Van Gogh Museum in Amsterdam Virtual Tour
Image Source: “Van Gogh Museum”, 2020

The ability of a museum virtual tour to provide information is essential to achieve an immersive and valuable experience. A well-organized virtual tour shares information effectively and imitates the feeling of being in the physical museum, as well as providing information at every point of interest in a museum. The Van Gogh Museum does not have textual information on the exhibits within the virtual tour, but instead uses an external mosaic of pictures to present information (see Figure 14). Similarly, the Smithsonian National Museum of Natural History does not have textual information about the exhibits included within the virtual tour, but uses the camera zoom option to explore exhibit descriptions. The Salvador Dalí Theater-Museum delivers



Figure 15: Launch page of the Smithsonian National Museum of Natural History Virtual Tour
Image Source: "Smithsonian National Museum of Natural History Virtual Tour", 2020

an immersive learning experience using interactive dialog boxes (see Figure 13). Each dialog box adds specific information regarding the artifact within the exhibit.

Additional noteworthy features of the three reviewed museum virtual tours are a navigation bar at the bottom of the screen to “jump” to different exhibit rooms, displayed at the bottom of Figure 10. The Van Gogh Museum and the Smithsonian National Museum of Natural History utilize the jump feature. Supporting this feature in both museum virtual tours for

increased navigation is a launch page (see Figures 14 and 15). The Van Gogh Museum allows users to jump to different floors of the museum from the launch page while the Smithsonian Nation Museum of Natural History enables the user to jump to different exhibits.

2.6 Criteria for Success

The review of three museum virtual tours assisted in creating application criteria for the El Caño Archaeological Museum and Park virtual tour application. The team informed the sponsors, Fundación El Caño and Footprint Possibilities Inc. of the attainability of different aspects of these museum virtual tours through discussion of the potential applications. The reviews of the museum virtual tour application in combination with research regarding the impact of virtual tour applications and the cultural significance contributed to the preliminary background necessary to develop a successful and maintainable virtual tour application for the El Caño Archaeological Park and Museum.

Chapter 3: Methodology

The goal of the project was to develop a virtual tour of the El Caño Archaeological Park in Panama that is available to people around the globe hosted on Fundación El Caño’s website. The virtual tour will display the artifacts from the museum and the archaeological sites in the park, with informational text available in Spanish and English. To accomplish this goal, the team developed the virtual tour in four distinct phases:

1. Gather Resources
2. Develop a Virtual Tour
3. Review and Refine the Application
4. Develop a Manual for the Application

3.1 Gather Resources

Together, the team and our sponsors Fundación El Caño and Footprint Possibilities Inc. compiled a list of requirements for the virtual tour. After considering the purpose of the application and the desired application functions, the team developed the scope of work (see Appendix C) and the plan of work (see Appendix D). The plan of work broke the project goals into three distinct goals: development of a virtual tour of the museum and park, creation of a manual for easy edits, and development of “virtual” exhibit rooms within the virtual tour application. These documents provided the team, Fundación El Caño and Footprint Possibilities Inc. specific, measurable goals and objectives for developing the final application.

To learn about best practices and mistakes to avoid when developing a virtual tour in collaboration with Fundación El Caño and Footprint Possibilities Inc., the team assessed the current requirements for the deliverable and conducted research accordingly. The main

deliverable is a virtual tour of the El Caño Archaeological Park and Museum hosted on Fundación El Caño’s website. There are two distinct steps of the research process: collect sponsor resources and virtual tour application research.

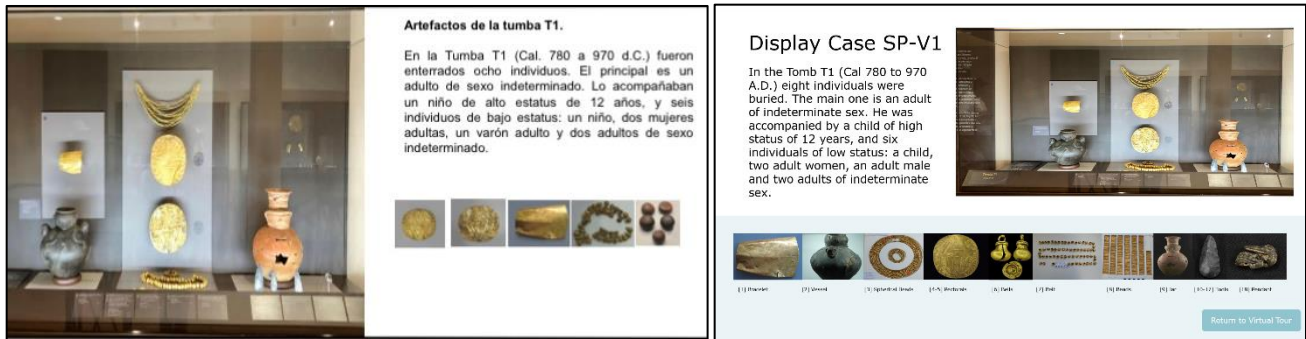


Figure 17: Display Case Formatting Iterations: Iteration 1 (left) and Iteration 2 (right)

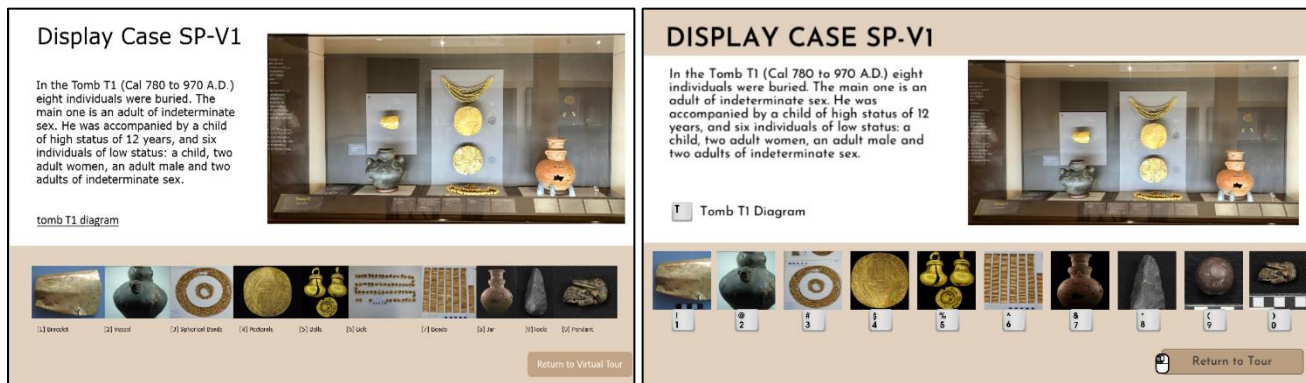


Figure 16: Display Case Formatting Iterations: Iteration 3 (left) and Iteration 4 (right)

Throughout the resource gathering phase and initial design discussions, the team and the sponsors continuously designed and refined in more detail the expected look of the application. The team and sponsors discussed these topics through Zoom meetings and through documents shared via Dropbox created by both Ms. Alexa Hancock and the team. These initial documents gave further clarification on the expected design and features of the virtual tour application discussed during the team’s meetings. A significant topic of the design discussions was the design of the popups in the tour, specifically the display case popups (see Figure 16 and 17). The

popup design had four iterations that involved changes to functionality, content, and color sections. Iteration 1 is the most rudimentary design, and the formatting limits the ability to display all the features and images across different display cases. Iteration 2 and 3 are very similar and only differ by the color scheme, where the team pulled the light blue color from Fundación El Caño’s website. However, the information display panels inside the museum are brown so Ms. Hancock chose the team a lighter shade of brown for all design elements. The final changes from Iteration 3 to iteration 4 includes the reformatting of the smaller artifact images, the addition of images to indicate keypresses and clicks, and the addition of another design element at the top of the panel.

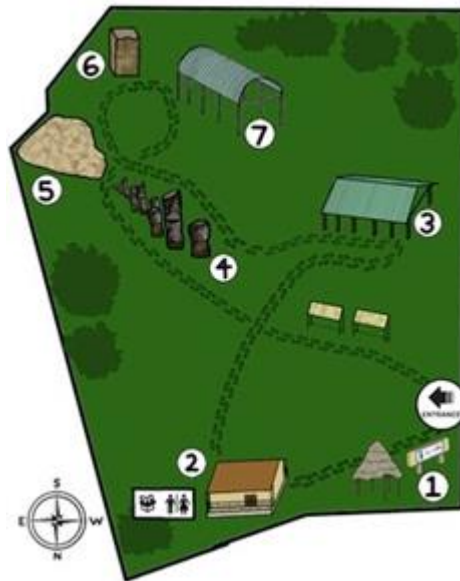
In addition, Ms. Alexa Hancock provided the English translation of the information to be featured in the virtual tour through Dropbox as well as over fifty 2D images from locations at the park, including the inside of the museum, the burial sites, and signs around the park. The documents shared include the text that displayed adjacent to artifact exhibits in the museum. By



Figure 18: 360-degree photo locations and naming for the museum section of the tour

sharing images and textual information of the park and the museum, Ms. Hancock provided the team the ability to visualize the site before planning the desired locations of 360-degree images.

Due to the virtual nature of our project and the team's inability to travel to Panama, Ms. Hancock collected over eighty 360-degree images of the locations of the park to be featured in the virtual tour. These images include the interior of the museum (see Figure 18) as well as seven different locations in the park (see Figure 19), such as the excavation sites and other areas of



*Figure 19: Map of the outdoor section of the virtual park
Image Source: Baez, K., Kandaras, M., Louis, M., White, J., 2019*

interest featured in the park. Ms. Hancock photographed the park and museum using two different specialized 360-degree cameras, the Samsung Gear 360 (“Gear 360”, 2020) and Insta360 Nano S (“Insta360 Nano S”, 2020) and then uploaded the images to Dropbox. Figure 18 clearly articulates the desired 360-degree photo locations inside the museum to guarantee sufficient collection of images. The figure displays the floor plan of the El Caño Archaeological

Museum with the display case locations shaded in grey. The blue stars indicate 360-degree photo locations, and the label numbers indicate rows, and the label letters indicate columns. The team believes employing this grid labeling is intuitive.

3.2 Virtual Tour Development

The design and development of the virtual tour involves research on preexisting virtual tour applications, see section 2.4.2 Virtual Tour Programs and 2.5 Evaluation of Museum Virtual Tour Applications. The team selected Unity based on the research tabulated in Table 1: Matrix of Virtual Tour Applications in section 2.4.2, as well as Table 3 in Appendix A. The following subsections further elaborate on the process of identifying constraints, selecting a development environment, and developing a timeline for application development. Andrew Whitney led the technical development of the application, while Michael Reilly, Molly Sykes and Cory Helmuth worked on the design process and information gathering. Breaking the team into two distinct groups more effectively utilized the skills of each team member while maintaining team wide involvement in the deliverable development. All team members contributed to all portions of the project, focusing individual efforts to areas that complement their strengths.

3.2.1 Application Design Constraints and Collecting Pictures

In the beginning stages of the design process, mockups are important for setting expectations on design and the complexity of the application. Creating mockups before any development of the application begins is important for communicating effectively what the final product will look like and keeping track of progress. As the final design elements adjusted, the team designed new mockups to better illustrate the final product.

The next step was identifying constraints before the development of the virtual tour to design the methods of implementation. The methods of implementation describe the way certain tasks are coded into the application. Identifying constraints provided the team a better understanding of the expected implementation timeline and facilitated the sponsors understanding of the timeline of development.

One constraint was that the project had a strict budget which limited the team's camera and software options. Most professional grade 360-degree cameras and professional virtual tour software packages are expensive. Budget limitations also affected the external programs and website plugins the team could use. The second constraint was programming experience; only two team members are Computer Science majors, which made designing an application a difficult task. To design an application from scratch would limit the complexity of the application. Options that did not require a lot of programming or programming knowledge were optimal. The final constraint was time as it limited the team's options when considering features to include, so looking for templates and other online tools helped reduce development time.

Designing a clear, concise, and informative home page created a starting point for the development of the tour. A home page is crucial for separating options for the visitors and allows the user to quickly navigate into the virtual tour. It also made it easier for the team to develop the tour, developing in a top down flow path, starting from the menu, and working our way down deeper into the virtual tour paths.

3.2.2 Development Collaboration

The most important part of working in a team is effectively collaborating on a project. To maintain constant, clear, streamlined communication with the entire team and sponsors, the

project used Dropbox for remote sharing and collaboration on documents. The Dropbox included a Milestone Chart spreadsheet where team members update the status of various tasks (see Figure 20). Members claimed tasks to complete throughout the process. The Milestone Chart

MILESTONE CHART

Project Start:		Wed, 9/9/2020		
Display Week:		1		

TASK	ASSIGNED TO	PROGRESS	START	END
Development				
Inside Museum Photo Integration	Mike/Andrew	100%	9/9/20	9/12/20
Outside Museum Photo Integration	Mike/Andrew	25%	9/10/20	9/20/20
Addition of Arrows and Popups	Mike/Andrew/Molly	100%	9/10/20	9/17/20
Artifact Photo Gathering	Cory/Molly	100%	9/15/20	9/20/20
Content of Popups	Mike/Molly/Andrew	100%	9/13/20	9/20/20
Main Menu	Cory/Molly	100%	9/12/20	9/18/20
Spanish Textual Review	Alexa	95%	9/16/20	9/20/20
Edits From Dr. Mayo	All	100%	9/18/20	9/20/20
Wix Website Integration	Cory/Andrew	10%	9/20/20	10/1/20
Finding and Fixing Bugs	All	20%	9/20/20	10/8/20
Final Virtual Tour Edits	All	0%	9/26/20	10/1/20
Revisions				
Edit Surveys (Spanish and English)	Cory/Molly	100%	9/10/20	9/18/20
Dr. Mayo Feedback	Molly	90%	9/10/20	9/18/20
Survey Group Selection	All	75%	9/15/20	9/20/20
Surveys Sent Out	All	0%	9/20/20	9/26/20
Review of Surveys	All	0%	9/26/20	9/29/20
Review of Application with Sponsors	All	0%	9/29/20	10/10/20

Figure 20: Milestone chart used in the developmental process of the virtual tour application

contained four sections to organize the tasks further: development, revisions, paper, and manual. Each section listed tasks relating to each topic to streamline the project progress.

The team created a repository in Microsoft Teams that facilitates working on PowerPoints and Word documents simultaneously across multiple devices, improving workflow, and increasing productivity. Additionally, the team used a Google drive account to keep track of data collected, forms, meeting minutes and agendas, surveys, and other information. The use of two information storage platforms separates the development components stored in Google Docs from deliverables stored in Microsoft Teams.

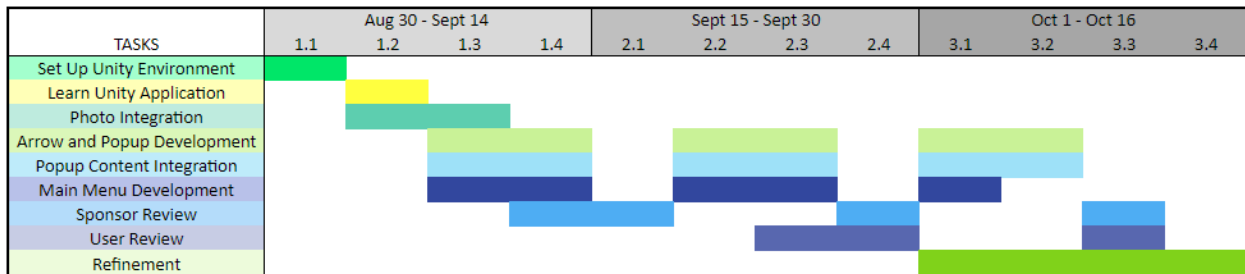
Throughout the project, the team met weekly with sponsors Ing. Ricardo Montanari and Ms. Alexa Hancock for progress updates. During these meetings, the team updated the sponsor on the application, received feedback, and adjusted deliverables as needed. The Milestone Chart was essential to keeping all groups updated in between meetings. The sponsors and the team updated the Milestone Chart by assigning tasks during meetings. In addition to weekly meetings, the team scheduled additional meetings to ensure effective communication.

The team selected GitHub as the organizational tool for the coding portion of our deliverable. GitHub is a website that utilizes the technology Git to manage code for large software projects and facilitates team members working on the same project. When a team member was done editing, they would commit their changes to the online repository. This allows each member of the team to easily control different versions of the repository, without losing information. GitHub and similar collaboration software are essential in industry for effectively creating software.

3.2.3 Development Timeline

The team strived to complete the application development stages in a timely manner to keep the project on track. Creating a structured timeline allowed the team to maintain consistent progress with weekly reflections to readjust the development actions according to issues. A structured timeline guided the team and outlined the tasks required to achieve a quality deliverable for the sponsors. The team separated different portions of the project and developed them in intervals which created smaller obtainable goals. The portioning of the project through the timeline allowed the product development to remain streamlined and allowed progress to be easy to track. The Gantt Chart (see Table 2) served as a reference for the development section of the Milestone Chart.

Table 2: Gantt Chart for expected progress of application for A term



3.3 Application Review and Refinement

A successful virtual tour application has multiple iterations during development that improve upon themselves to strive for a seamless user experience. Feedback from virtual visitors is important in the development and sustainability of any online application, especially a virtual tour application (Priolo et al, 2017). Following the final iteration of the tour prior to its submission to the sponsors, the team selected a set of individuals with varying ages, technological skill levels, and stakeholder groups to survey the virtual tour application via

Google Forms. The survey contained four sections: Personal Questions, Museum Tour Feedback, Park Tour Feedback, and Virtual Tour Application Feedback. The Personal Questions section of the survey gathered information regarding the individual's ease of use with technology, and asked individuals to identify which groups would benefit the most from the addition of a virtual tour. The Museum Tour Feedback and Park Tour Feedback sought to gain information regarding possible errors in each specific tour segment. The final section, Virtual Tour Application Feedback, contained questions regarding the overall functions of the virtual tour application such as ease of use, image and textual content, and design.

