

A FRAMEWORK FOR EQUITABLE DESIGN IN EXTENDED REALITY
CULTURAL HERITAGE EXHIBITIONS

A THESIS SUBMITTED TO THE GRADUATE DIVISION OF THE
UNIVERSITY OF HAWAI'I AT MĀNOA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

IN

COMPUTER SCIENCE

MAY 2021

By

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Keywords: extended reality, design frameworks, exhibitions, equitable design

Acknowledgements

I would like to express my gratefulness to the many people that have supported me in ways that led me to be able to reach this milestone in my academic career. I would first like to thank my thesis advisor Jason Leigh, who has also been acting as an advisor to me since my time as an undergraduate student. The opportunity, support, and encouragement he has given me was integral to the culmination of this research and my ability to do the work that I do. I would also like to thank my other committee members; Daniel Suthers, who through advising and attending his classes shaped my understanding of qualitative methods and humanities types of research within the field of Computer Science. Noelle Kahanu, who provided me insightful advice and viewpoints from a humanities perspective that was essential to the development of this research. Also mahalo to her for introducing me to professionals who helped me gain practical experience in exhibition design as well as provide their mana'o to aid in the foundation of this research. Also mahalo to all of the participants of the interview portion of this research for their time, thoughts, and encouragement.

On that note, I would like to extend gratitude to organizations and its people that helped shape my understanding of the importance of protecting, preserving, and education of cultural heritage. To the team at Bishop Museum, particularly Michael Wilson, Brad Evans, Leah Caldeira, and Jillian Swift. To the Office of Indigenous Innovation at the University of Hawai'i, particularly Kamuela Enos. To the navigators and admin team at the Polynesian Voyaging Society whose work continues to inspire to this day. The UHWO Academy of Creative Media, and Chris Lee for entrusting in me the development of Create(x) and Wao Ki'i.

I would like to thank the research assistants at LAVA, particularly those who helped with the development of Wao Ki'i, Ronnie Kauanoë, Kaila Foltz, Nurit Kirshenbaum, Katrina Turner, Ross Turner, and Scott Ngyuen. All of their thoughts, input, and contributions has made this work possible.

I would also like to thank others who were not directly involved in this research, but their support has allowed me to reach the level of understanding I have today. Vernadette Gonzalez, who has supported me from the time I was an undergraduate. The kia'i at Hui o Kuapā who graciously let myself and Jolie Ching work with them to digitize the stories and environment of Keawanui Fishpond. Michelle Brown and Jason Edward Lewis, who both have encouraged me to critically investigate the capacities that technology affords us for cultural and creative expression. Patrick Karjala, who is both a great research colleague as well as showed me the ropes of being a MS student.

Last but obviously not least, I would like to thank my family, who although questions why I would still want to be in school, have encouraged me regardless. And my partner Abundanzia Delavega for supporting me at every moment where I felt that I was in over my head.

Abstract

Extended Reality (XR) technologies continue to be developed by GLAM (galleries, libraries, archives, and museums) and other institutions to create cultural heritage exhibitions to preserve and transmit ancestral knowledge of a particular community. This thesis proposes a shift in the paradigm of exhibition design; one that is not only user-centered but also measures the success of an exhibit by the equity it provides the community of the cultural heritage. The equitable design framework is introduced and adapted particularly for XR development, to aid in the embedding of equitable methods within the typical methodology of software developers who may work within the cultural heritage field. Building on prior Indigenous guidelines and methodologies, the equitable design framework consists of waypoints that can be interpreted as behavioral design patterns for XR developers to help build the skill of cultural sensitivity and reciprocity into their practice. Through an ethnographic study, this thesis contributes to the creation of an explicit model of design values derived from interviews of professionals in a variety of fields who are of Native Hawaiian descent and demonstrates how it has affected the design of a XR exhibition called Wao Ki'i. With this proposed framework and process, this thesis contributes to the ongoing conversation of ethical design and collaborative methodologies and argues for the importance of the community's own people, ancestral knowledge, and creative expression to be meaningful factors in the development and design of XR cultural heritage exhibitions.

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Introduction

Extended Realities (XR) are environments created through spatial computing technologies that allow for the creation of digital immersive-interactive environments. This includes technologies that are known as augmented reality (AR), mixed reality (MR), and virtual reality (VR) (Doolani, et al., 2020).

In the realm of cultural heritage preservation and education, XR technologies have been utilized in a number of projects to create digital realities that would both immerse and educate those who visit them of various cultural heritage topics. These XR cultural heritage projects are found in GLAM institutions (galleries, libraries, archives, and museums), universities, and public exhibitions spaces, and are created by institutions or individuals whose typical design goals are to entertain and educate.

As XR technologies become more affordable and widespread, XR developers need an understanding of how to develop XR projects that are as least harmful or extractive as possible towards the descendants of the cultural heritage; as well as be mindful of potential opportunities for equity for the descendants. Even the most well-meaning XR developers are likely to not consider equitable practices in their development process without further research and experience than what a typical education in XR development provides them. It has been expressed by both Indigenous researchers and professionals that some software development methodologies have done little to consider the community of the cultural heritage more than as a generalized stakeholder or through a few specific cultural consultants to get approval from at some stage of the development process. It is argued that it is more ethical or beneficial to actively involve community members within the entire development process (LaPensée, 2020) (E-Line Media, 2014).

The purpose of this research is to introduce a design framework particular for XR cultural heritage projects that may be adapted into a typical software development cycle in a way that will aid in the creation of XR projects that are equitable and ethical to the community of the cultural heritage. The two research questions that are addressed in this thesis are:

RQ1: What are the actions and behavioral design patterns needed to be adopted by XR developers to create equitable projects for the community of the cultural heritage?

RQ2: How do we apply these design patterns to current software development cycles of XR projects?

Through the recognition of what can be equitable to a community through a XR cultural heritage project, XR developers will be able to design and implement a project that is as least extractive or harmful to a community as possible. To consider a culture's unique perceptions of

place, time, and storytelling, a XR developer may design new user experiences that are unique and may provide a deeper understanding of a culture's perspective and values. This design framework will be referred to as a pathway to emphasize the fluidity of the practice of designing anything that incorporates the diverse realm of cultural heritage, as the researcher will need to balance typical measures of exhibition design success, such as maximizing throughput, profitability, and generating PR, to ones that will optimize for equity, reciprocity, and the promotion of the diversity of knowledge. This design framework will be broken down into design waypoints, which can be thought of as behavioral design patterns for the XR developers themselves, to adapt their own methodology so that collaboration, reciprocity, and equity for the community of the cultural heritage will be embedded into their process.