3.3.1 Survey Population Selection Process

The purpose of the virtual tour is to provide access to the information at the El Caño Archaeological Site to people around the world, specifically the people who cannot visit or do not want to visit the site. To ensure the application provides a seamless user experience for all users, including the target audience, the team selected a survey population to accurately represent the potential user audience. The identified feedback from individuals who spoke English and individuals who spoke Spanish was crucial to ensure the experience is the same for everyone using the tour. The team also prioritized people with expertise in archaeology to critique the quality of information and the way the tour presents. The team finally surveyed people with expertise in computer science in order to hopefully get feedback on possible ways to improve the technical aspects of the tour, and overall people from different age ranges to get feedback on usability and organization to the general public. With these survey respondents, the team received information that helped find defects in the program and edit the usability and design of the application.

3.4 Maintenance and Long-Term Sustainability

The main factor in the maintenance of the application is maintaining compatibility between the website from which users can access the tour and the application itself. The application requires 190 MB of data on the Fundación El Caño website. A key factor in creating a sustainable project is thorough documentation. Proper documentation allows the future staff of Fundación El Caño who wish to update the tour to view the code, make edits and adapt the tour as the exhibits change. Commenting the code, along with providing documentation in a manual is essential to keeping the product sustainable and facilitates the task of changing the product.

The team maintained a file directory that makes code easy to navigate and allows users to update images, captions, and other important information. Good organization of the code, along with quality documentation, leads to quicker and more effective maintenance while hopefully yielding fewer mistakes. The user manual (see Appendix F) provides further information of the file directory for the virtual tour.

3.4.1 Documentation

The team developed a Maintenance Manual to deal with any potential issues in the future. The team wrote the manual in Microsoft Word and is split up into five sections; the *Introduction*, *Software Preparation*, *Important Things to Understand*, *Modifying the Project*, and *Exporting the Project*. These five sections describe in detail how to change and maintain the application for the future.

Unity requires a license to use its software and an active login account. The manual details the user account setup process, the software installation process, and how to load the correct versions of Unity required for the project. Along with these steps, the manual includes

links to Unity’s website for quick access to these pages. The *Software Preparation* section in the manual covers these topics.

The manual describes in detail, with screen shots of the Unity development platform, how to modify the program (see Figure 21). The development steps are quite complicated at times and may be confusing to someone not formally acquainted with common coding practices and file structures, therefore the addition of images in the manual attempt to simplify the process. To compliment the *Modifying the Project* section, another chapter called *Important Things to*

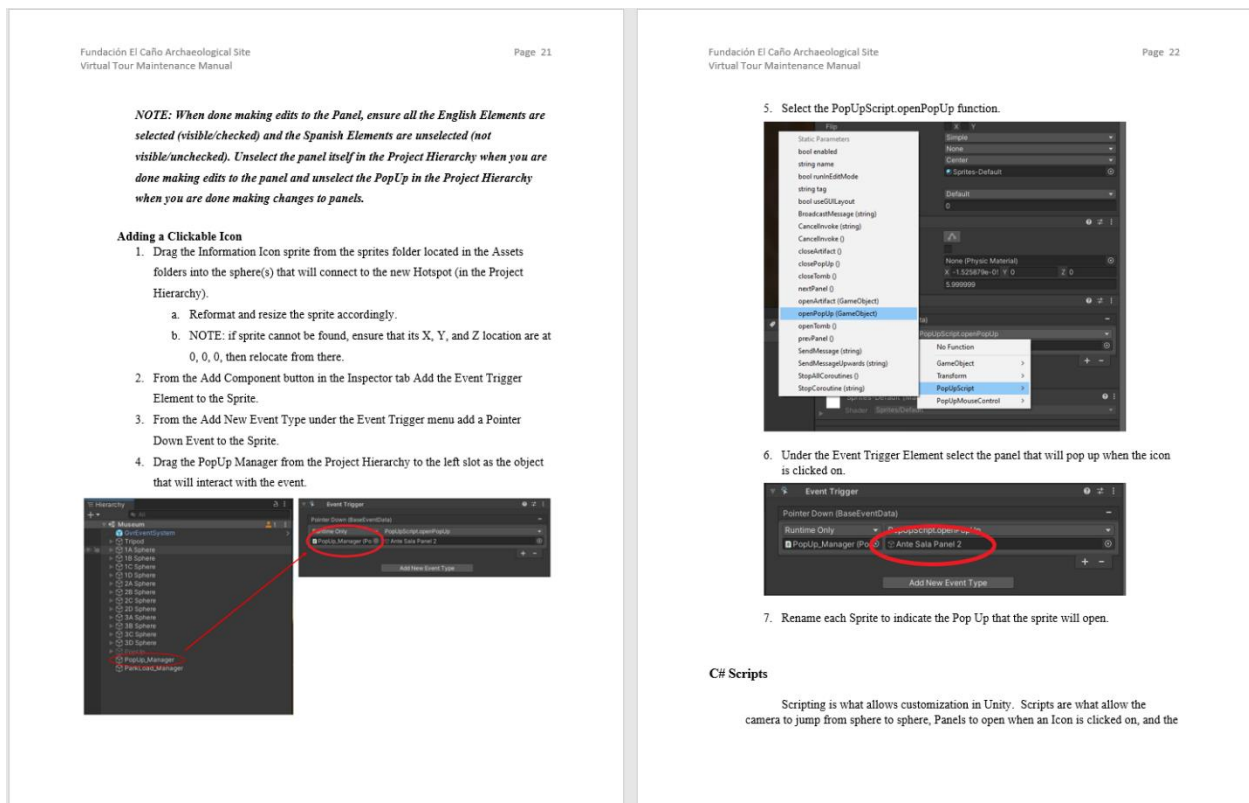


Figure 21: Screenshot of page 21 and 22 of the Virtual Tour Maintenance Manual

Understand explains and smooths the transition in understanding these confusing details. Finally, the manual includes a section that describes the process to export the project from the Unity software in the correct format to load it onto Fundación El Caño’s website.

3.5 Summary

Through the steps defined in this section, the team successfully created a web-based virtual tour application. Successful research was critical to creating mockups and collecting images. Mockups were essential for keeping the team on track throughout the project and reducing time spent developing the application. Conducting user surveys allowed for project refinement and provided a better user experience. Proper and thorough documentation allows for Fundación El Caño to maintain their virtual tour application.

Chapter 4: Implementation and Results

The team developed the virtual tour of the El Caño Archaeological Park and Museum with continual discussions and feedback from our sponsors, Ms. Alexa Hancock and Ing. Ricardo Montanari. Following the initial developmental process, the team refined the virtual tour application through the analysis of surveys. In addition, the team developed a maintenance manual to maintain and continue development of the virtual tour application following the completion of the team's involvement. This chapter details the developmental process of the virtual tour and the maintenance manual.

4.1 Development Process

The development of the virtual tour application used a platform which enabled the combination of visuals and text in an interactive manner to allow users to virtually tour the museum and park. The initial platforms candidates were Google VR Tours, Matterport, Unity, and JavaScript.

The team chose Unity due to its community support, ease of use as a development tool, and maintainability. Unity offers Unity Collaborate, which is Unity's Version Control System (VCS). Unity Collaborate allowed the team to work concurrently on the same application from multiple computers, thus speeding up the development process. Breaking the development of the application into two sections made the developmental processes more streamlined. Section one was the development of the museum tour, and section two was the development of the park tour. The team decided to develop the museum portion of the tour first due to its grid-like organization and the ability to resolve the problem of presenting the artifacts. The team concluded that by

developing the framework for presenting the artifacts and the museum the development of the park would be more efficient.

While developing the museum section of the application, development moved slowly as the team learned how to use Unity. The team was able to utilize assets from GoogleVR's SDK for Unity. Assets provide a technique to register clicks with a dynamic reticle. Referencing forums on Unity's website was crucial for learning how to place 360-degree images inside of spheres and using a mouse to look around the virtual space. Furthermore, the team followed a YouTube tutorial by Nicholas Dingle on interacting with sprites to transition between spheres (Dingle, 2017). After developing the core framework, the team presented progress to the sponsors and then began development of the museum portion of the virtual tour.

Once the team received the 360-degree photos from Alexa, the next step was to add the images to the project and a sphere for each location. Placing 2D arrows in the environment and connecting the spheres with these arrows enables the user to navigate between the spheres. The following development included the creation of the pop-up panels to enhance the user's experience. The team created a script in C# that would interact with objects in the application, allowing the user to click on specific exhibits and learn more information. After consulting the sponsors, the team added additional panels for each artifact within the exhibit, allowing for a more immersive experience of the artifacts. Modifications to the script allowed for opening new popups of artifacts while the display case popup is still open. These modifications included methods of using the keys on the user's keyboard to allow the association of artifact pop-ups with their exhibit. Later alterations to this script added the means for the pop-ups to contain both the English and Spanish text for all panels, so the user could view the tour in either language. For the use of both languages to be successful, the team researched how to make global variables

persist across objects and scenes. Global variables persisting across objects and scenes is possible by creating a static C# Object with public variables.

Following the completion of the museum portion of the tour, the team began development of the opening screens of the virtual tour to select a language preference and the starting location in the virtual tour. The design of each of the sections of the tour (the main menu, the museum tour, and the park tour) as separate scenes allowed the application to keep random access memory (RAM) usage down. Creating another C# script provided a useful tool for loading the desired scene, while unloading the inactive ones. Additionally, this script is responsible for loading the user's language selection. The team then turned its attention to the outdoor park section of the tour.

Development of the park section went faster than the museum because the framework required for development already existed and there were less pop-ups to include. While incorporating the park section, the team created a method for the user to switch between the park and museum without having to reload the application. The goal of this additional feature was to provide a more immersive user experience. The second to last phase of the application development included hosting the application on a WPI server for the sponsors to view, present feedback and suggest changes. When the team revised the tour, a team member updated the server with the edited project for all members and sponsors to continuously review. After the completion of both the museum and park tour sections, the team produced a webpage containing links to the survey in English and Spanish, along with a link to the tour.

The collection of feedback involved the distribution of the webpage to a variety of survey groups to gain insight on the state and quality of the virtual tour application. The team then

processed the results of the surveys to improve and refine the project. After the completion of all the minor revisions, the team developed future major revision suggestions covered in the recommendations section (Chapter 5).

4.2 Virtual Tour

Figure 22 illustrates the user experience of the virtual tour in a hierarchical diagram of the click paths in the virtual tour. The diagram starts at the launch pages to enter the tour, and then identifies the selections available in each tour segment. This hierarchical diagram illustrates the tier structure of the virtual tour application, with tier one at the top of the diagram, labeled as

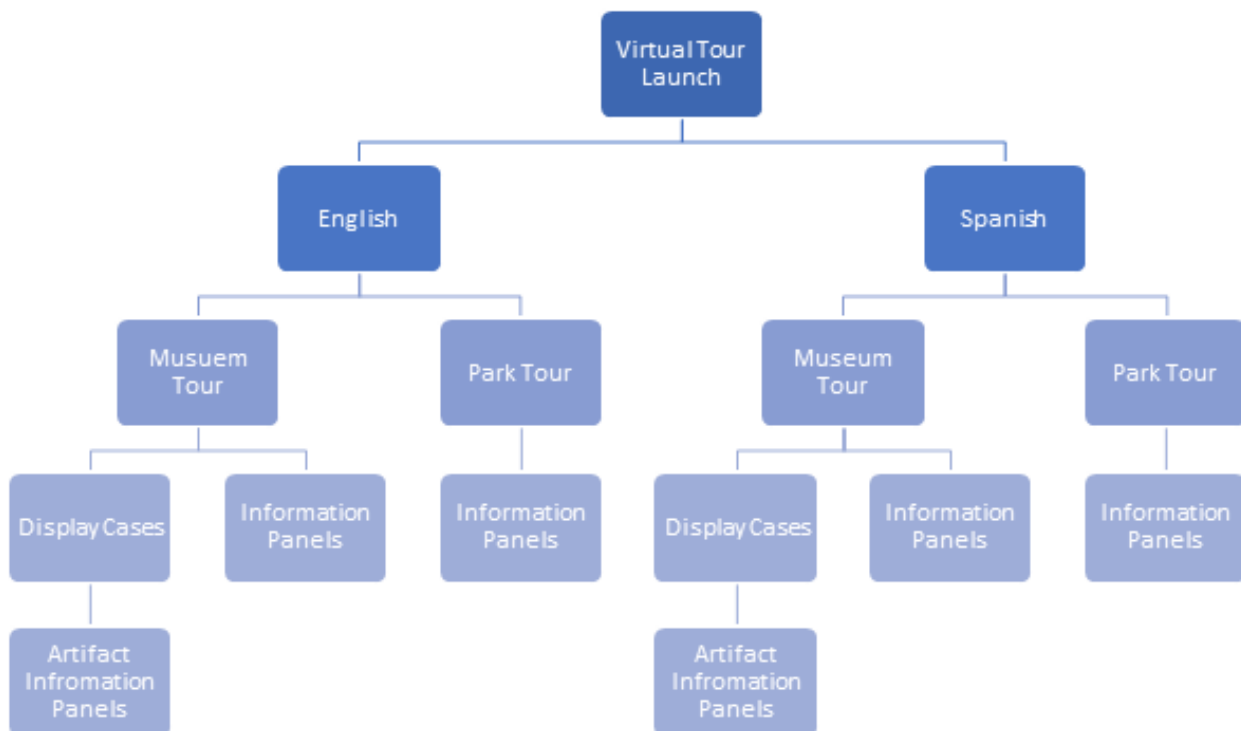


Figure 22: Click Path of the Virtual Tour Application

virtual tour launch. The program launches (tier 1) and displays a page prompting the user for a language selection, English or Spanish (tier 2). After a language selection, the second launch

page prompts the user to select which portion of the tour to explore, the museum or the park (tier 3). The selection of a tour segment brings the user into the virtual tour application at the specified location allowing the user to explore the El Caño Archaeological Site. The selection of the museum tour branches into two additional selection paths, the selection of information panels and the selection of display cases (tier 4). The information panels display information regarding the museum's history and significance, while the display cases provide details about the artifacts inside the museum. Inside a display case selection an additional selection of artifact descriptions is available which presents specific details about each artifact (tier 5). Returning to the tour segment selection page (tier 3) and selecting the park tour brings the user to an additional selection of informational panels with information pertaining to the archaeological excavations around the park. The following sections describe the different paths the user can take.

4.2.1 Language and Location Selection

The launch page of the application offers the user a language selection to experience the virtual tour in either English or Spanish. The launch page (see Figure 23) has two language selection buttons at the bottom of the screen with a background image of the archaeological park. Following the language selection on the launch page is the tutorial page which informs the user how to interact with the tour (see Figure 24). The page notifies the user about clicking the icons for popups, arrows for navigation, clicking to exit the main panels, and pressing the “B” key to exit the artifact panels. The final page of the main menu is the tour selection page. The tour segment selection page presents two choices for the user to enter the tour - the Museum Tour or

the Park Tour. The tour segment selection page (see Figure 25) contains two tour selection buttons at the bottom of the screen, as well as the logos of the sponsors for the tour application.





Figure 23: Launch page of El Caño's Virtual Tour Application (Language Selection Page)

Image Source: El Caño Archaeological Park Virtual Tour Application, 2020



Tips & Tricks

Icons


These are located around the museum and park, using the white dot, click on the 'i' icons to learn more about exhibits and points of interest, click on the door icon to go between the park and museum.

Interaction

These are located on each pop up, press the keys on your keyboard to interact with corresponding items on the menu, or left click on your mouse if the mouse is shown.

Navigation



Arrows are located "at your feet", look down and click on them using the reticle to move between location.

Continue

Figure 24: Tips and Tricks page of the El Caño's Virtual Tour Application

Image Source: El Caño Archaeological Park Virtual Tour Application, 2020



Figure 25: Tour segment selection page of Fundación El Caño's Virtual Tour Application
Image Source: El Caño Archaeological Park Virtual Tour Application, 2020

4.2.2 Navigating the Museum Tour

Following the selection of the museum segment of the tour from the tour segment selection page, the tour loads at the entrance of the museum (see Figure 26). From the starting location, the user navigates through the tour by clicking on arrows located on the floor of the

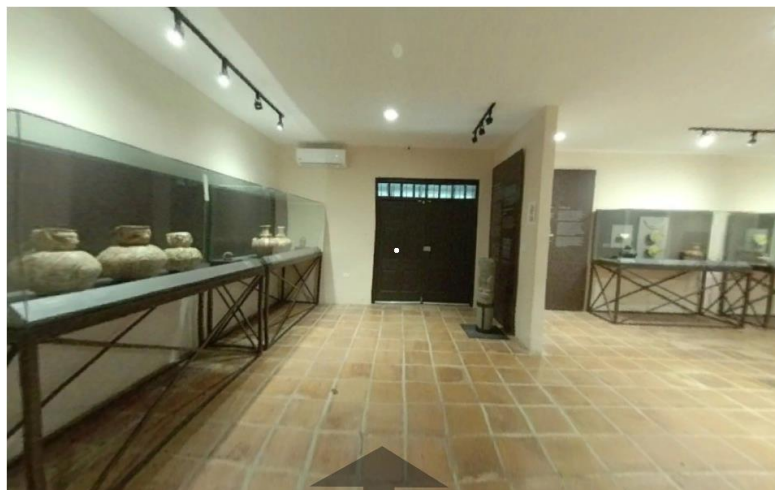


Figure 26: User's perspective museum tour section
Image Source: El Caño Archaeological Park Virtual Tour Application, 2020

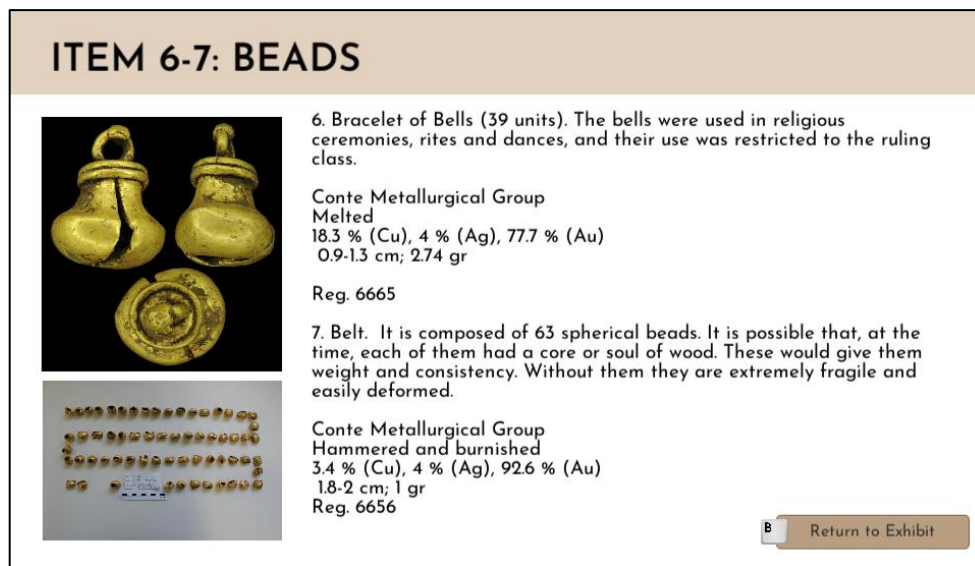
virtual museum. To access the information provided in the tour the user can click on information bubbles denoted by an information icon. The icon gives the user access to informational panels and display cases. The museum portion of the tour contains four information panels and eleven display cases containing information and artifacts from the excavations at the park. The selection



Figure 27: Museum tour display case popup
Image Source: El Caño Archaeological Park Virtual Tour Application, 2020

of a display case in the museum virtual tour displays a popup for the specified display case along with a description of the display case, a 2D photo of the display case, a key press option to access a diagram of the tomb related to the artifacts in the display case, and key press options to options to access more specific details about each artifact in the display case (see Figure 27). The key press “T” accesses the diagram of the tomb that shows the excavation location of each artifact which is denoted by a “T” keyboard icon. Ten additional photos of artifacts from the display case line the bottom of the screen, along with their respective keyboard button graphics 1 to 0 (see Figure 27). Pressing any of these numbers on the user’s keyboard accesses an additional popup with more detailed information about each artifact, such as the chemical composition,

size, and historical significance (see Figure 28). As noted at the bottom of the artifact panel, the key press “B” returns the user to the display case popup, and a click, denoted by a mouse click icon, returns the user to the museum tour. The display case and artifact popups provide the primary source of information in the virtual tour.



*Figure 28: Museum tour artifact popup
Image Source: El Caño Archaeological Park Virtual Tour Application,
2020*

4.2.3 Navigating the Park Tour

The selection of the park from the park segment selection page places the user outside the museum. The park tour has the same navigational features and information icons as the museum tour. The park tour navigates the user to various excavations, monoliths, and information boards around the park (see Figure 29).

The Park Tour layout is the same as the map that resides on the El Caño Self-Guided Tour app that Fundación El Caño maintains (see Figure 19 in Section 3.1). The tour begins at the entrance with an informational popup with the background of the park. From the park section of the tour the user can enter the museum tour through a door icon located at the front of the

MOUND 3



In 1979 the National Directorate of Historical Heritage took over the administration of the site and managed the first scientific works. These included surveying the site, taking an infrared aerial photograph, placing some sculptures (or rather what was left of them) in their original location, and partially excavating the main alignment of the monoliths, the M3 and M4 mounds, and the roadway.

When Mound 3 was first excavated, it was a small hill similar to others that you can see if you look to the south. Secondary burials (in urn and burial bundles) were found in these mounds. Underneath them primary burials were excavated. These were of people arranged in extended position over the floor of their tombs. Regarding the latter type of burial, in the 1980s at least ten tombs of low status individuals were excavated under Mound 4, immediately south of Mound 3. The skeletons drawn on maps of this area appear to be individually buried adults, except in two cases (tombs 11 and 13) which could be multiple burials of two adults. Neither their sex nor their age was recorded. All the tombs (4-9, 11-13 and 15) have ceramics of the Late Count and Macaracas stylistic groups, so it can be assumed that they are contemporary with four of the tombs in the cemetery sector destined for the burial of high-status persons, Area 1 (T1, T2, T4 and T7).



Return to Tour

Figure 29: Park Tour popup

Image Source: El Caño Archaeological Virtual Tour Application, 2020

museum from the park tour (See Figure 30). In addition to reentering the museum through the door icon, the user can use the key press “H” to return to the home screen of the application and select the museum segment of the tour. Both options, the selection of the door icon and the key press of the “H” key, are available inside the museum segment of the tour to enter the park segment of the tour (see Figure 27).



Figure 30: Front of the El Caño Archaeological Museum

Image Source: El Caño Archaeological Park Virtual Tour Application, 2020

The team included popups at each of the seven areas of interest, noted on the map of the park (see Figure 19 in Section 3.1), with visuals and information or just visuals to provide additional details. The map of the virtual tour is accessible throughout the tour with the key press “M” (see Figure 30). Similar to the entrance popup, the area of interest popups include relevant information about the points of interest and detail the discoveries at each location. Several popups contain multiple panels of information, which the user can access using the “N” and “P” key presses, like the other keypress options available within the tour.

4.3 Maintenance Manual

To help Fundación El Caño maintain, edit, change, and in general modify the application, the team developed a maintenance manual that describes each of these items in detail. The maintenance manual is split up into five sections as follows:

- Introduction
- Software Preparation
- Important Concepts to Understand
- Modifying the Project
- Exporting the Project

The virtual tour utilizes a GitLabs website, so most aspects of the manual are straight forward. The most extensive section of the maintenance manual pertains to modifying the project. The project modifying section requires close attention to detail with explicit definitions and explanations for each step. Although the coding knowledge required to modify the application is not easy to learn in a short amount of time, the manual allows Fundación El Caño’s staff to modify the application without this knowledge through the use of screenshots, explicit

instructions, and links to Unity’s own support webpages. The manual presents text instructional steps in tandem with images to guide the reader through the process of adding the new spheres and additional interactive elements. In addition, this section includes directions for the creation of new panels for the information popups to present the images and text related to the artifacts and areas of interest.

4.4 Survey Results

The team collected twenty-seven survey results, five Spanish survey results and twenty-two English survey results. Although the actual sample size was significantly less than the desired/anticipated survey sample size, the results from the survey provide important data to improve the virtual tour application and quantify the success of the application. The team created charts and graphs to visualize the data from survey respondents.

The survey respondents’ answers to questions to identify errors and shortcomings of the tour indicate that navigational errors are the most significant. Figure 31 and 32 display the results to the question “please select any defects that you may have experience” for the museum tour

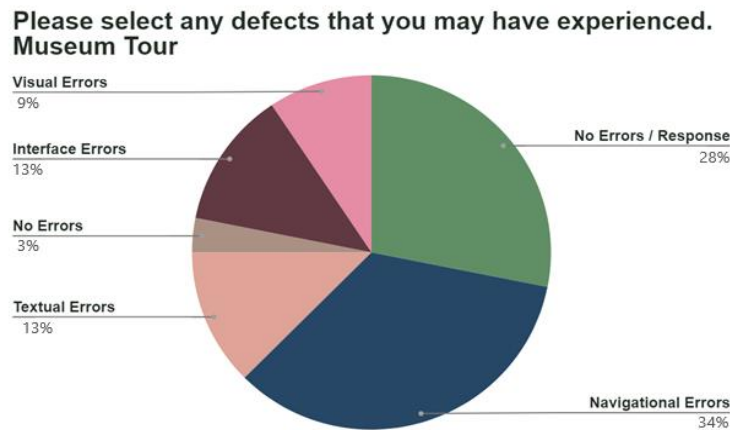


Figure 31: Please select any defects that you may have experienced. Museum Tour

and the park tour, respectively. Out of the twenty-seven survey takers, 34% of respondents report that the museum tour has navigational errors, and 17% of respondents report that the park tour

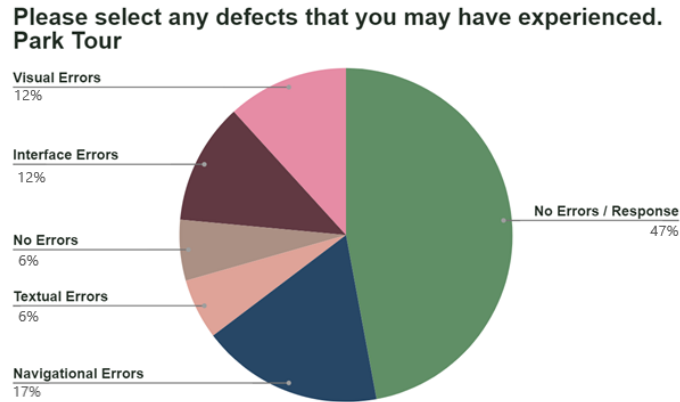


Figure 32: Please select any defects that you may have experienced. Park Tour

has navigational errors. In the follow up question, to gauge the survey respondent’s desired changes, “ what can we do to improve the way the tour displays information” (see Figure 33) 50% of respondents indicated that making the tour “more intuitive and easy to use” would improve the functionality of the virtual tour application. The team enhanced the virtual tour application based on these responses by adding navigational instructions, integrating in redundancy, and streamlining the park tour path.

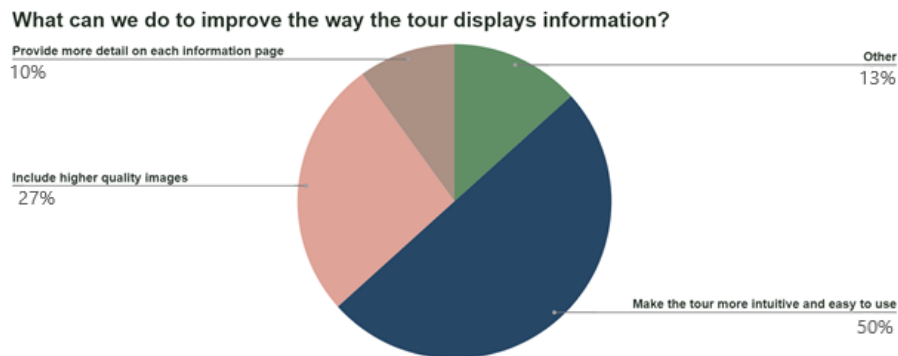


Figure 33: What can we do to improve the way the tour displays information?

The survey questions that quantify the overall success of the virtual tour application are as follows: “How well does the tour promote the El Caño museum and park?” (Figure 34), “How would you rate your overall experience?” (Figure 35), and “Who do you think would benefit the most from the distribution of this tour?” (Figure 36). Before making navigational edits and other major application changes, approximately 50% of virtual tour respondents rate their overall experience with the application a 4 out of 5 indicating that the application was just below

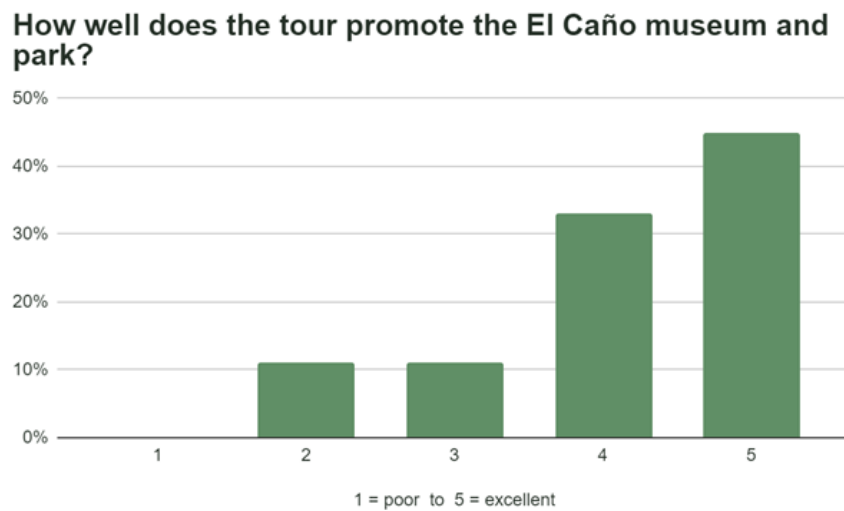


Figure 35: How well does the tour promote the El Caño museum and park?

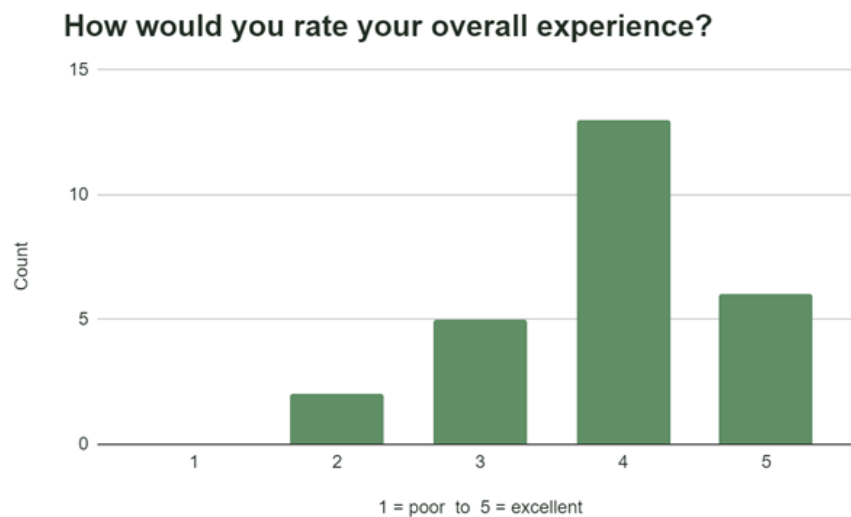


Figure 34: How would you rate your overall experience?

excellent (see Figure 35). Another significant finding from the survey responses are regarding the project stakeholders. The team identified in section 2.3 the stakeholders as academics, park visitors, students, and others who are not able to visit the site. The stakeholders identified by survey respondents align with those the team identified (see Figure 36). Respondents indicated academics (researchers and scientists) to be the most important (37%), then scientists (34%), and

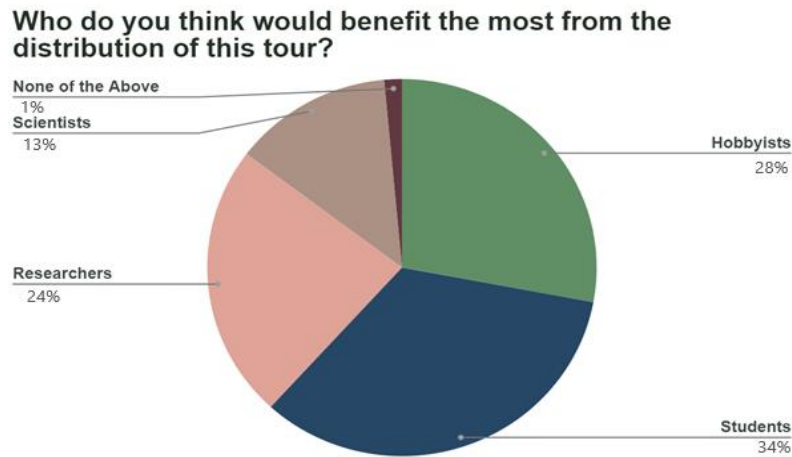


Figure 36: Who do you think would benefit the most from the distribution of this tour?

finally hobbyists (28%). The team designed the virtual tour to be used by the identified stakeholders, and the alignment of stakeholder groups indicates that the virtual tour application successful fulfills the needs of the stakeholders.

The final survey question that the team designed to quantify the success of the virtual tour application, asks the survey respondent to indicate how well the tour promotes the El Caño Museum and Park. Over 75% of survey respondents expressed a positive response to this question, giving above a score of 3 out of 5, and approximately 45% of respondents gave the tour the highest possible score, rating the promotion of El Caño Museum and Park through a virtual tour excellent (see Figure 34). The success of the virtual tour application at promoting the El

Caño Museum and Park indicates that users enjoy the experience and maintain interested in the archaeological site during virtual tour interaction. User interest in the El Caño Museum and Park increases the sites notability and hopeful leads users to spending more time on the website and encouraging others to experience the virtual tour application.

Chapter 5: Recommendations and Conclusion

5.1 Deliverables

The final deliverable to Fundación El Caño is the final virtual tour application and a maintenance manual to support it. The team delivered the application in a package that is easy to integrate on a website. The team also provided Fundación El Caño with the source files so they can make changes to the application. The manual allows Fundación El Caño to understand the development process and make modifications to the application as they see fit.