Just as navigational waypoints are points in which one will measure and recalibrate their direction of travel in the physical world, XR developers can apply the notion of design waypoints to navigate and correct their XR development cycle as they progress through it. Along with an explanation of each waypoint, a list of questions will be provided for the XR developer to aid in the customization of the waypoint to fit whatever lineage and topic of cultural heritage they are exhibiting. These questions will not be exhaustive but will provide a starting point to conversations that XR developers will need to have with their development team, as each development experience will be unique to the cultural heritage and community that the XR developer collaborates with. Each of these design waypoints that will be proposed are derived from Indigenous guidelines, methodologies, and frameworks for research and media & technology development involving Indigenous cultural heritage.

The inspiration for the creation of this design framework comes from the prior work of developing the original prototype of Wao Ki'i (fig. "forest realm of images"), an XR environment that is housed in the newly formed Create(x) lab in the Academy of Creative Media building at the University of Hawai'i at West O'ahu. The early challenges of development for this project, along with other personal past experience in the development of XR cultural heritage projects, made it integral to research and develop a design framework that could better provide methods that would improve the capacity of XR projects for equity for the community of the cultural heritage, as the extractive nature of cultural heritage XR projects became apparent. Also, as a part of this research, the thematic findings of a series of ethnographic interviews conducted with Kanaka Maoli (Native Hawaiian) professionals were used to determine what sorts of design practices, methodologies, and goals are considered ethical and equitable for the Kanaka Maoli community in particular to validate the structure of the equitable design framework, as well as to create a model of design goals to aid in the redesign of the second prototype of Wao Ki'i.

It is my intention that through the interviews, literature, and knowledge that is shared within this thesis, an XR developer will have a framework to begin to develop an understanding of the considerations, processes, and histories they must recognize to be able to better prepare themselves to design an equitable XR cultural heritage project for the communities of the cultural heritages.

Background

Term Usage

Indigenous

To be clear in meaning, definitions of the terms used in this paper are needed. For my own usage in this paper, the term Indigenous is a collective term to describe the diverse populations of peoples from around the world who are descendants of continuous lineages of place-based ancestral knowledge.

However, there exists more nuance to the term, particularly in contexts when speaking about past and current efforts of decolonization. Dr. Linda Tuhiwai Smith, a Ngāti Awa and Ngāti Porou professor of Indigenous and Māori Studies, and Education, authored *Decolonizing Methodologies* (1999), which explains that the term Indigenous can be problematic as it has been used as a collective term for a vast group of populations whose experience with imperialism has been widely different. Generalizing the diverse groups of people that can be considered Indigenous does little to address their unique knowledge, histories, and needs. However, it is still used as a collective term in ways such as the term Indigenous Peoples that emerged in the 1970s, which was created to describe the experiences, issues, and the struggles of the world's colonized peoples. The term has also been construed in meaning to be used against Indigenous communities, as Smith (1999) also explains:

“[Indigenous] has been co-opted politically by the descendants of settlers who lay claim to an 'indigenous' identity through their occupation and settlement of land over several generations or simply through being born in that place- though they tend not to show up at indigenous peoples' meetings nor form alliances that support the self-determination of the people whose forebears once occupied the land that they have 'tamed' and upon which they have settled. Nor do they actively struggle as a society for the survival of indigenous languages, knowledges and cultures.” (p.7).

It is for reasons such as this that not all people who would be included in the collective definition of Indigenous choose to use this term. Other English or non-English terms such as Aboriginals, First Peoples, First Nations, and much more are preferred to describe their own communities.

However, for the context of this thesis the collective term Indigenous will be used, and other unique terms will be used if a particular group is explicitly mentioned. With that being the case, it is critical to be mindful that Indigenous peoples are not of a single community with shared values, beliefs, and needs. Every Indigenous community has their own unique cultural heritage continuity that includes ontologies, epistemologies, and protocol for knowledge sharing that must be recognized and respected throughout the XR development process. This thesis will

emphasize Indigenous-led research, guidelines, and work as Indigenous communities' cultural heritage have been often subjected to being treated as mere research and exhibition objects (Smith, 1999).

Kanaka Maoli

In the Hawaiian language there are multiple terms that are used to refer those of Native Hawaiian ancestry. Kanaka (person), Kanaka Maoli (full-blooded Hawaiian person), Kanaka 'Ōiwi (Native person), Kanaka Hawai'i (person of Hawai'i) are all terms that can be used to refer to a person of Native Hawaiian ancestry. Throughout this thesis, these various terms may be used by both myself, quotes from cited literature, and quotes from interviewees. I favor the term Kānaka Maoli to refer to those with any Native Hawaiian descent, even though the dictionary definition of the term is "full-blooded Hawaiian person" (Nā Puke Wehewehe 'Ōlelo Hawai'i, 2021). Contemporarily, this term is commonly used by those who have any "amount" of Hawaiian ancestry. The term Kanaka can be used generally to refer to any individual, Kanaka 'Ōiwi can refer to any Native person, and Kanaka Hawai'i can refer to anyone "of Hawai'i" not necessarily having any Native Hawaiian ancestry. Also, the use of kahakō (macron) and 'okina (') will be used for Hawaiian words written myself as it is my own personal preference to use them, but they may not be included in quotations where the original author chose not to use them.

Cultural Heritage

The United Nations Educational, Scientific, and Cultural Organization (UNESCO) defines cultural heritage as a collective term for multiple categories of cultural heritage (UNESCO, 2021). There is Tangible cultural heritage, which includes movable, immovable, and underwater cultural heritage such as paintings, monuments, and underwater ruins. This encompasses all the physical heritage of a culture. The second category is Intangible cultural heritage which includes oral traditions, performing, arts, rituals, and more. There is also Natural heritage which includes cultural landscapes, physical, biological, or geological formations.

Equity

Equity, outside of the field of finance, as a concept has been discussed in various fields such as education or political science as a way to describe methods and frameworks for providing capacity, support, and resources to individuals who are unfairly disadvantaged. It is often compared to the term "equality;" however, the nuance of equity can be described as

providing resources based on individual needs so that everyone may have equal advantages rather than providing the same resources to each individual (McSherry, 2013). This thesis addresses the power dynamics between institutions that exhibit cultural heritage and those who are affected by the impact of these exhibits. In this context, equity becomes methods to increase the advantages of the process and creation of cultural heritage exhibits for the community of the cultural heritage.

Brief History of Exhibition Design

As stated in the introduction, cultural heritage exhibitions typically reside in or are produced by institutions such as GLAM institutions or universities. With that comes the need to understand the historical context of the relations between cultural heritage exhibition, exhibition design, and the institutions that typically create these exhibitions.