5.1.1 Virtual Tour

After Ms. Alexa Hancock and Fundación El Caño reviewed the virtual tour program, the team finalized the small changes, exported the project, and transferred the program and the source files over to Fundación El Caño. In addition, the team set-up a repository for Fundación El Caño on GitLab for offsite hosting and storage of the project and for backup versions to be used and edited in the future. This permits Fundación El Caño to be flexible with their approach to hosting the project, e.g., whether they wish to embed it into their existing website or host it externally with a link, or both.

The team developed the Virtual Tour Application in Unity, and exported to a WebGL build, automated by Unity Software. WebGL is a JavaScript API that renders 2D and 3D on modern browsers. This means that the platform can get wide use across the world and anyone can access the virtual tour over the Internet from a desktop. Another advantage is that there are frequent updates for Unity itself. This is not a problem for this project because browsers will support older versions of WebGL and currently support old versions released in 2011.

5.1.2 Manual

Fundación El Caño requires the ability to update and change the content of the virtual tour in the future. To aid this process, the team developed a manual to describe and guide the staff on how to update artifact images, descriptions, and environment photos. The manual includes a section called “Important Things to Understand” to provide the Fundación El Caño staff with information about project organization and the file structure (see Appendix F).

The manual includes instructions on how to set up the Unity platform, how to create new spheres, how to create new sprites including arrows and popups, and how to export the updated project. The knowledge of the creation of spheres to hold the 3-dimensional images and sprites to act as the interactive elements allow the staff of Fundación El Caño to alter the tour. The staff can add artifacts to the virtual displays and add new information as the archaeologists uncover more discoveries at the excavations.

5.2 Recommendations

Through the development of the virtual tour application and the limitations due to time and resources, several recommendations for further development became apparent.

There is potential for an Interactive Media and Game Development or Computer Science MQP project opportunity to further develop the virtual tour. Useful and impactful features that could be added are “virtual” exhibit rooms and creating an edit feature inside of the tour, increasing the current virtual tour’s ability to be modified within the program itself. The addition of the virtual exhibit rooms would give Fundación El Caño the ability to display the hundreds of artifacts currently in storage to the world. Especially because Fundación El Caño has limited resources and the expansion of the current museum at the park is not an option. Virtual exhibit

rooms solve this issue. The team discussed the concept of a virtual exhibit room in initial sponsor meetings with the team, however, would have been outside the scope of an IQP project.

In addition, the creation of an edit feature will allow the staff at the park to modify, add, and remove virtual rooms, photos and artifacts from the display cases. As artifacts get switched out from display cases, it is important to match the photos on the virtual tour with what is currently being displayed at the museum. This would make the virtual tour more accessible to people who do not know coding. This would also make the program itself more accessible to other kinds of organizations to create their own virtual tours, if Fundación El Caño became interested in sharing the technology.

Another aspect that the current virtual tour does not address is experimenting with audio files that read the text on-screen. This feature would simulate the experience of a human guide and make the tour accessible to more individuals. Integration of mixed media such as audio and video provides a more immersive experience that is more accessible to all.

5.3 Conclusion

Panamanian culture revolves around the things that makes Panamanians who they are. The abundance of artifacts and culture, yet lack of convenient and easy access to experience the historic findings in Panama, make it hard for the general public and others around the world to see these discoveries. Therefore, making an application like the virtual tour so valuable to Fundación El Caño. Allowing people from all over the globe to experience and learn about the amazing discoveries at the El Caño Archaeological Park enables sharing Panama's culture and its appreciation to many more people. Additionally, the virtual tour creates an immersive experience for people to learn and study the historical cultures in Panama's history. The

significance of the archaeological site to Panamanian culture cannot be measured and the team hopes Fundación El Caño will be able to continue the work they do and enjoy the deliverables the team has created.

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Appendix A: Virtual Tour Application Research

Table 3 provides the tabulated research regarding potential virtual tour applications. The table lists the pros and cons for each application with regards to the following categories: cost, ease of development, and sponsor desires (3D environment, addition of virtual exhibit rooms).

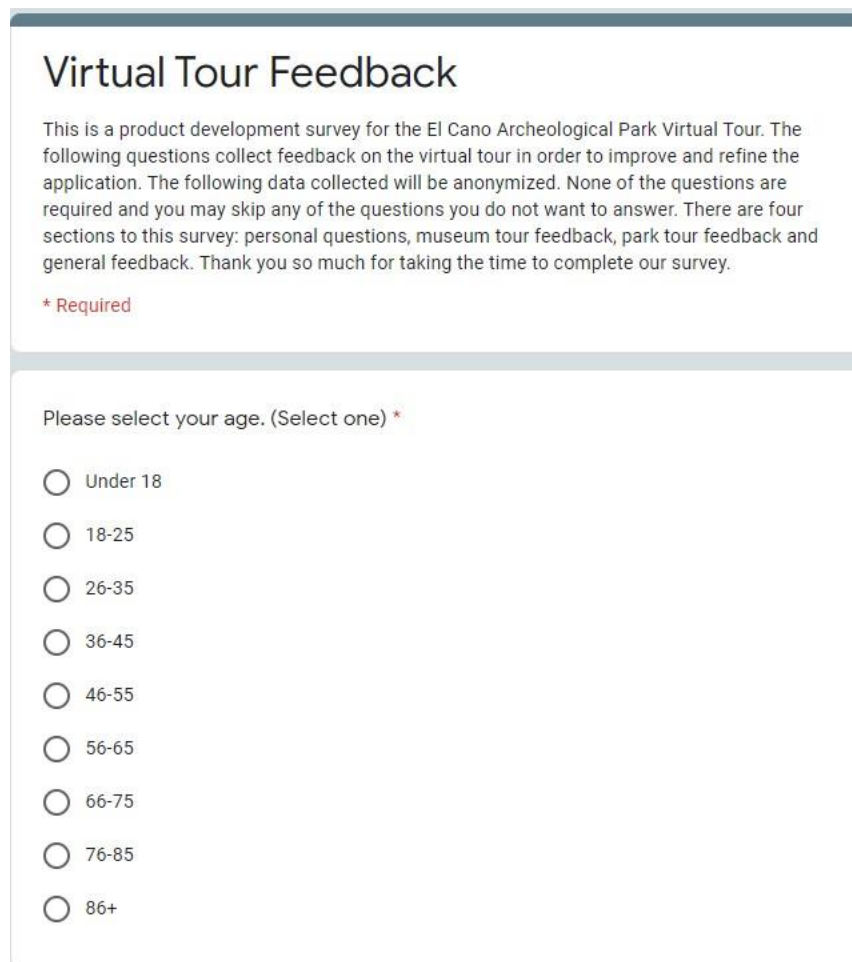
Table 3: Pros and Cons table of virtual tour applications

Application	Pros	Cons
Matterport	<ul style="list-style-type: none"> - Fully built virtual tour application - Access to a help service - Use service to publish virtual tour - Maintained by Matterport 	<ul style="list-style-type: none"> - Requires specific camera types - Requires a subscription (\$9.99/month) - Unable to create “virtual exhibit” rooms
Google Tours	<ul style="list-style-type: none"> - Free to use - Accessible on multiple devices through the Google Tour platform - Use service to publish virtual tour 	<ul style="list-style-type: none"> - Unable to create “virtual exhibit” rooms
Unity	<ul style="list-style-type: none"> - Free to use - 3D immersive environment - Ability to create “virtual exhibit” room - Access to platform support - Export easy to integrate into Fundación El Caño’s website 	<ul style="list-style-type: none"> - Less refined/not as clean and professional looking - Significantly more work - Requires maintenance by the park
JavaScript	<ul style="list-style-type: none"> - Lightweight structure - Free and easy to code 	<ul style="list-style-type: none"> - Limited virtual and 3D components

	<ul style="list-style-type: none">- Ability to create “virtual exhibit” room	<ul style="list-style-type: none">- Less immersive of an experience- Requires maintenance by the park
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Appendix B: Survey for Development Feedback

The following survey was used to review the virtual tour and provide feedback to improve the virtual tour deliverable. The results to the following questions seen in Figures 31 to 35 provided the team information to edit and refine the virtual tour application. The team distributed the survey via the online platform Google Forms, with text available in both English and Spanish.



Virtual Tour Feedback

This is a product development survey for the El Cano Archeological Park Virtual Tour. The following questions collect feedback on the virtual tour in order to improve and refine the application. The following data collected will be anonymized. None of the questions are required and you may skip any of the questions you do not want to answer. There are four sections to this survey: personal questions, museum tour feedback, park tour feedback and general feedback. Thank you so much for taking the time to complete our survey.

* Required

Please select your age. (Select one) *

- Under 18
- 18-25
- 26-35
- 36-45
- 46-55
- 56-65
- 66-75
- 76-85
- 86+

Figure 37: Page one of the virtual tour survey

Personal Questions

Data from the following questions helps us put your responses in context.

Which gender do you most identify with? (Select one)

- Female
- Male
- Prefer not to say
- Other: _____

How would you describe yourself? (Select all that apply)

- Student
- Researcher
- Hobbyist
- Scientist
- None of the above

Who do you think would benefit the most from the distribution of this tour?
(Select all that apply)

- Students
- Researchers
- Hobbyists
- Scientists
- None of the Above

How experienced do you consider yourself with technology? (Select one)

- I regularly have trouble working with computers and technology
- I don't have trouble most of the time working with computers and technology
- I am confident in my usage of computers and technology

Figure 38: Page two of the virtual tour survey

Museum Tour Feedback

The following section pertains to the overall quality of the museum tour section of the virtual tour.

Please select any defects that you may have experienced. (Select all that apply)

- Textual Errors
- Navigational Errors
- Visual Errors
- Interface Errors
- Language Selection Errors
- Other: _____

Please elaborate on your previous selections.

Your answer _____

Figure 40: Page three of the virtual tour survey

Park Tour Feedback

The following section pertains to the overall quality of the park tour section of the virtual tour.

Please select any defects that you may have experienced. (Select all that apply)

- Textual Errors
- Navigational Errors
- Visual Errors
- Interface Errors
- Language Selection Errors
- Other: _____

Please elaborate on your previous selections.

Your answer _____

Figure 39: Page four of the virtual tour survey

Virtual Tour Application Feedback

The following questions assess your virtual tour experience as a whole.

Did the tour load in an acceptable amount of time? (Select one)

Yes

No

Other: _____

How would you rate your internet speed? (Select one)

1 2 3 4 5

Far Below Average Far Above Average

How well does the tour promote the El Caño museum and park? (Select one)

1 2 3 4 5

Poor Excellent

Was the tour easy to navigate? (Select one)

1 2 3 4 5

Challenging to navigate Easy to navigate

Did the Virtual Tour look aesthetically pleasing? (Select one)

1 2 3 4 5

Far Below Average Far Above Average

How would you rate the quality of images and graphics? (Select one)

1 2 3 4 5

Poor Excellent

How would you rate the information presented in the virtual tour? (Select one)

1 2 3 4 5

Far Below Expected Far Above Expected

What can we do to improve the way the tour displays information? (Select all that apply)

Provide more detail on each information page

Include higher quality images

Make the tour more intuitive and easy to use

Other: _____

How would you rate your overall experience? (Select one)

1 2 3 4 5

Poor Excellent

Do you have any other comments on the tour as a whole?

Your answer _____

Figure 41: Page five of the virtual tour survey

Appendix C: Scope of Work

The project will be developed in Unity and is virtual tour which will allow website users to access interactive information about the El Caño Archaeological site and the accompanying museum that will be housed on their website.

The goal of our project is to increase the outreach of the El Caño Archaeological Park and Museum by making the artifacts and park available to everyone through a virtual tour hosted on Fundación El Caño's website, with text available for Spanish, English and French speakers, so that a greater audience can grasp the historical significance of the site. It allows those who are not able to visit the park to still enjoy the experience of being there.

The goal of the tour is to generate interest in the site, and promote the preservation of Panama's history, and reaching a larger audience.

Another goal is to provide a way to organize the artifacts in an online catalog.

The project will generate interest in the site and expand the audience of the website by providing an immersive experience through which English, Spanish, and French speakers can gain knowledge of the cultural history of the area, without having to travel to the park.

Work Breakdown Structure:

All members will reach into all aspects of the project and, while small individual tasks will be delegated out to individual members of the team, the main overarching tasks will take collaboration from all members.

- Development of the application – All Members
- Create 360-degree pictures of museum

- Create 360-degree pictures of park
- Create Virtual Tour of museum
- Create Virtual Tour of park
- Create Virtual Exhibits
- Catalog of Artifacts
- Documentation and writing descriptions

Appendix D: Plan of Work

Goal Statement 1:

Design and produce an online virtual tour of the El Caño Archaeological Museum and park.

Action Steps:

Using a 360-degree camera, capture images of the museum and park

In Unity, build the basic functionality of a virtual tour using the 360 pictures

Develop a method to display pictures of the artifacts within the application

Refine product into a deliverable

Develop a manual with maintenance instructions

Goal Statement 2:

Make virtual tour application easily editable and expandable.

Action Steps:

Connect application to the existing database of artifacts

Design an easy way to upload and make new virtual rooms

Expand on the manual to include instructions for editing

Goal Statement 3:

Develop the additional “virtual” exhibit rooms to display the artifacts that are not in the display cases at the El Caño Archaeological Museum.

Action Steps:

Determine the required amount of virtual space required to display all artifacts

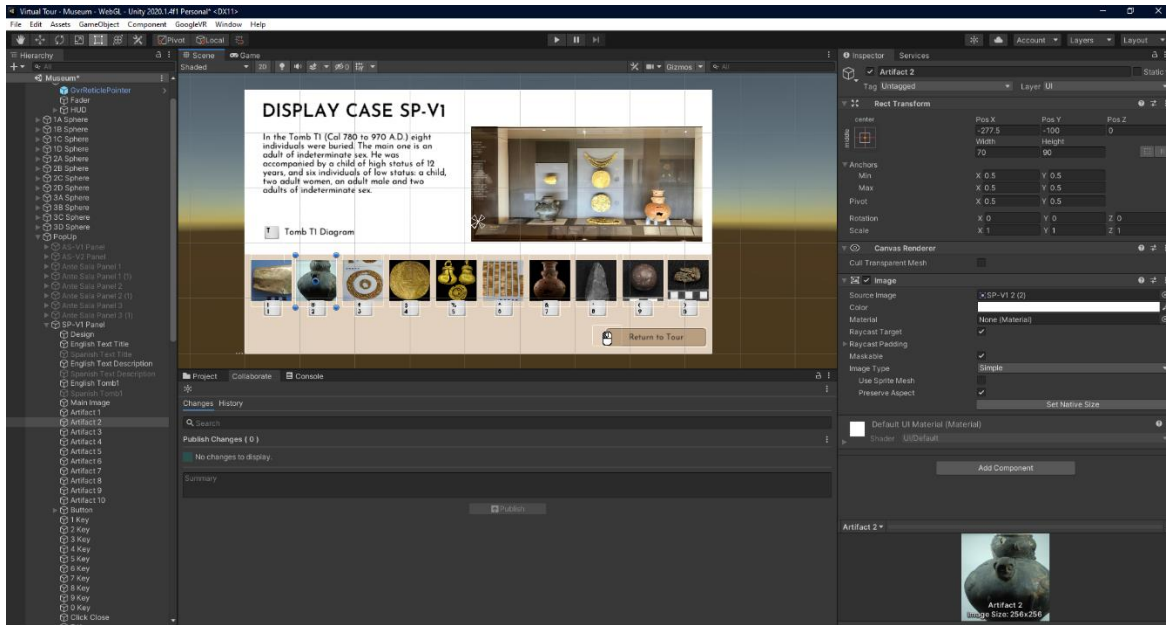
Expand the virtual tour with new rooms

Populate with more pictures of artifacts

Appendix E: Maintenance Manual

The following pages contain the El Cano Archaeological Museum and Park Virtual Tour Maintenance Manual.

El Caño Archaeological Museum and Park Virtual Tour Maintenance Manual



By:
Cory Helmuth
Michael Reilly
Molly Sykes
Andrew Whitney



WPI



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Introduction

This manual describes how to update, modify, and maintain the El Caño Museum and Park Virtual Tour. This manual is split up into three general sections: setting up your computer, making modifications, and committing changes to the tour.

The virtual tour is a Unity project that requires a few items to be set up before working on the project. First is your Unity account and ensuring Unity will allow you to work with their software. Second is Unity Hub, which is home to the Unity Editor which allows you to update and modify the virtual tour.

Software Preparation

Unity Hub

Unity Hub is the official platform for Unity to manage projects, licenses, and Unity versions. Create an account following the “Create Account” page on Unity’s [Official Website](#). Unity provides users with documentation on [installing Unity Hub](#). To work on projects, a valid license is required.

Unity License

You can manage licenses from the Unity Hub. Once signed in, navigate to the cogwheel icon at the top right of the editor. After clicking it, click on License Management. There will be two options, Activate New License or Manual Activation. [Click here](#) to go to the official Unity Documentation for more help on Activating Licenses.

Project

After completing the steps in the previous sections, you should be signed in with a valid license. Download the Virtual Tour Project Asset Files that was provided by the IQP Team. This includes the Assets and ProjectSettings, allowing you to make edits to the entire project as needed. Once the project has been downloaded, go to Unity Hub, and navigate to the Projects Tab. Create a new Project, title it as you please. Delete the Assets folder. Drag in the Assets folder provided by the team. Then, close the Unity Editor, navigate to the Project files in the computer File Manager. Delete the ProjectSettings Folder that was automatically created and drag in the ProjectSettings Folder the team provided.

Unity Versions & Modules

This Project was built and developed using Unity Version 2020.1.4f1. If this version is available download the project using this version. When prompted on the Modules screen, add WebGL Build Support to the install. If this is missed the first time, it can be added by navigating to the Installs Tab and clicking the three dots on the Unity Install. Select add Module, then select WebGL build support. Click next, accept the terms and click Done.

Text Editor

To edit the scripts on the Project you need a text editor. The recommended text editor for working with Unity is VSCode by Microsoft. This text editor has “IntelliSense” for Unity classes and imports, making coding easier and more efficient. VSCode can be installed [here](#). The extension needed for Unity IntelliSense can be found [here](#). The link also provides the most up to date instruction on how to sync Unity with VSCode.

NOTE: Any text editor can be used to make edits to the scripts, VSCode was used during development, and at the time of this manual's creation, the most supported editor for Unity development.

Opening Project

To open the Project, navigate to the Project Page in the Unity Hub. Under Unity Version, select the correct Unity Version (currently 2020.1.4f1, update as needed). Under the Target Platform tab select WebGL. After properly selecting these two items, click on the project to open it.

Important Things to Understand

File Structure

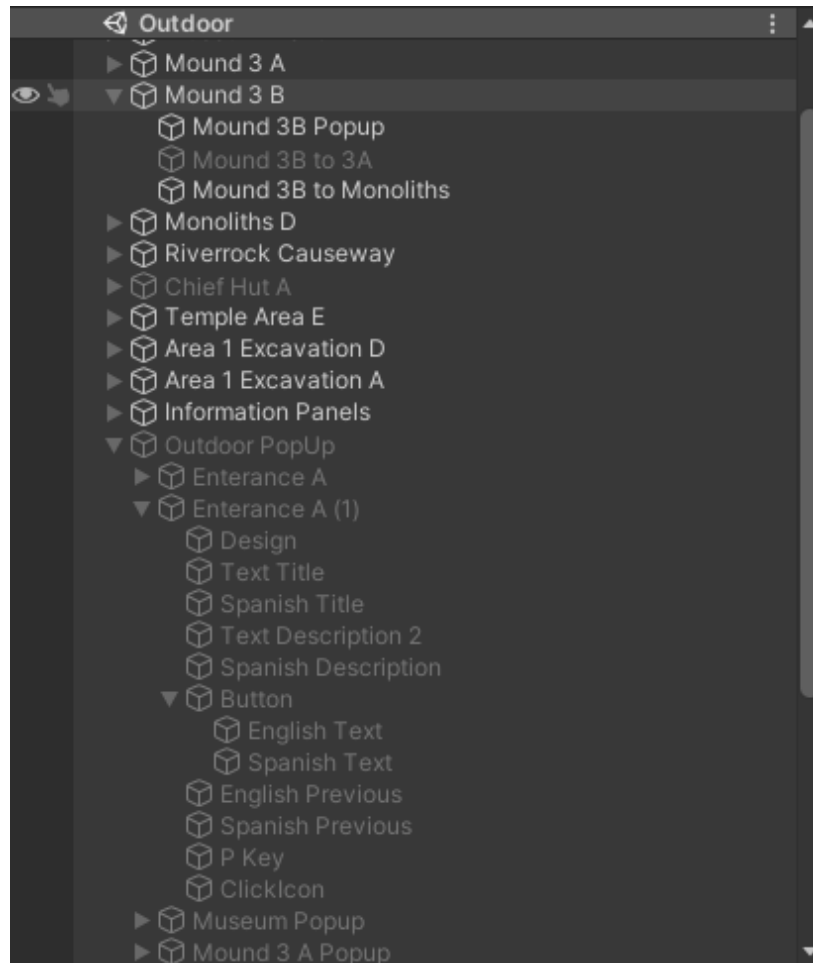
The file structure of the project is designed to organize the assets used to create the application. The following section explains the files that will be found in each asset folder:

Table 4: Asset Folder File Descriptions

Data	Static C# files that hold variables to be accessed from more than one scene or object.
Exhibits	Images of the Exhibits and Artifacts to be used in Pop-Ups
Fonts	Collection of fonts used through the application
GoogleVR	Assets provided by GoogleVR
Logos	Logos for the sponsors and other organizations
Materials	Generated files of materials also include Insideout material along with 360 images.
Outdoor	Images for the outdoor areas of interest
Scenes	Scenes that are used in the project
Scripts	All C# scripts used in the project
Shaders	Insideout shader located here, any future shades would go here
Sprites	All 2D logos/clickable objects, keys also located here
Textures	360 images also located here, also and folder of Materials located here

Project Hierarchy

The Project Hierarchy is an important part of working on the project. This is where you can view different scene objects, select them, and modify their location within the hierarchy. When an object is selected the Inspector Tab will open, here you can edit components of the objects. The Inspector will be shown in *Modifying the Project*.



Modifying the Project

This section covers how to make edits to the project, how to add hotspots, how to create sprites (arrows and clickable icons), and how to create/modify popup panels. It also briefly covers C# scripts.

Adding Hotspots

Adding a Sphere

The spheres allow for the creation of the virtual environments at the desired locations.

1. In Project Hierarchy, under the scene you would like to modify right click and create a new sphere located under 3D Objects tab.
2. Move the sphere to a location that does not overlap with other existing spheres.
3. Change the scale for the sphere to X = 3, Y = 3, Z = 3.
4. Under the Material tab select the Insideout shader.
5. Drag and drop selected 360-degree photo on to the sphere.
6. Rename the sphere appropriately.

Creating a Sprite from Scratch

Sprites allow for the interactive elements included in the tour, such as the arrows and the popups. Other methods of creating the specific sprites are noted in other sections below.

1. Select the sphere in which the new sprite will be located.
2. Right click the sphere name under the hierarchy and select the sprite object under the 2D object menu.
3. Drag the desired image from the sprites section and resize and rotate according to the orientation of the sprite.
4. Create a new component using the “Add Component” button at the bottom of the inspector menu.
5. Search for the “Sphere Collider” component and add it to the sprite. Then set the radius according to the desired size of the sprite (Recommended radius is 2).
6. Add another component, search for “Event Trigger” and add it to the sprite.
7. Add a new event type as pointer down.

(NOTE: The other information to be included for pointer down depend on the type of sprite desired, and how to add the two main sprites is detailed below)

Adding an Arrow

The arrows act as a method of navigation which allow the user to traverse the sphere where the user is currently located to a sphere which is assigned to the arrow.

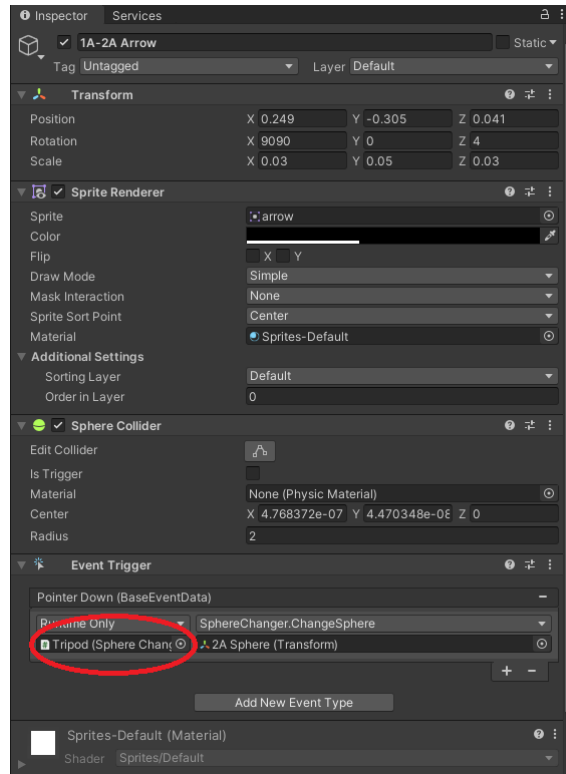
If an arrow already exists:

1. Copy an already existing arrow from a sphere and place in the sphere(s) that will connect to the new Hotspot.
2. Reformat them accordingly so they point in the correct direction in each sphere.
 - i. NOTE: if arrow cannot be found, ensure that its X, Y, and Z location are at 0, 0, 0, then relocate from there.
 - ii. Recommended rotation for arrows is as follows X: 9090, Y: according to orientation of arrow, Z: 4.
 - iii. Recommended scales for indoor arrows are X: 0.03, Y: 0.05, Z: 0.03.
 - iv. Recommended scales for outdoor arrows are X: 0.02, Y: 0.02, Z: 0.03.
3. Under the Event Trigger Element for each new arrow replace the new Transform element with the new sphere that was just created.
4. Rename each arrow to indicate which sphere it is pointing towards.

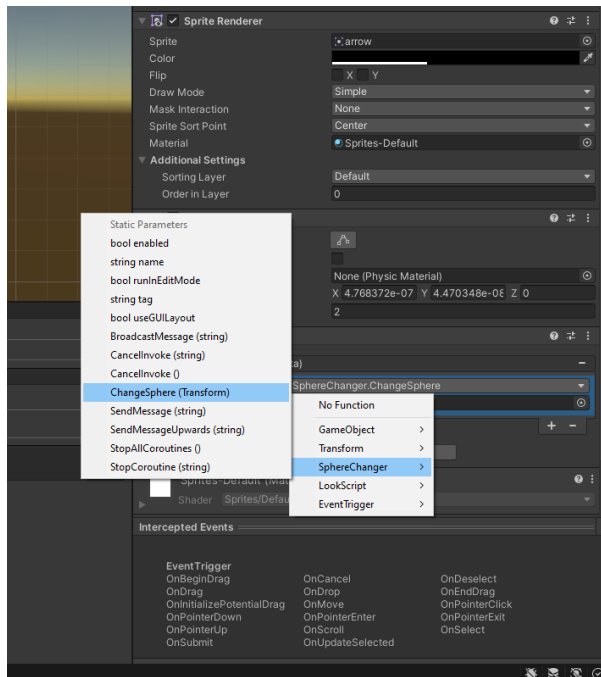
If an arrow does not exist:

1. Drag the arrow sprite from the sprites folder located in the Assets into the sphere(s) that will connect to the new Hotspot.
2. Reformat and resize them accordingly so they point in the correct direction in each sphere
 - i. NOTE: if arrow cannot be found, ensure that its X, Y, and Z location are at 0, 0, 0, then relocate from there.
 - ii. Recommended rotations for arrows are X: 9090, Y: according to orientation of arrow, Z: 4.
 - iii. Recommended scales for indoor arrows are X: 0.03, Y: 0.05, Z: 0.03.
 - iv. Recommended scales for outdoor arrows are X: 0.02, Y: 0.02, Z: 0.03.

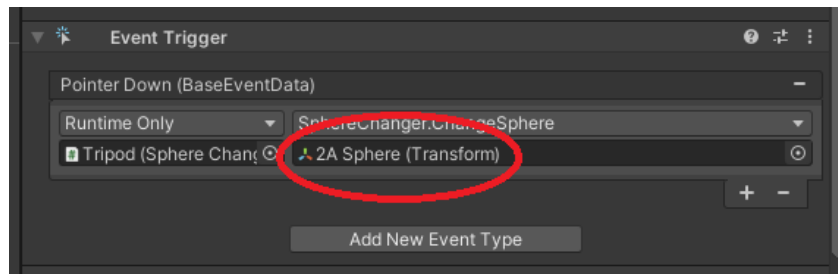
3. Add the Event Trigger Element to each arrow.
4. Add a Pointer Down Event to each arrow.
5. Drag the Tripod from the Project Hierarchy to the left slot as the object that will interact with the event.



6. Select the SphereChanger.ChangeSphere function. Select SphereChanger and then ChangeSphere (Transform).



7. Under the Event Trigger Element for each new arrow, replace the new Transform element with the new sphere that was just created.



8. Rename each arrow to indicate the sphere that the arrow will move to.

Adding and Editing Popup Windows:

When adding a new pop up there are two main steps:

1. Creating a panel and populate it with information.
2. Adding the clickable icon within the correct sphere(s).

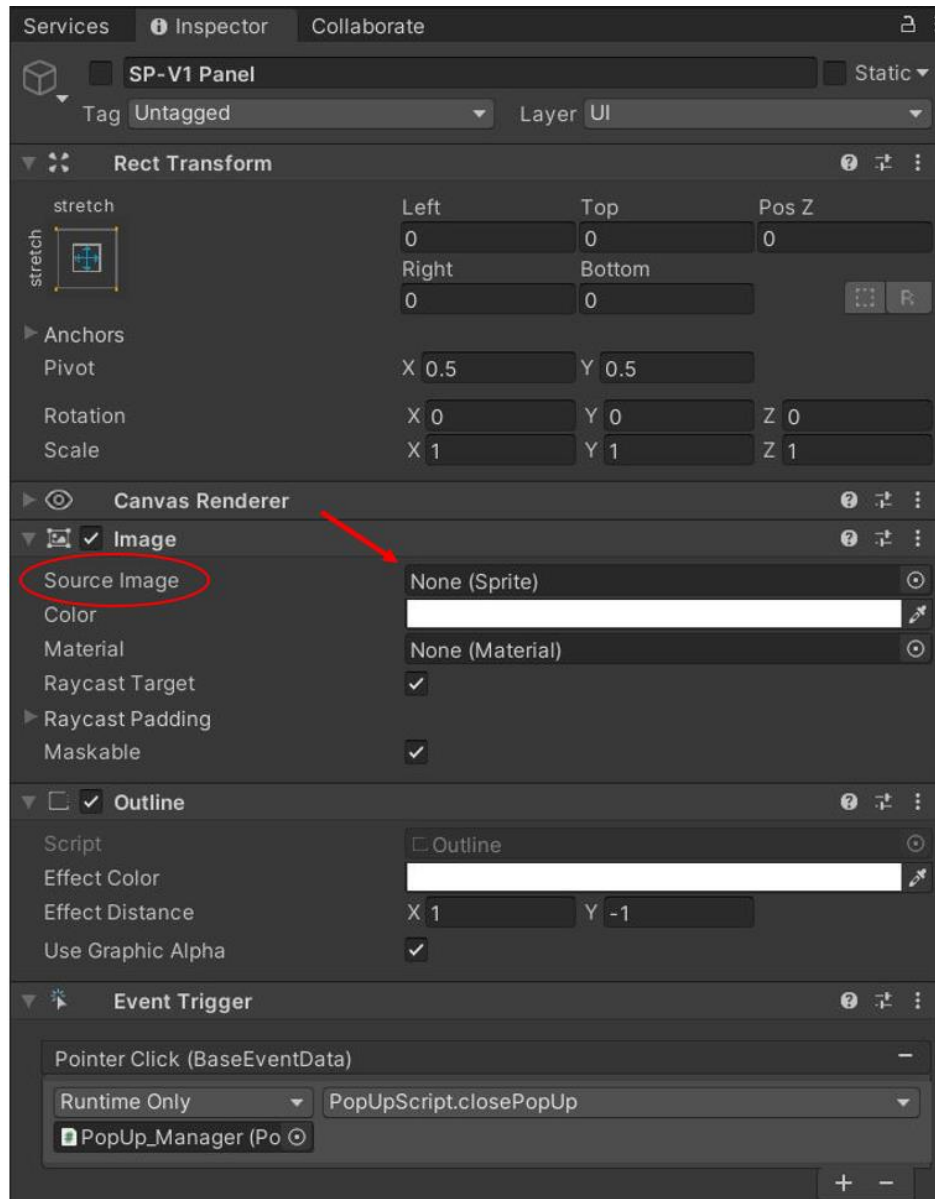
Creating a Panel

A typical panel will look as follows in the Project Hierarchy:



1. Copy and paste an existing panel that most closely matches the intended design of the new panel and change rename according to the information to be included. To copy and paste right click on the popUp and copy and then left click on PopUp and click paste.

2. Change the source image to “None (sprite)”.



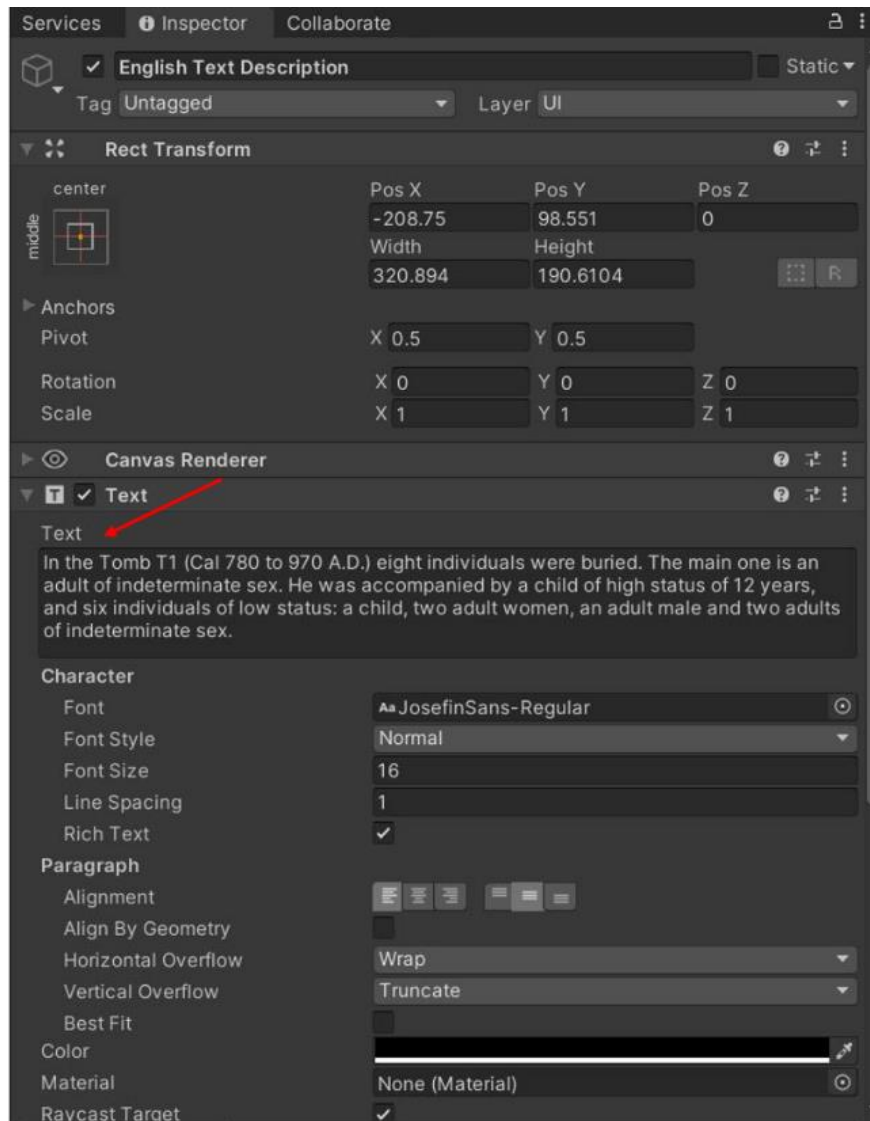
Adding Textual Information

The following instructions instruct how to add English text to the new panel. The same process should be repeated to add Spanish text to the new panel.