The purpose of exhibitions, especially for cultural heritage, has evolved since the inception of the practice. In Western museum traditions, the original intent for the creation of cultural heritage exhibitions was to provide the general public, who at the time had limited traveling opportunities, a glimpse of imported “curiosities” from faraway places (Hughes, 2015).

Of course, today we understand that the imported curiosities that were on display at these early exhibitions were at times stolen art, artifacts, and even in the worst cases, Indigenous people themselves. Often, none of these ‘curiosities’ were fully understood or presented accurately by the exhibitors. The foundation of exhibition design was sensationalism, that is to create spectacles to provoke visitor interest, and to make the visitor feel they had a shocking, wondrous, or exclusive experience at the expense of accuracy.

As an example, in the 1904 St. Louis World’s Fair, the fair included the exhibition of the Philippine Exposition, which included sub-exhibits such as the Philippine Encampment and Reservation. This World Fair and exhibition came after the recent purchasing of the Philippines by the United States after the Spanish-American War. The Philippine encampment included model schools, bands, and police drill teams to convince the American public that the Philippines should eventually become a part of the United States in a similar way that Hawai’i was recently annexed about six years prior (Kennedy, 1988). However, in juxtaposition to a display of “tamed” Filipinos, in the Philippine Reservation, four villages were created: Igorot, Negrito, Visayan, and Moro to exhibit the “primitive” culture of the Philippines (Kennedy, 1988). Particularly for the Igorot, the Indigenous people of Luzon in the Philippines, were made to repeatedly perform inaccurate showcases of their own ceremonial practices. They were also reportedly given dogs to butcher and eat daily, as this was considered a spectacle for fair

goers. A descendant of one of the Igorot men was interviewed, and explained that eating dog meat was rare and reserved for specific ceremonial purposes (Allen, 2004). This juxtaposition between the Encampment and the Reservation can lead one to assume the intention of these two exhibitions were to show the positive “civilizing” affect that the United States had on the Philippines. This further promoted the idea of the positive effects that American imperialism had on foreign lands, as well as justified American expansion as it would be evident through these exhibitions that these “primitive” cultures did not have the capability to be independent nations.

Also at the 1904 World’s Fair, the government of China funded, designed, and built exhibitions to showcase their own cultural heritage, with the intention to portray China as deserving of recognition as a world power through the wealth displayed in their vast number of exhibitions (Imperial Chinese Commission, 1904). At the Chinese exhibition space, a recreation of Prince Pu Lun’s palace was created and the prince himself was in attendance at the fair. Although this is only one of many world fairs, which is just one in a long history of large scale exhibitions, this example shows the power of cultural heritage exhibition. Through the context and experience of an exhibit, it is just as easy to dehumanize and infer superiority over those who are exhibited as it is for a community to be empowered through the context in which their cultural heritage is displayed, and governments and institutions have used this power to further their own agendas. To design cultural heritage exhibitions is to design a narrative. Whoever has control over the narrative of a people will have the advantage to create lasting biases and impressions towards a people based on how they choose to portray them.

In current times, curation and exhibition design practices have tried to move away from sensationalism as a design practice. Many institutions have recognized there is a responsibility as a knowledge institution to make an effort to accurately portray whatever cultural heritage they have in their collections. However, these institutions often are businesses that need to bring in visitors to thrive. It is well recognized in marketing practices that the use of exclusivity may encourage potential consumers to buy a product or service. So, it can be understood that the temptation for sensationalism and the dehumanization of Indigenous people in exhibition design is still ever present, whether intentional or unintentional.

User-centered design are common priorities in the field of exhibition design. For example, *The Visitor Bill of Rights* (Rand, 2000) outlines the obligations that museums have to their visitors. These rights are the following:

1. Comfort: "Meet my basic needs."
2. Orientation: "Make it easy for me to find my way around."
3. Welcome/belonging: "Make me feel welcome."

4. Enjoyment: "I want to have fun."
5. Socializing: "I came to spend time with my family and friends."
6. Respect: "Accept me for who I am and what I know"
7. Communication: "Help me to understand and let me talk too."
8. Learning: "I want to learn something new"
9. Choice and control: "Let me choose; give me some control."
10. Challenge and confidence: "Give me a challenge I know I can handle."
11. Revitalization "Help me leave refreshed, restored."

A user-centered design is effective in designing an experience that is satisfying to visitors, which may encourage them to visit again or recommend the experience to their peers. For cultural heritage exhibitions, the design is uniquely concerned with the visitor's cultural experience (engagement, meaningful experience, knowledge/learning and emotional connection) (Konstantakis, Michalakis, Aliprantis, Kalatha, & Caridakis, 2017). However, this strategy of user-centered design does not take the community of the cultural heritage into consideration, as they are not often included in the profile of a typical user.

When possible, another strategy to draw larger numbers of visitors into an exhibition space is to utilize emerging technology to create exciting and unique exhibition experiences. For example, in the 1960s, the growth of "hands-on" exhibitions began to be developed and adopted by institutions such as the Exploratorium in San Francisco (Hughes, 2015). These hands-on exhibitions utilized emerging technologies of the time, to create interactive exhibits that allowed visitors to not just have access to the traditional "artifact and placard" presentations that are standard in museums, but educates through unique interactive experiences.

In our current day, XR technologies are being used in exhibition spaces for a similar reason. Technologies such as virtual reality have been around for decades now; however, the cost of the hardware has decreased, and developing software for the hardware has become widely accessible through video game engines such as Unity (Unity Real-Time Development Platform, n.d.) or Unreal (Unreal Engine, n.d.). With the lowering cost of XR hardware for personal use, institutions have an opportunity to create XR content for both use in their own exhibition spaces, and as outreach to those who have the appropriate hardware at home.

Unless XR developers have a background in Cultural Heritage or Museum Studies, they will find themselves hired for an exhibition that may grant them the same power and responsibilities as a museum curator or exhibition designer; however, without the same background and training. Although XR software may be a potentially effective revenue or

marketing strategy for institutions, it provides a greater challenge to the XR developers to properly and effectively communicate cultural heritage within a XR environment that could be potentially housed in any setting.

In a section within *Decolonizing Methodologies* (1999) titled *Ten Ways to Be Researched (Colonized)*, Smith writes that the seventh way to be researched is by creating virtual culture as authentic culture:

“For those who can afford it, virtual reality can already substitute for exotic travel and armchair voyeurism. Art collections from museums can now be viewed from anywhere in the world and ancient ruins can be reconstructed and entered by a tourist who never needs to leave home. According to Tasmanian Aborigine Jimmy Everett, 'White people actually "farm" Aboriginal culture . . . moulding it into static stereotyped images of what is accepted by white Australians as being Aboriginal. Anything that doesn't fit the white criteria is rejected on the presumption that it is not wholly Aboriginal.' 'Scientific' knowledge of peoples can be created for virtual experience and conversations can be designed between ancient warriors and modern-day observers. Cultural differences can be controlled by selecting and pushing buttons. Dehumanization of the Other continues.” (Smith, 1999, p. 122).