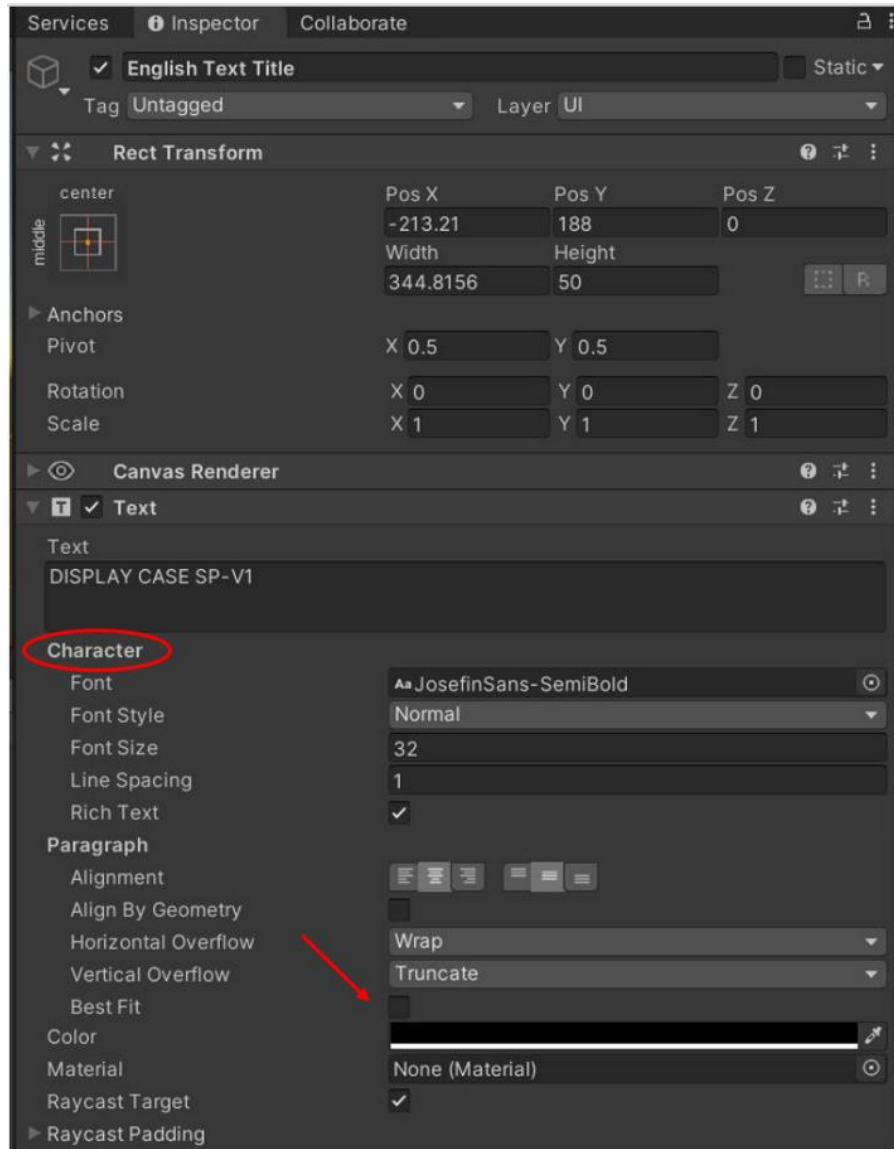
1. Select the respective tab from the new panel's dropdown in the project hierarchy such as *English Text Title* or *English Text Description*.



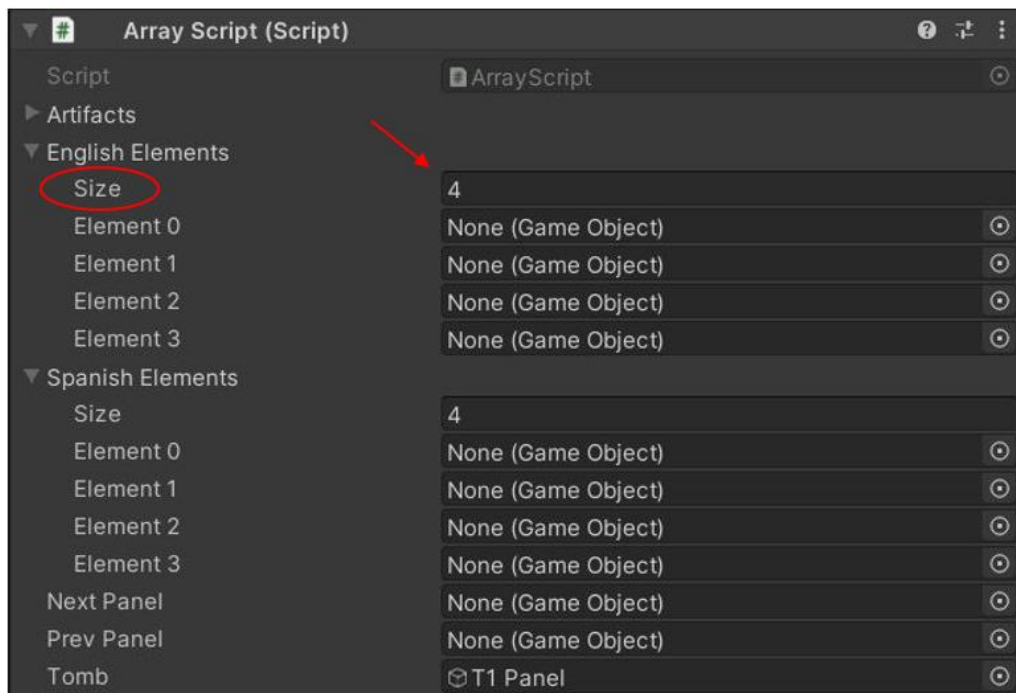
2. In the Inspector tab of the selected project hierarchy dropdown, text can be added in the text box area. Copy and paste or type the desired text into this area.



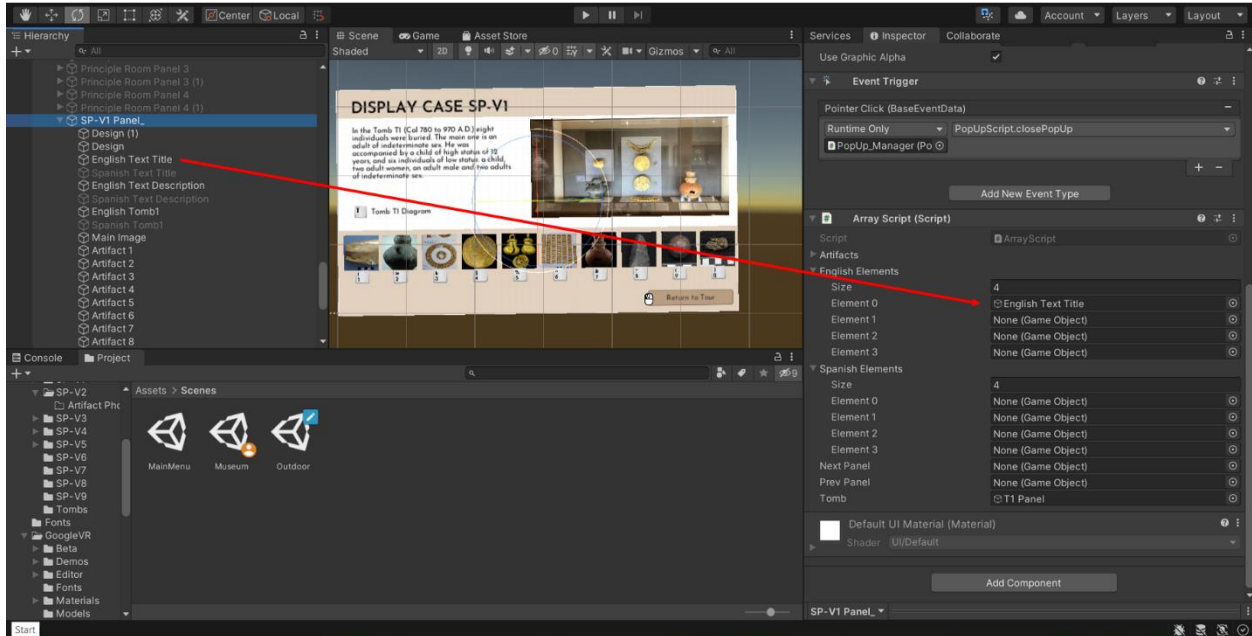
- The text size, font, and other formatting can be edited in the Inspector tab in the Character section. To allow for font size changes to be seen, make sure the Best Fit box is not checked.



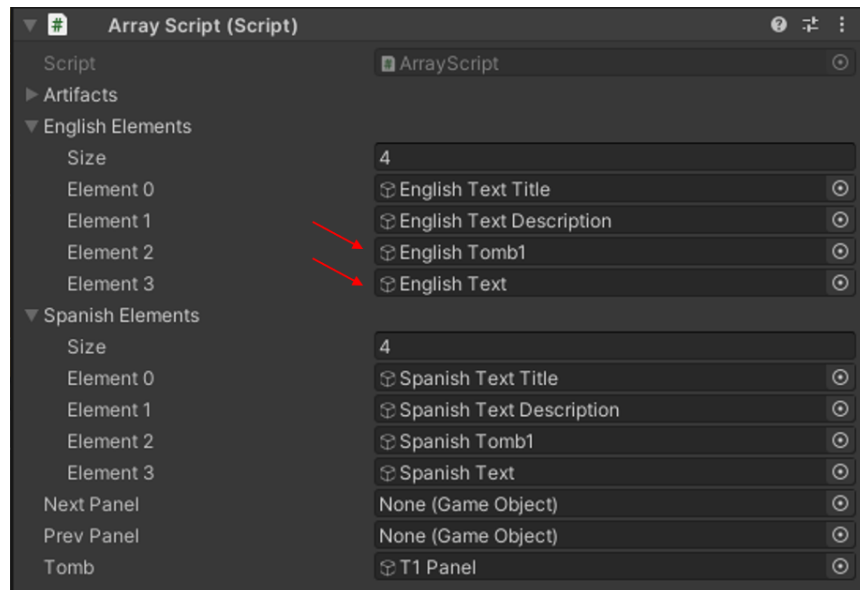
- To allow for the user to switch between English and Spanish in the application an array of the textual elements must be set. Click on the new panel in the Project Hierarchy. In the inspector under the Array Script section, change the size under the English elements section to the number of populated text boxes. To determine the number required for the array count the title, the number of text descriptions, the tomb diagram, and the button. The example that is followed requires 4 buttons.



- Drag the English text elements from the Project Hierarchy into the empty slots under the Array Script English Elements. When completing this step make sure that the new panel is selected and not the individual text elements.

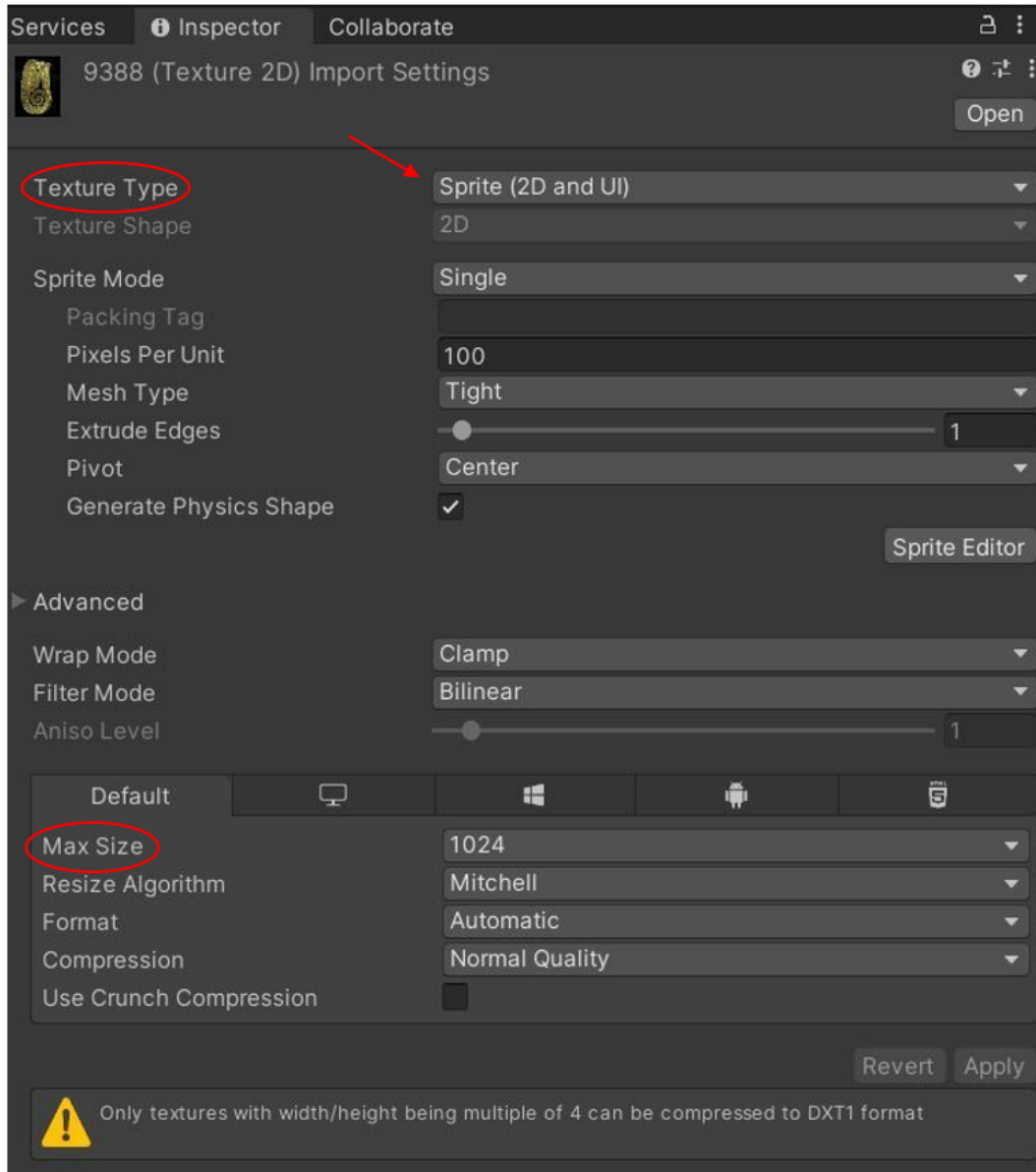


- Check to ensure that all the text elements are added to the array. Common mistakes include forgetting to include both texts for the tomb button and the return button.