This quote explicitly states the power and problem of XR technologies. Through XR technology, the developer is essentially manipulating reality or creating a new one. Developers have full control over the presentation and agency of the environment, people, and experiences that within a digital reality. Even though the elements are digital, digital realities can still affect users' sense of presence and immersion in a way that impacts the user's perception (Skarbez & Whitton, 2019). With that fact, XR development for cultural heritage exhibition must learn from the history that GLAM institutions have had in exhibition design and the obligations those institutions have to the community of the cultural heritage.

Museums are often perceived by the general public as the authoritative voice on the accuracy and authenticity of cultural heritage. However, curators, researchers, and staff of the museum may not descend from the Indigenous cultural heritage that they are presenting. This creates a strange and strained relationship between the museum and the communities of the cultural heritage, where foreigners are essentially dictating the Indigenous peoples' own culture back to them. As for general visitors who are not familiar with the cultural heritage, what they learn as authentic cultural heritage is actually presented through the lens of the perceptions of outsiders, who have the capability to display the cultural heritage inaccurately for reasons that range from simple ignorance to harmful intent.

As an example, in *Sovereignty Out from Under the Glass: Native Hawaiian Rhetorics at the Bishop Museum* (2015), Dr. Lisa King describes the “uneasy relationship with [Bishop Museum]’s Native Hawaiian collections and with the Native Hawaiian communities it claims to serve.” Bishop Museum is a museum of Natural and Cultural History that was founded in 1889 on O’ahu, Hawai’i. It was built by Charles Reed Bishop in memory of his late wife, Princess Bernice Pauahi Bishop who was the last descendant of the royal Kamehameha family (Bishop Museum, 2021). A quote from King’s article of Noelle Kahanu, the past Director of Community Affairs for Bishop Museum:

“As with any institution with such a long history, Bishop Museum has had lessons to learn, relationships to mend, and wounds to heal. ... When we closed Hawaiian Hall in 2006, we closed the door on speaking about Hawaiians in the past tense with that anonymous omnipotent all-knowing Western voice... on speaking about Hawaiians, not with them” (King, 2014).

The Hawaiian Hall renovation that is mentioned in Kahanu’s quote was the Bishop Museum’s attempt to design against the dehumanizing nature of traditional exhibition practices, so that they may do better for the Kanaka Maoli community whose cultural heritage is the museum’s central focus. On the redesign of the renovated exhibition space, King writes:

“The overall rhetorical impact of this presentation is layered: it grounds the visitor in the origin stories of Hawai’i rather than the official Euro-American history that begins more or less with contact; it creates a taxonomy of objects and ideas organized from those stories, rather than based on Euro-American scientific endeavors; it blends contemporary artists’ works with artifacts, chants, and mo’olelo (stories/histories); and it addresses the Hawaiian Kingdom’s overthrow and annexation in order to extend Native Hawaiian history into the present. The conceptual groundwork upends the traditional museum’s approach and the Bishop’s long-standing approach of forwarding Euro-American renderings of history over a silenced Native Hawaiian populace. If visitors (Native or non-Native) arrive with the expectation of finding canonized Euro-American history, the new Hawaiian Hall instead immerses them in a worldview firmly grounded in Hawai’i, from a perspective of connected cosmology, land, and history” (King, 2014).

Museums practices are shifting towards practices that include Indigenous community consultation, design built from ancestral knowledge and aesthetics, contemporary stories of Indigenous peoples, contemporary advocacy, and other practices that are equitable to the community of the cultural heritage. Although these practices are still not universal, nor by any means perfect in implementation, XR developers should make efforts to adapt their practices

with the same goal in mind: to design against the dehumanization that can easily occur in cultural heritage exhibition and provide equity to the community of the cultural heritage throughout the development and implementation process.

Related Work

There have been many past studies into the ways in which immersive and interactive technology can aid in cultural heritage education, exhibition, and preservation. Recent research in the gamification of cultural heritage exhibitions (Torsi, Ardito, & Rebek, 2020) has recorded promising feedback in the ability of narrative scenarios to invoke interest in younger visitors, as having an interactive quest would better engage and communicate the context of a cultural site to them. Other recent research has suggested that XR technologies can provide accessibility to intangible cultural heritage, especially those that may not be actively practiced, through the visualization of the cultural heritage in a virtual reality space and the resulting immersion it provides to a user (Selmanović, et al., 2020). Other research suggests that along with immersion, collaboration is an important part of designing experiences for cultural heritage as it is through active engagement that learning occurs (Andreoli, et al., 2017). There has also been research in designing cultural values into interactive exhibits. This research argues that based on the understanding of cultural values of a community, the UX design of an exhibition should change. For example, the breaking of traditional methods of artifact presentation and limiting the accessibility of knowledge within an exhibit to correlate to cultural values of consent (Wakkary, et al., 2015).

Much of this kind of research is what influences the design processes of XR cultural heritage exhibitions. In fact, some of these references aided in the design of the first Wao Ki'i prototype. However, for all the research that builds the understanding of the ways in which XR and interactive technologies can help one improve engagement, empathy, and knowledge acquisition in a visitor, the usefulness or equity of the project for the community of the cultural heritage is not often measured, as the focus of cultural heritage exhibition design is on a visitor that does not know the culture.

Equity

Equity design has been used within different fields to try to design methods to increase opportunity for those who are impacted by oppression. One approach that has been foundational to other equity-centered frameworks is Liberatory Design created by the National Equity Project (National Equity Project, 2021). This core beliefs of this design framework are:

1. Racism and inequality have been designed into systems and thus can be redesigned.
2. Designing for equity requires the meaningful participation of those impacted by inequity.
3. Equity-driven designs require equity and complexity informed processes.

The parts of the framework include 6 iterative steps: Empathize, Define, Inquire, Imagine, Prototype, Try. After each step, Notice and Reflect are two additional steps to return to, to remind designers to be mindful of their decisions. This design was built upon the Stanford d.school's Design Thinking Process with additional parts added and modified for equity-centered design (Stanford d.school, n.d.).

In a very similar way as Liberatory Design, this thesis's design framework will ask key questions to help the developer build mindfulness and methods, but in the context of providing equity in the development of cultural heritage XR exhibitions. The steps of this thesis's design framework will be related to the Software Development Lifecycle rather than the Design Thinking Process, although both have similarities in their iterative structure.