Adding Images

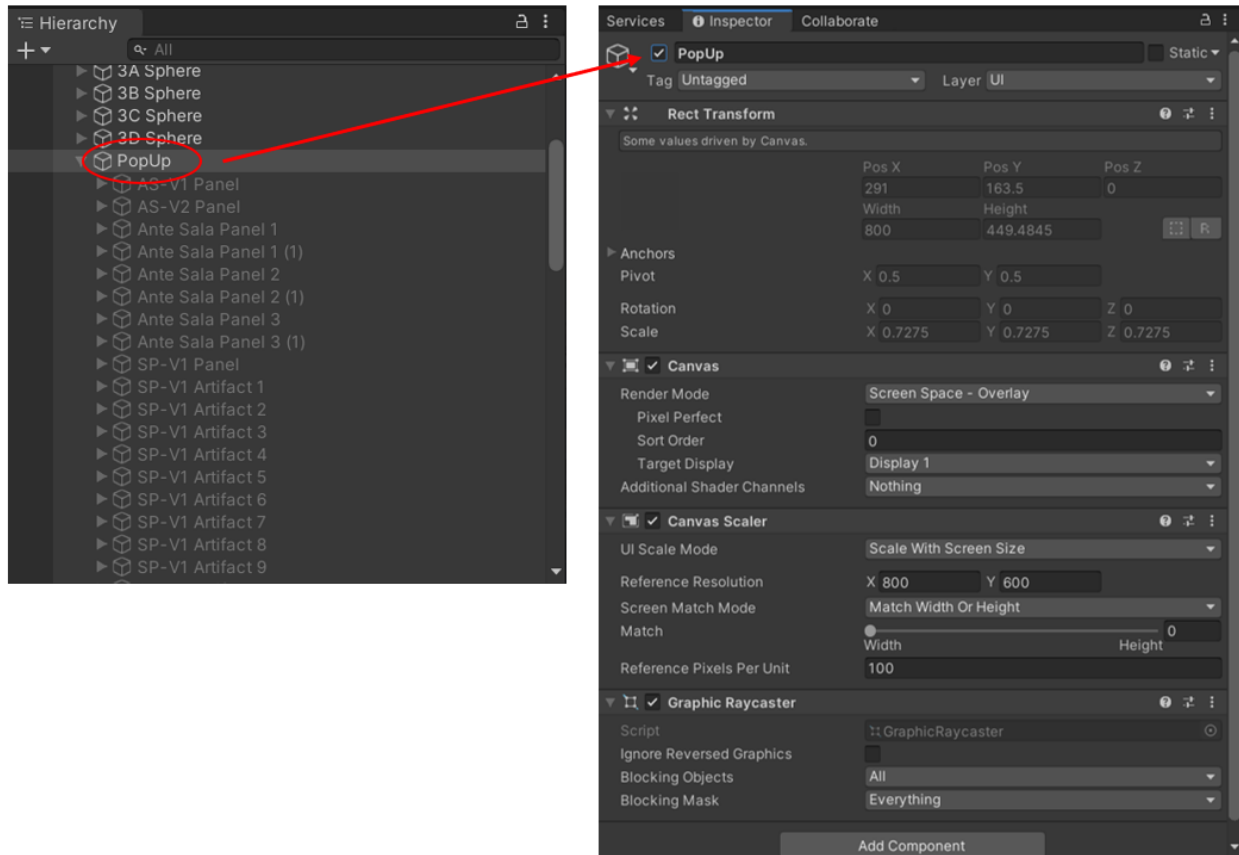
1. Drag image from personal computer file explorer into the desired Asset folder in Unity.
2. In the Asset folder select the image. In the Inspector change image type under Texture Type to “Sprite (2D and UI)”.



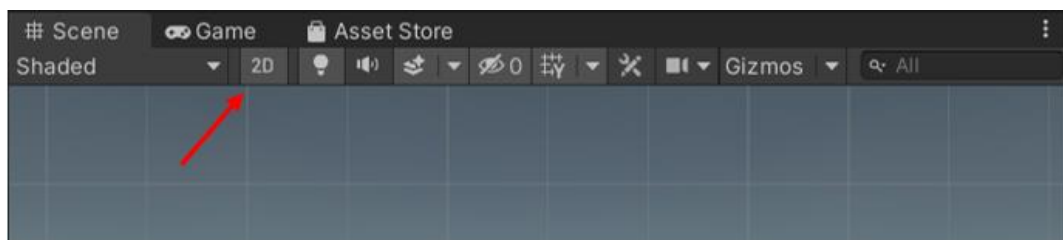
3. To reduce file size change Max Size. To optimize both the image quality and the file size reduce the Max Size as much as possible without making the image unclear.

Formatting the Popup

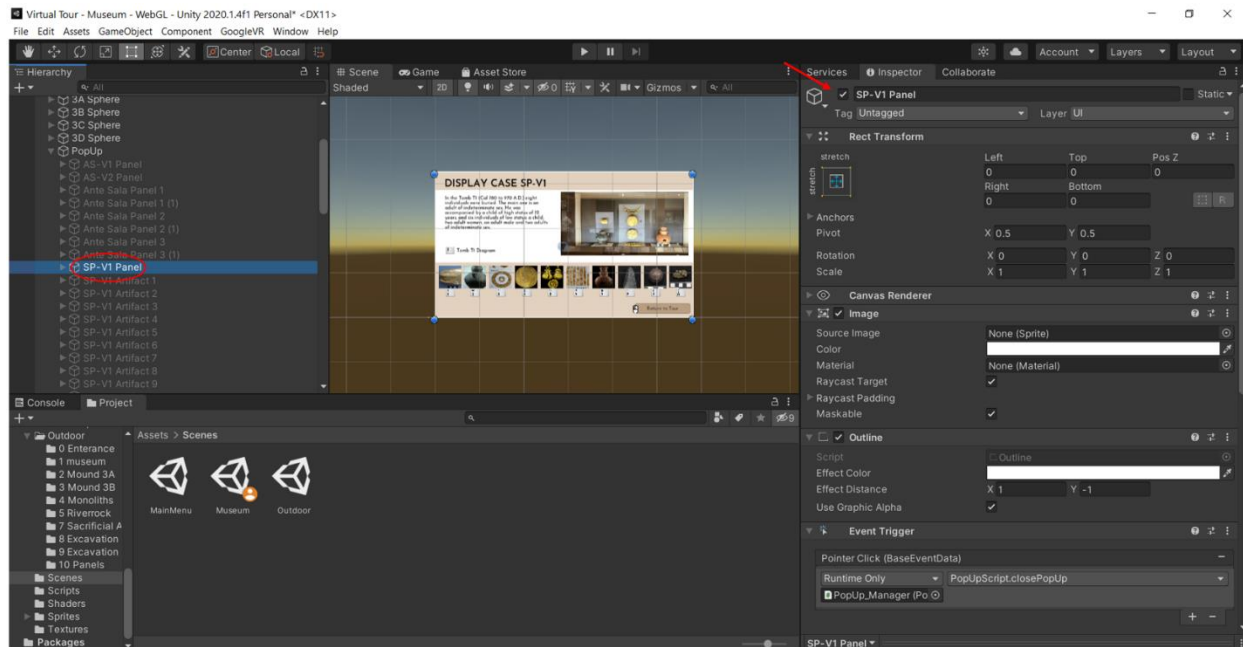
1. In the Project Hierarchy select Popup from the dropdown. And check the checkbox in the Inspector to be able to view selected panels. This must remain checked while editing all panels.



2. Selecting 2D in the #Scene tab will allow for better views of the panels.

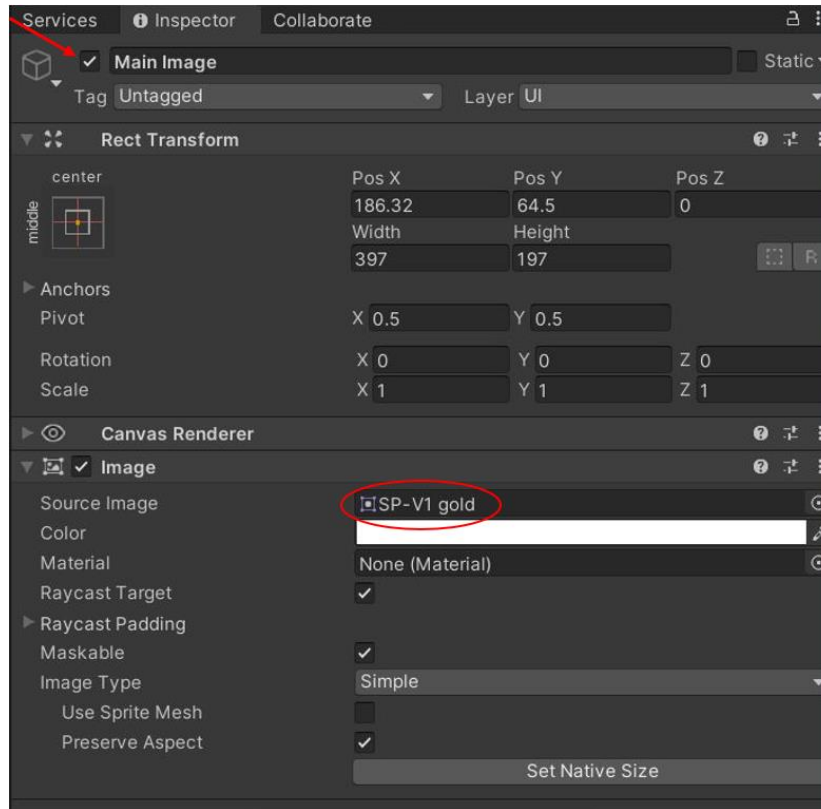


3. To view individual panels, select the desired panel from the Project Hierarchy and check the checkbox next to the panel title in the Inspector. To make edits make sure that only one panel is select at a time. Unselect the panel you have finished working on before moving to a new panel.

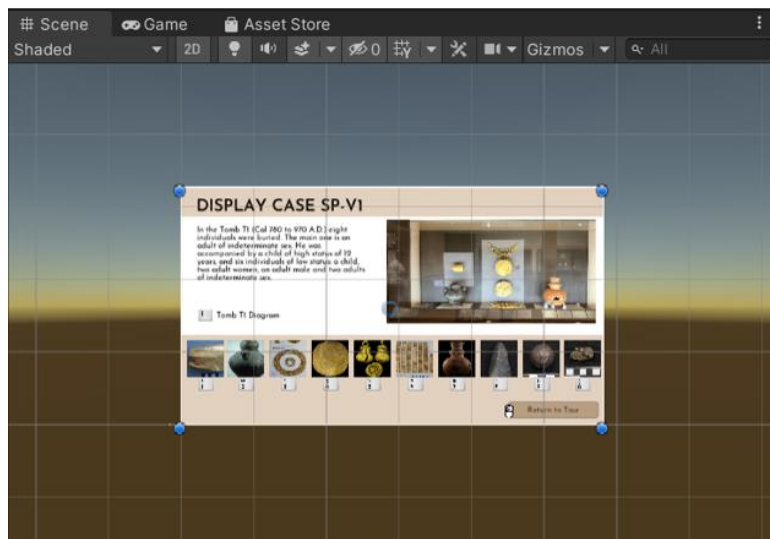


4. To edit specific elements select them in the Project Hierarchy. In the dropdown of the panel all the elements in the panel are visible. Select the desire element and make sure the checkbox in the Inspector is selected. *Note: When the checkbox is checked the element is visible in the panel, when the checkbox is not selected the element is not visible.*

- To change photos, in the Inspector tab of the image you would like to change under the Image section drag and drop your desired image from the Assets folder into the selection bar.



- To change the size and position of each element in the panel, they can be dragged and resized like using other applications like PowerPoint.

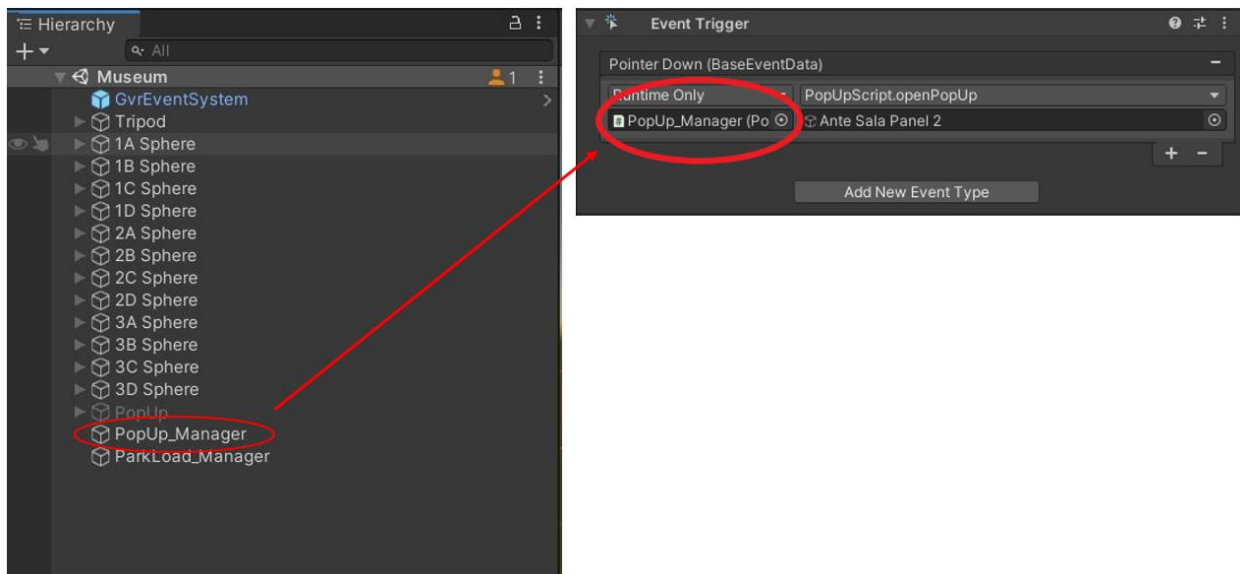


NOTE: When done making edits to the Panel, ensure all the English Elements are selected (visible/checked) and the Spanish Elements are unselected (not visible/unchecked).

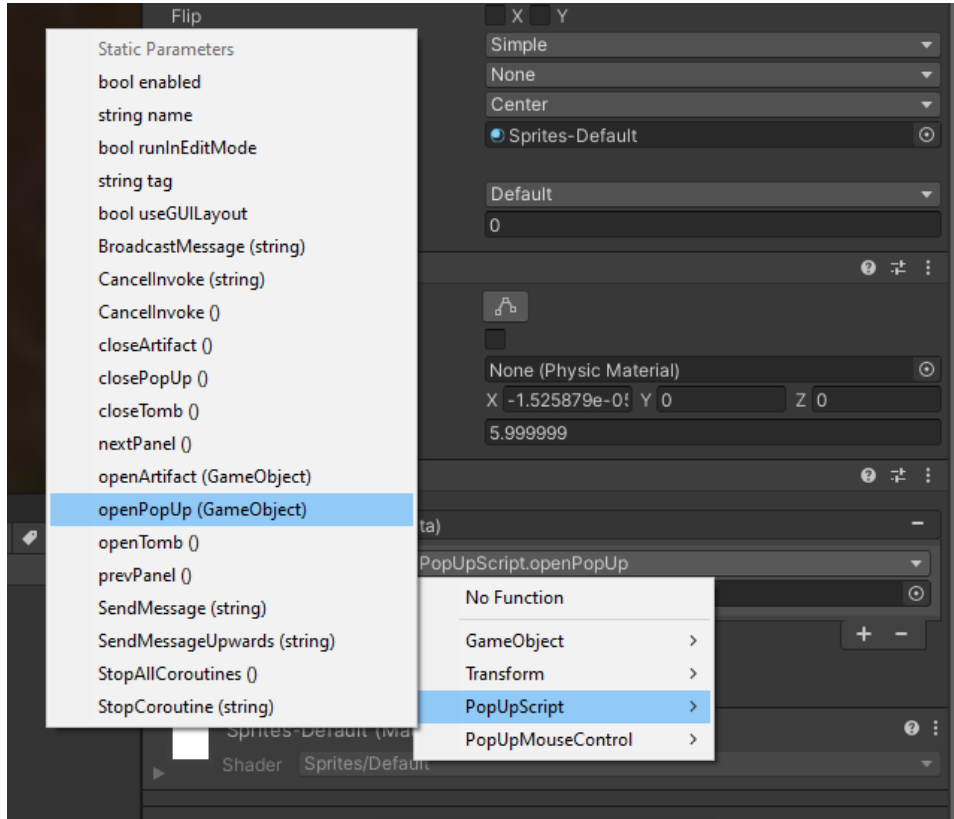
Unselect the panel itself in the Project Hierarchy when you are done making edits to the panel and unselect the PopUp in the Project Hierarchy when you are done making changes to panels.

Adding a Clickable Icon

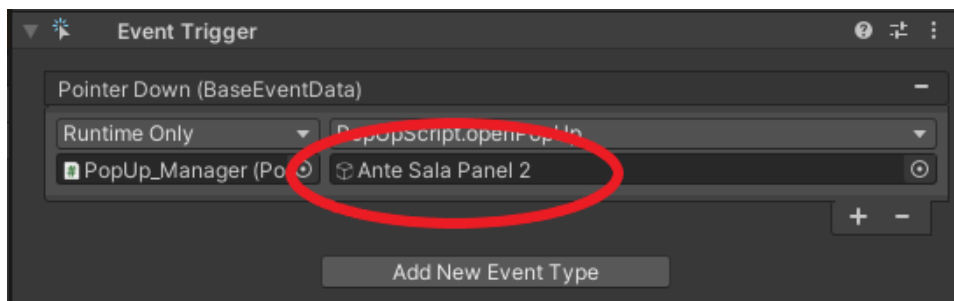
1. Drag the Information Icon sprite from the sprites folder located in the Assets folders into the sphere(s) that will connect to the new Hotspot (in the Project Hierarchy).
 - a. Reformat and resize the sprite accordingly.
 - b. NOTE: if sprite cannot be found, ensure that its X, Y, and Z location are at 0, 0, 0, then relocate from there.
2. From the Add Component button in the Inspector tab Add the Event Trigger Element to the Sprite.
3. From the Add New Event Type under the Event Trigger menu add a Pointer Down Event to the Sprite.
4. Drag the PopUp Manager from the Project Hierarchy to the left slot as the object that will interact with the event.



5. Select the PopUpScript.openPopUp function.



6. Under the Event Trigger Element select the panel that will pop up when the icon is clicked on.



7. Rename each Sprite to indicate the Pop Up that the sprite will open.

C# Scripts

Scripting is what allows customization in Unity. Scripts are what allow the camera to jump from sphere to sphere, Panels to open when an Icon is clicked on, and the changing of spheres. They also can allow data to be shared between scenes and objects and can work as creating new elements to store information within each object. Scripts are attached to an object, once attached they can be assigned local variables, and then the script can perform tasks and functions of the

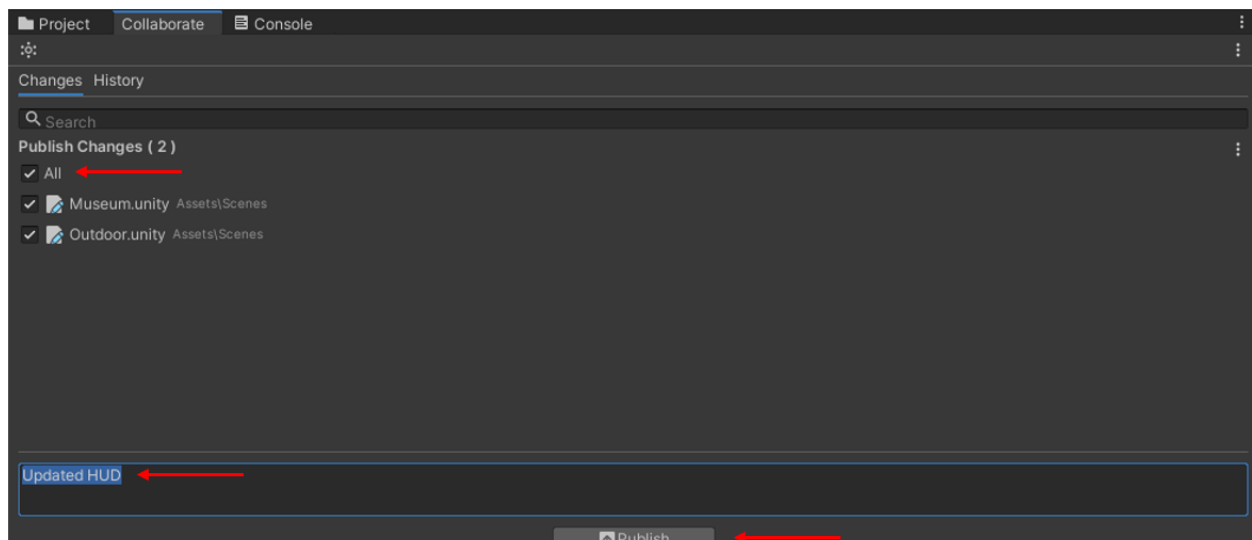
task can be assigned to action events. To learn more about scripts in Unity, reference the documentation of the API and about scripts in Unity.

Unity API: <https://docs.unity3d.com/2020.2/Documentation/ScriptReference/>
Unity Scripting: <https://docs.unity3d.com/Manual/ScriptingSection.html>

Unity Collaborate

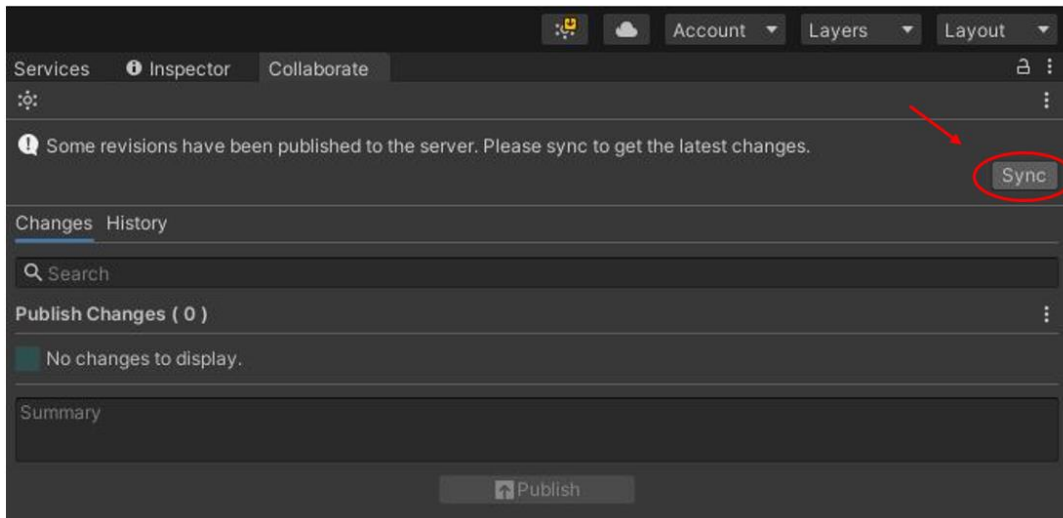
Pushing Changes

When you are done making changes, save the project. Navigate to the collaborate tab. If it is not visible, on the top bar go to, Window, then Collaborate.



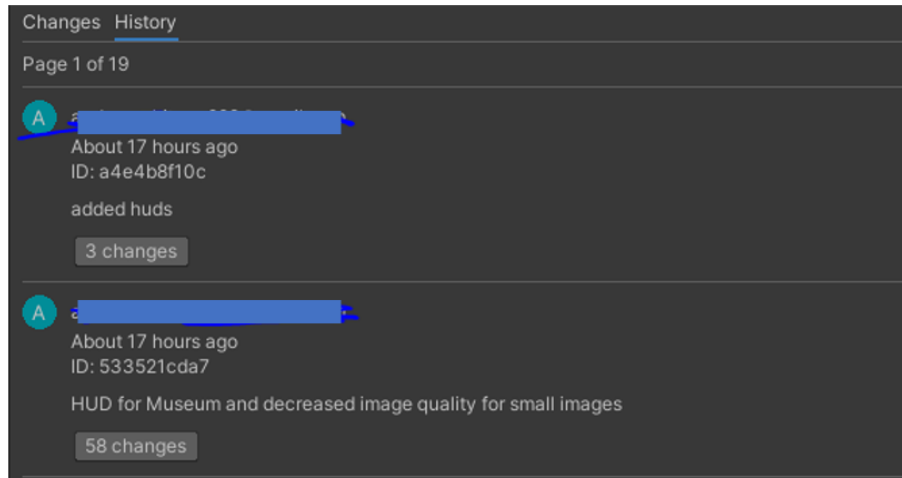
Select 'All' under Publish Changes, then update the description as needed based on the changes you made in the text box at the bottom. Then Click Publish.

Pulling Changes

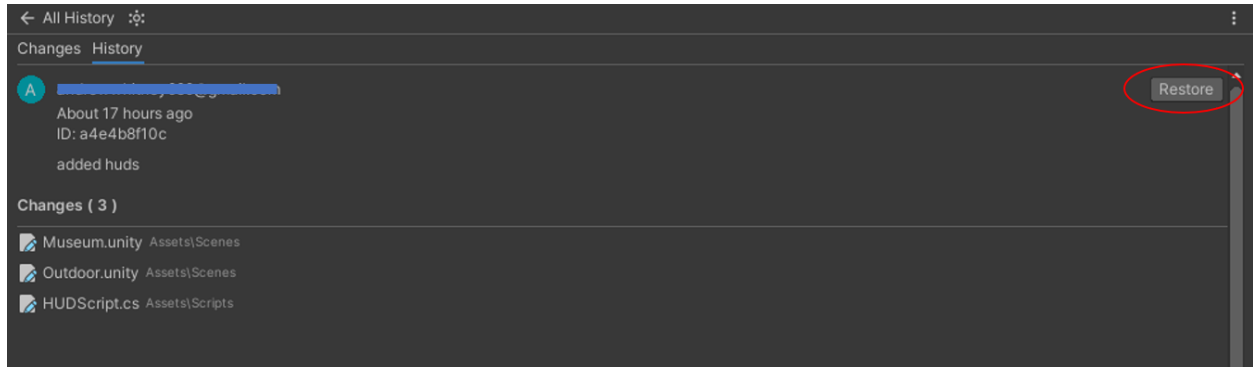


Navigate to the Collaborate tab the same way as earlier. Click the sync button to sync changes from the cloud to your local project.

Reverting Changes



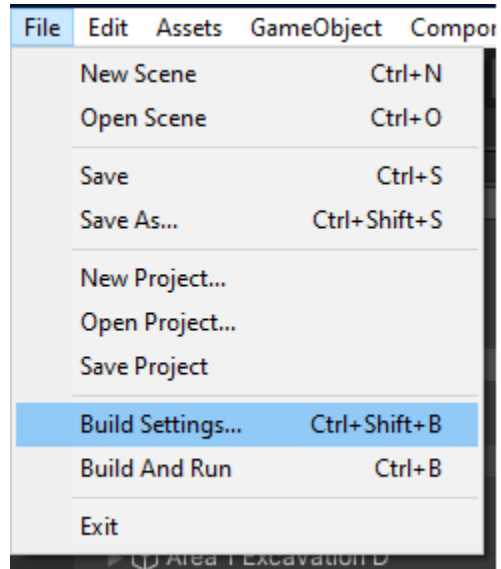
To revert to an earlier version of the project navigate to the History Tab within the Collaborate window. Find the commit you wish to revert to. Click on the changes button.



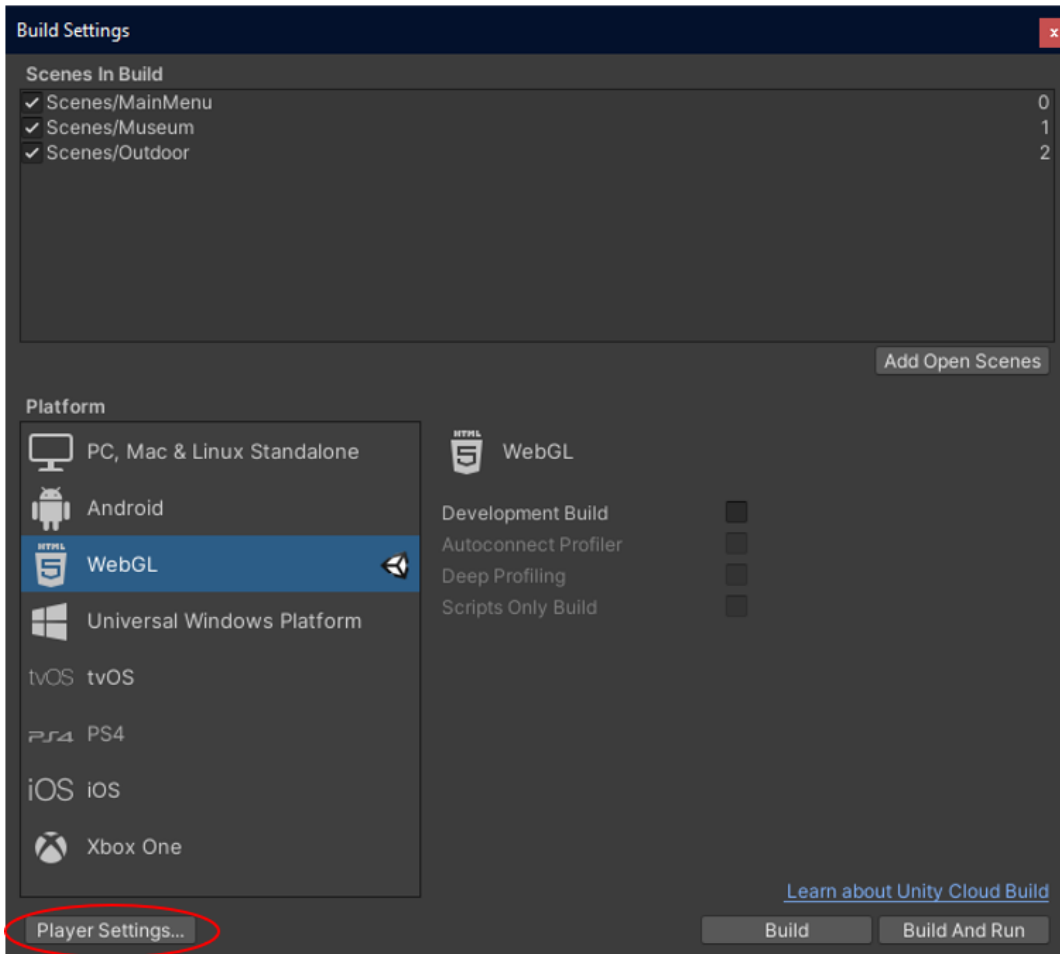
Click the restore button at the top right to restore to this version.

Exporting the Project

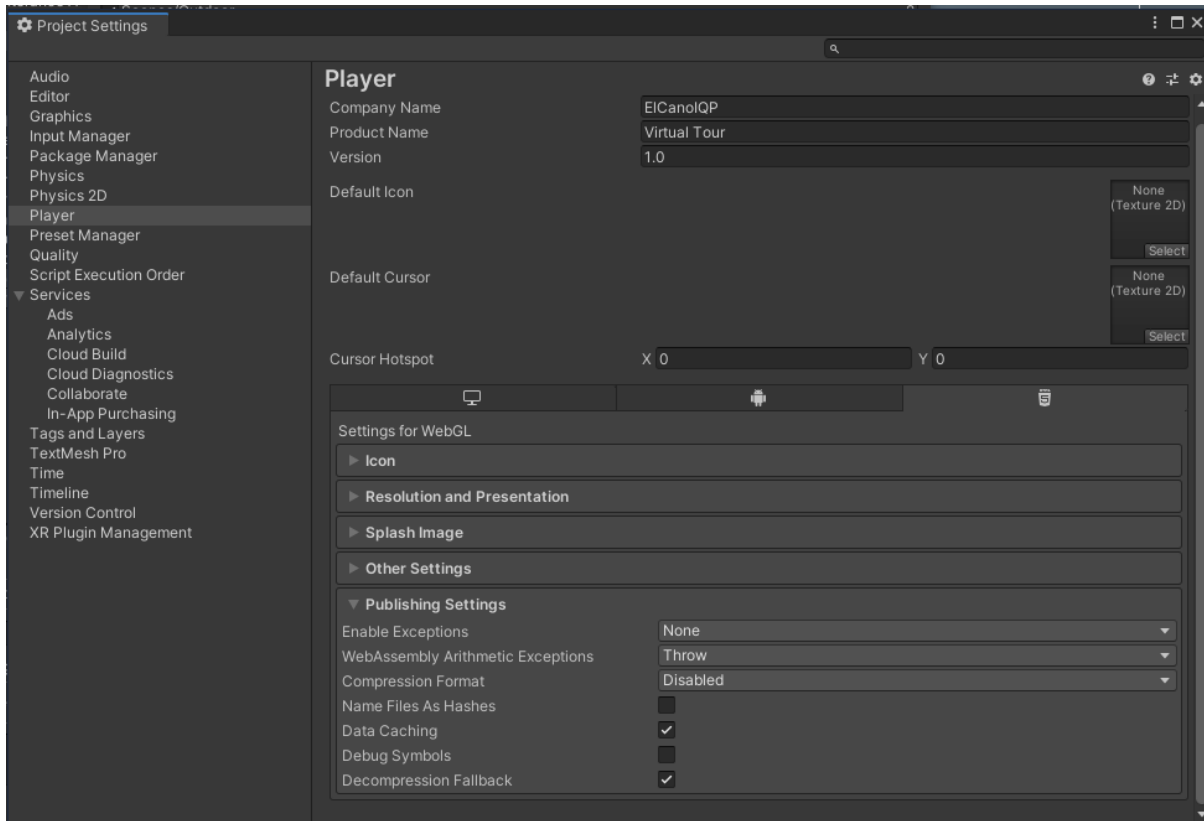
1. Click File then Build Settings...



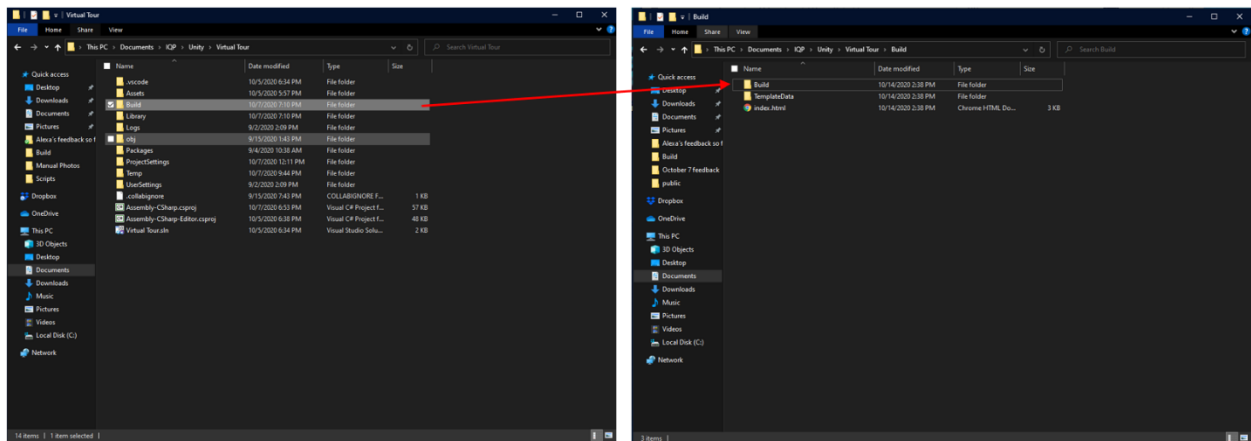
2. Ensure the Build is WebGL, and all boxes are unchecked.
3. Select Player Settings.



4. Ensure the Settings match the image below.



5. The build will be in the Build folder.



6. In the Build Folder, copy the Build and TemplateData, and the index.html file. Paste into the correct folders related to the website.

*NOTE: To keep build size down, follow the documentation on reducing file size:
<https://docs.unity3d.com/Manual/ReducingFilesize.html>*

OPTIONAL: git and GitLab

If using git and GitLab to keep track of the build files, here are the following tutorials on using Git, and using the new versions of the build.

Installing Git: <https://git-scm.com/book/en/v2/Getting-Started-Installing-Git>

Copy the files from the Build folder in the Project Directory to the public folder in the GitLab repository on your local device.

Updating files: <https://docs.gitlab.com/ee/gitlab-basics/add-file.html>

NOTE: to all multiple files, repeat the add command until all files are added. You can check this with the command: git status