Design Waypoints

The reviewed literature and interview themes will be organized by attributes. These attributes are the equitable design waypoints that will be explained more in detail in the Results section. The waypoints were conceived from the reviewed literature, so the literature review will be presented through the waypoints that the literature supports. Common attributes such as Positionality or Sovereignty were often used within the frameworks and guidelines within the reviewed literature. Reoccurring attributes and their similarities were organized into potential groupings that were relevant to software design. Through the responses collected in the interviews, an attribute was considered particularly relevant if it was mentioned in the interview responses without prompting. The attributes were then organized into the five resulting waypoints. The waypoints are:

Positionality: The relation and influence that one's own identity, biases, and profession has towards a community and its cultural heritage.

Locality: The historical and cultural context of the location of the cultural heritage in relation to the community, exhibition location, and XR environment.

Sovereignty: The building of capacity for community descendants to have authority and voice for the narrative, presentation, data, user experience, protocol of knowledge transmission, and creative expression within the XR environment.

Responsibility: The responsibility the XR developer has to advocate for the community of the cultural heritage in way defined by the community collaborators on the development team, to provide reciprocity, to do no harm, and to provide access to the resulting XR environment and its assets to the community.

Feedback: The creation and implementation of a method for collecting, analyzing, and archiving

feedback from both cultural heritage experts and the general community of the cultural heritage. These are elaborated in the following sections.

Positionality

Positionally, in this case, is the relation of the developer to the community and cultural heritage the XR project intends to include, particularly the influences and biases that one may have towards the cultural heritage and its community.

As an example, to recognize my own positionally I will share that I was born and raised on the island of Kaua'i in Hawai'i. My mother is Kanaka Maoli with Kaua'i and Ni'ihau lineages, and also has ancestry from Japan, the Philippines and Portugal. My father's parents have German and Mexican heritages respectively. I recognize that I am in a position where I develop XR projects that involve my own cultural heritage, which may give me more influence or perceived authority over topics of cultural heritage. However, I do recognize that I am not any sort of knowledge keeper, elder, or any term that refers to describe someone who learns, practices, and passes on traditional ancestral knowledge that they acquired, typically, from a lineage of other traditional cultural practitioners. Even though I am part of the community, my position in context to these projects is as a XR developer. As such, I still need to go through the same processes that someone who is not a part of the community will need to go through to ensure that projects involving cultural heritage are proper, equitable, and ethical. I could research any amount of my own cultural heritage through literature, video, and other typical research practices, but that developed understanding could not equate to a knowledge keeper or elder who has dedicated much of their life to the cultivation of expertise in any such cultural heritage topic. As such, it is important to recognize the areas in which expert collaboration is needed.

A particular challenge in XR development is the developers own bias in interpreting how technology should hold and transmit knowledge. The XR developer essentially designs the experience that the user will have within a digital environment, the way knowledge is transmitted through the design of the environment, UI, and other capabilities they will afford the user may need to be reviewed to be more aligned with a community's own practices of transmitting knowledge.

For example, in *Indigenizing AI: The Overlooked Importance of Hawaiian Orality in Print* (2020), Dr. Noelani Arista presents questions to emphasize the risk of the perceived authority that technology is given:

“[...] in what ways can digital applications constitute Native peoples with “knowing” rather than taking their place, supplanting the integral relationships that people cultivated among themselves by way of caring for ‘ike [data]? Will computer memory replace experts and elders as repositories of knowledge, for example, supplanting human (maoli) relationally? This is an important question for Native people. At what point in the process of the application development are knowledge keepers who have integrated their expertise called upon to ensure that the ‘ike (data) is structured and delivered in a customary manner in line with centuries of care? What is arguably necessary is institutions that train knowledge keepers who are fluent in language and trained in computer science.”

In much of the same way that institutions such as museums were given the perceived authority over the transmitting and care of ancestral knowledge, technology has also been given a similar perceived authority. Just like a museum exhibit, the XR digital environment is an exhibition space that may hold the knowledge; however, the context, accessibility, and presentation of the knowledge to be transmitted is integral to providing equity to the community. An XR project that can facilitate the relations between knowledge keepers and their own community is much more equitable than an XR project that holds and dispenses knowledge as if the knowledge had no explicit Indigenous origin. Also, an XR project can never be made to imply it holds more authority than the community and its cultural practitioners. XR designers must be mindful of their influence over a community’s cultural heritage as their XR projects can influence the greater interpretation of a particular cultural heritage. The ability to present cultural heritage topics through emerging technologies will ultimately provide XR designers perceived authority over such topics.

If an XR developer is working for an institution or entity with past history with a community, such as a museum or university; knowing and acknowledging these past histories will also aid in communicating proper boundaries and relations with that community; especially true for Indigenous communities who have historically been dehumanized as research objects by Western institutions (Smith, 1999). As mentioned in the Background section, institutions such as museums are still trying to earn Indigenous communities trust to this day, in part because the history of cultural heritage exhibitions has been fraught with extractive and abusive design practices.

For this reason, it is essential to create relationships with collaborators who have expertise in the cultural heritage topics of the project and connection with the community. Traditionally, this is done through cultural consultants. In this context, this is a term to describe a

role where knowledge keepers, experts, or anyone from a specific cultural heritage that gives their opinion and advice for the current state of the contents of the project which would be shown to them at different stages of development. However, this level of separation of the community from the development processes is not considered optimal by many Indigenous communities. These consultations often come too late in development, which may render their advice un-influential to the resulting project, as such an approach would provide little influence or opportunities for well informed consent on the resulting project (LaPensée, 2020). In an interview with Ishmael Hope, a Iñupiat writer for the video game *Never Alone* (2014), whose narrative is based on an Iñupiat traditional story, when Hope is asked how he got involved in collaborating with E-Line media on the development of the game, Hope said:

“I told them that this project needed an equal collaboration with Native people, not only because it was ethically responsible, but to make a better video game. There were too many details, too many facets of our worldview, too much dialogue to navigate to even know where to begin, that it couldn’t have successfully been created without equal Native collaboration on every level” (E-Line Media, 2014).

An estimated 40 Iñupiat elders, storytellers, and community members contributed to the development of the game.

In the publication of the *SPEAR: A Framework for Indigenous Cultural Games* (2020) by Anishinaabe, Métis, and Irish professor and game developer Dr. Beth LaPensée, she writes about cultural consultants:

“Ideally, Indigenous cultural games should take a step beyond putting Indigenous people in limited roles such as cultural consultants or voiceover actors. While these roles provide some influence in a game, they do not contribute to building capacity for sovereign games on creative or economic levels” (LaPensée, 2020).

Both professionals are emphasizing that someone who does not have an understanding of a community and their culture will not be able to create a project that encapsulates the intricacies of cultural aesthetic, knowledge, and values. Also, without key community involvement, proper consent to the sharing of cultural heritage topics cannot be given. To provide context, in the quote from LaPensée, what she refers to as “sovereign games” are games in which Indigenous communities have economic control, development leadership positions, and intellectual property protection for video games that include their own cultural heritage (LaPensée, 2020). Further than cultural consultants, co-leadership between community members and non-community members of an XR development team needs to be established. Also, community members must be properly compensated and credited for their contributions. Community members have no

obligation to contribute to a project for free just because it involves their own cultural heritage.

Also, the threat of inaccurate and harmful representations of their cultural heritage should not be the reason that free consultation is offered. Instead, the XR developer should recognize their position to allow space for a community member to build capacity for their own community. Although not every co-collaborator or co-leader on a development team will go on to be an XR developer, the experience and resources shared through the development process can be used to foster talent and innovation to those in the community who are involved in the project.

In the case that collaboration and leadership cannot be fostered due to things such as lack of proper community expert contacts, inability to create a relationship of trust within the community, lack of community support, proper methods for knowledge sharing, or any sort of capacity building; then the XR developer should consider whether the cultural heritage topic is something that can actually be feasible to develop with their current position. In cases such as this, the topic of cultural heritage should be pivoted to better fit the ability and relationships of the XR developer, or the project should not be done at all. Lack of proper community collaborators and leadership may still result in a completed XR project, but with little opportunity for community equity or innovation, a lack of consent from the community to depict and share their cultural heritage, and a higher risk of harm due to the likely inaccurate representation and knowledge. From an ethical standpoint, it is for these reasons that the project should not be created at all. In the publication from *On-Screen Protocols & Pathways: A Media Guide to Working with First Nations, Métis, and Inuit Communities, Cultures, Concepts and Stories* (2019), to quote a checklist that was developed for non-Indigenous collaborators:

“If it is not representative of your culture or background.
If it has anything to do with Indigenous history or culture;
If you have to question your belongingness to a group or community;
If you are uncertain your good intentions will deliver balance and respect;
or if you are unsure this is a story you should be telling; then...
Don't Do It.”

Locality

Locality is the context of location, histories, and community involved in the creation of an XR project. An XR developer must consider the cultural heritage's place, its histories, and the relations the descendants of the cultural heritage have globally. In this way, an XR developer may provide equity to not only a select number of community members who are involved on the

team, but also bring equity to the place in which the culture subsides. There are three layers to consider in Locality, the Locality of where the XR project will be created, the Locality of where the XR project will be experienced, and the locality of the environment within the XR Project itself.

For the first layer, which will be referred to as Locality of Creation (LoC), the location of origin of cultural heritage topic that is exhibited needs to be understood, as place plays a key role in the formation of cultural heritage. In the book, *Ho‘oulu, Our Time of Becoming* (2016), Kanaka Maoli scholar Dr. Manulani Aluli Meyer researches the foundations of Native Hawaiian epistemology through a literature review and interviews of Kanaka Maoli educators. Within her findings, she writes:

“Place matters. The connectedness mentors felt with ancestors, land, and the surrounding environment were significant images throughout the interviews. Mentors spoke often of birth place and ‘ohana [family] in terms of what kept them grounded, inspired, and focused. These images were often couched in cultural terms of continuity, spiritual purpose, responsibility and genealogy” (p. 143).

Although this is a uniquely Hawaiian example, it can be understood that place shapes knowledge as at any place dwells unique lineages, experiences, and other stimuli. To fully capture the context of any sort of cultural heritage, its origins must be understood. To be able to contribute new knowledge to a cultural heritage topic, one must be able to recall its lineage.

Within the New Zealand film industry, a 128-page publication called *The Brown Book* (2013) was commissioned by the ‘Ngo Aho Whakaari, Association of Māori in Screen Production as a way to make relevant historical and cultural knowledge known to film industry professionals who wished to work in New Zealand with Māori film professionals. This book includes information about the history of the Māori, the history of the film industry in New Zealand, significant Māori film professionals, context to the history of Māori language revitalization, cultural protocol, Māori production companies, and much more. This book was designed to create a foundation of knowledge in which one can start to build a connection and reciprocal relationship with the Māori film community by developing an understanding of place and context. Creating a genuine relationship with any community is integral, as there is no other way to approach knowledge acquisition that is non-extractive. In this way, all of the local relational and cultural contexts can be understood so that the resulting project will:

1. Not repeat harmful representation or methodologies that have harmed a community in the past.

2. Have the ability to innovate based on past and contemporary work so that the project is not just a copy of past work that one was not aware of.
3. Be able to describe the lineage of a cultural heritage topic through its place and practitioner relations, so that it can be understood by all where the knowledge originates from.
4. Identify values based on the historical and cultural contexts so the resulting project can be something that is relevant and familiar to the community.
5. Have the ability to recognize and collaborate with the proper community members and cultural practitioners who will do good for their community.

Understanding the specific values of a culture of a place can also aid in design considerations of XR exhibitions. In *How to Build Anything Ethically* (2020) Suzanne Kite, an Oglála Lakḥóta artist and composer, describes how determining how to build artificial intelligence in a 'Good Way' can be based on ethical protocols, as an example she shares:

“What is a 'Good Way'? A Good Way is the Lakota way of talking about ethical protocols. Lakota decision making processes, as with many Indigenous decision-making processes, embed ethics that look Seven Generations ahead. When this concept is applied to AI, Seven Generations means that the protocols outlined here are a way to plan for not just the AI of tomorrow, but for Seven Generations of AI into the future” (Kite, Stover, Janis, & Benesiinaabandan, 2020).

Through this quote, the ways that design can change based on a unique Indigenous decision making process can be understood. In Kite's paper, it is made clear how this design practice of looking seven generations ahead affects the process of the creation of ethical artificial intelligence. In the same way for XR development, the design practices of the community should shape the way the experience is designed. If this Lakota design practice was used in an XR development, how would the design of the digital environment change to provide for seven generations ahead, especially since it is very likely that the environment will no longer exist at that time? It is through reflective processes of knowledge and values of a place that further innovations in the design of XR development can be created.

The second layer is Locality of Experience (LoE) where the XR project is meant to be distributed. Because of the digital nature of XR environments, they are able to be duplicated and housed wherever the proper technology is available. Distribution plans will differ between projects, but the important consideration is whether the presentation of the cultural heritage topic will be designed in a way that it can be experienced properly in any sort of locale. Take the VR simulation, Kilo Hōkū (Karjala, Lodes, Noe, Sikkink, & Leigh, 2018). I was

one of the developers on the project, and after creating a stable version of the VR non-instrumental modern Hawaiian wayfinding tool, we published the simulation to itch.io (Itch.io, n.d.) as a free download. A common comment for Kilo Hōkū is that there is no guidance or goals given to the user of what to do in the simulation. That is because we designed it to be used with an actual wayfinding teacher to guide the student's experience within the simulation. With no teacher, there is no way to actually access the deeper wayfinding knowledge, as visualizations that are presented within the simulation will have no context or sense of how to be used without one. This need for a wayfinding teacher limits the LoE. However, in some cases, this may be a necessary feature due to the knowledge sharing protocol of a community.

Although the reason for this design decision for Kilo Hōkū was that we did not think the LoE would leave contemporary Hawaiian wayfinding classrooms, other XR cultural heritage projects may consider a design such as this to help protect sensitive cultural heritage. Digital data has the ability to be duplicated and shared in a way that is uncontrollable, especially once released into any sort of internet connected network. For Indigenous cultures who have protocol in place in which the sharing of certain knowledge has temporal, locational, and contextual restraints, the distribution, accessibility, and content of a XR project must be discussed and well defined with the collaborators of the cultural heritage.

In proposed guidelines for the designing of respectful technologies (Kotut, et al., 2020) much emphasis was put on this need for clear communication with a community of what knowledge was considered *Restricted* (knowledge bound by location but not in what can be shared), *Discretionary* (knowledge that can be shared only at the discretion of the knowledge keepers), *Public* (Information that can be shared unrestricted by anyone, anywhere), and *Sacrosanct* (knowledge that is not consented to be shared through any other means other than word of mouth at a sacred location). The act of knowledge sharing, not just the knowledge itself, can be intimately tied to place.

The third layer is the Locality of Extended Reality (LoXR), that is, the reality that will be created within the XR project. This is a unique consideration to XR development, as the reality that is created through XR technologies may be considered a whole other place altogether. Within this digital environment, creative expression and experience design can create accessibility to the user to visuals, sounds, interactions, and other experiences that would not otherwise be accessible to them in reality.

VR in particular has been called the “ultimate empathy machine” (Milk, 2015) as virtual

environments allow a user to experience and feel embodied environments that may not be accessible to them. However, as many critiques to this claim point out, it is important to recognize that creating meaningful empathy requires much more complex experience design than just allowing a person to occupy a foreign space or a foreign body (Sampat, 2016) In the book *Empathy Engines* (2016) the game designer Mattie Brice describes the purpose of her game empathy machine, in which users had to physically interact with the designer's body to play. Brice expresses the concern that simply playing a game or being immersed in a digital reality is not the same as sharing someone else's lived experience, no matter how intimate the experience is designed to be. Brice is quoted:

“With the rise of VR has come this claim that one of its strengths was how the medium can act as empathy machines for people to understand one another, particularly advantaged people exploring the experience of the oppressed. Similarly in video games, the proliferation of games made by queer people about their experiences were dubbed “empathy games” which followed a pattern of the wider industry and games audience only caring about what marginalized creators are doing if it involves them talking about their pain and trauma” (pp.72-73).

It is important to understand that in digital environments when sharing an experience, whether it is the queer experience as Brice does so in her work or through the cultural heritage exhibitions that are the focus of this thesis; the experience cannot be just the act of gazing. These spaces and experiences cannot simply give access to a space, but it also must challenge the user to have an experience that will invoke greater thought and reflection about the content. It is only than any sort of relation and understanding can be formed within the user.

Also, to take into consideration when designing the LoXR are the ways in which a community expresses spatial realities. As an example, in the book *Kanaka Hawai'i Cartography: Hula, Navigation, and Oratory* (2017), Louis explains:

“Many Kanaka Hawai'i still perceive themselves as an extension of nature and treat all natural and metaphysical elements as part of a sacred genealogical relationship. Precontact Kanaka Maoli incorporated vital spatial knowledge about the places where they live, work, and pray into various cultural practices, including ka ho'okele, Hawai'i navigation; ka haku 'ana, Hawai'i verbal arts composition; and ka hula, Hawai'i dance.” (p.1)

To put a particular emphasis on hula, hula in itself is a form of augmentation of the environment and self to transmit knowledge, as Louis also explains:

“Hula performances are the perfect multisensual delivery system of Kanaka Hawai'i

spatial/temporal knowledges. Every hula performance stimulates the aural, visual, and olfactory senses. [...] A dancer embodies an event occurring in a space/time deemed worthy of timelessness, transmitting spatial/temporal knowledge through symbolically choreographed movements, rhythmic and vocal accompaniments, and appropriate adornments. The observer/participant can become disembodied from space/time of the event being memorialized through a mesmerizing, trance-inducing engagement of multisensual arousal, regardless of whether or not firsthand spatial/temporal knowledge has been experienced” (pp.162-163).

Already within Kanaka Maoli culture heritage, there is a tradition of immersive visualization that shares similar goals of expression as XR. The question in itself is its own research paper, but how would an XR developer design the sensory elements of an XR environment based on the established conventions, aesthetics, and protocol of hula? How would the pedagogy or protocol of any Kanaka Maoli cultural heritage exhibition change to reflect the pedagogical practices or protocol used in hula? These are the sorts of questions XR designer should approach in ways that are applicable to the communities they collaborate with. Every culture has their own traditions and conventions, such as ways of visualization and immersive augmentation. To build upon this knowledge rather than extracting cultural heritage to fit into a Western-standard form of presentation and expression aids in the innovation of the experience.

Overall, there is much to consider when it comes to the locality of an XR project. The three layers, Locality of Creation, Locality of Experience, and Locality of the Extended Reality, all require an intimate understanding of the protocol, needs, and heritage of a place.

Sovereignty

The development team should be at least partly composed of those from the community that can work as co-leads for every level of development such as writing, art, programming, UI/UX design, and so on. However, hiring community members with these skills may not always be possible. The next best thing is to hire community members who are willing to study and learn the skills needed. They will work closely with those on the developer team who will be working on areas where no community expertise is, at the time, available. This is the reciprocal knowledge sharing. As the community team member works closely with other development collaborators to share their cultural knowledge, the collaborator in turn provides development knowledge to the community collaborator and cedes creative direction and expression to the community collaborator. It is in this way that the team will innovate together by openly communicating what is possible through their respective understandings of their expertise. This

provides the community with opportunities for creative expression and authority.

Particularly for creative expression, this aspect is important to communities who have long been not in control of their own narrative on a mainstream level.

In an interview for the Smithsonian Center for Folklife and Cultural Heritage's magazine *Folklife*, Dr. Beth LaPensée, is quoted:

"We don't need to spoon-feed culture to people. It's an important aspect of our sovereignty that we are able to express ourselves at the level we want to, not on behalf of trying to reach everyone all the time." The article continued,

"That's part of why LaPensée left her role as a consultant in the video game industry, where she says creators try to change or adapt culture to make games more accessible to a wider audience. She also found that indigenous artists aren't hired as artists, only as consultants, so they don't get to create their own work. Through workshops and outreach programs, Native artists are earning meaningful roles in game design, becoming prominent figures in the indie game world" (Cregan, 2018).

Leadership in creation and expression for the community is equitable, especially through emerging technology that has perceived authority and easily generates interest in the average person. Collaboration should not be the presentation of a project to consultants for approval, but the community should collaborate and take the lead in the development aspects of the project from the start.

As an example of modes of creative expression, Indigenous Futurisms is a term coined by Dr. Grace Dillon, a professor in the Indigenous Nations Studies Program at Portland State University. The term is a homage to Afrofuturism, which is a genre that examines the intersection of Black culture, technology, and the African diaspora. In the anthology, *Walking the Clouds: An Anthology of Indigenous Science Fiction* (2012), Dillon writes in the book's introduction:

"All forms of Indigenous futurisms are narratives of biskaabiiyang, an Anishinaabemowin word connoting the process of 'returning to ourselves,' which involves discovering how personally one is affected by colonization, discarding the emotional and psychological baggage carried from its impact, and recovering ancestral traditions in order to adapt in our post-Native Apocalypse world."

As expressed in Dillon's quote, many Indigenous people express they are living in a post-apocalypse world as their heritage, ancestors, and land were taken and almost completely destroyed. Looking towards the past to imagine and work towards more abundant futures has been a common structure for this genre and practice of Indigenous artists and researchers.

This idea has been extended by other Indigenous artists, such as Jason Edward Lewis, a Hawaiian and Samoan digital media theorist, poet, and software designer, who describes the future imaginary. Lewis expresses that there are various approaches to illustrate an Indigenous future imaginary:

1. Manifesting the Future: imaginings of the future state of Indigenous individuals and communities.
2. Hybridizing the Present: re-imaginings of contemporary Indigenous lives and culture.
3. Altering the Past: counterfactual narratives that re-imagine historical events, often to create more positive contemporary and future realities for Indigenous.
4. Shaping the Infrastructure: engaging with the infrastructure of the present to bend it in a direction more conducive to Indigenous ontologies.
5. Critiquing the Project: reflection on the process through which Indigenous people are populating the future imaginary (Lewis, 2016).

XR realities affords developers the ability to bend reality in ways that allows developers to create these imagined futures, pasts, and presents to impart knowledge and values of the present-day community. For example, *Blueberry Pie Under a Martian Sky* (2016) was a virtual reality artwork that takes place seven generations in the future. It follows a young boy as he travels back to his ancestor's place of origin through wormholes in space. This virtual reality art experience was created by Anishinaabe artist Scott Benesiinaabandan. Visitors to Benesiinaabandan's virtual environment will experience aural and visual sensation that may not plainly explain what the visitor is experiencing, but present values, language, and aesthetics that invokes reflection in a user. This sort of expression and presentation, although harder to interpret, is less dehumanizing than a typical textbook description of cultural heritage.

Overall, within the design of the XR cultural heritage exhibition, the capacity for community authority and voice, creative expression, and meaningful contribution, should be embedded into the methods of the XR development process. For cases when the community developers do not have XR development expertise, extra time must be granted so conversations between the XR experts and the cultural heritage experts have ample time to develop into meaningful design.

Responsibility

As there is risk to a community through the exhibition of their cultural heritage, especially by those who are not from their own community, there exists responsibilities that a XR developer has towards the communities of the cultural heritage. These responsibilities include

supporting structural and creative decisions of the community members on the development team, continuous reciprocity for the knowledge shared, to do as little harm as possible, and to provide accessibility to the contents and experience of the XR exhibition to the broader community of cultural heritage.

Already through the past reviewed literature are the ways in which a XR developer can embed reciprocal and equitable methods into their XR development process. However, along with equitable methods are actual products that the XR development can reciprocate to the community for their contributions. It is the responsibility of the XR developer to manage the process of these products to be delivered to the proper community members or community institutions so that the products may benefit the community well past the life of the XR exhibition. These products encompass all of the collected and created data, media, and assets that can be legally and ethically shared with the community. There may be times in which these products cannot be shared due to intellectual property agreements, terms of service, personal rights, and other legal structures in place. Whatever the complexity, the particular products that can be archived and managed should be defined and presented to the appropriate community recipients.

XR presents a particular challenge in archiving since both hardware and software are forever updating, causing XR environments to become obsolete and unusable. There are existing methods for preserving and archiving the 3D models, images, sounds, and other media used to create the environment, but not the environment and experience itself. GLAM institutions (galleries, libraries, archives, and museums) have been researching the possible ways to preserve XR through similar methods of video game preservation, such as emulation or continuous incremental updates of the project to newer systems; however, most processes prove to be costly or imperfect to implement and further research is needed (McConchie & Ensom, 2019).

In any case, at least some form of preservation and archiving of the experience and its data should be shared with the community, as they have a right to the data since it is derived from their cultural heritage and communities. Indigenous data sovereignty is the right to control collection, access, analysis, interpretation, management, dissemination, and reuse of data (Walter & Carroll, 2021). The conversation over Indigenous data sovereignty is varied between communities, though it revolves around the lack of infrastructure or lack of recognition of infrastructure to measure and manage their own data, which is critical to how Indigenous communities are “seen” both globally and by current occupying states whose policy affects Indigenous people. The conversation also involves the recognition of sovereignty by research

institutions to Indigenous communities.

“The use of these data (Indigenous intellectual property, knowledge, songs, oral histories/stories, ceremonies, dances, texts, images, names and objects) are especially at risk of exploitation, abuse, appropriation, theft and misrepresentation. Universities and researchers have an obligation to acknowledge and respect tribal and cultural sovereignty, in part because of their long history of research abuses at the hand of researchers and because they can adopt and implement additional research guidelines beyond the Common Rule” (Marley, 2021).

In the case of XR development, the data products within the XR environment can be shared and utilized by the community or specific community members or entities where it is applicable. In this way, even if the XR experience itself is lost due to obsolescence, the contents, knowledge, and other pieces may be used in new contexts by the community members where they see fit.

Overall, it is the responsibility of the XR developer that the equitable methods are not just defined, but actually implemented throughout the development process. It is also important for the XR developer to actively maintain relationships with community collaborators through clear and open communication. To do this may be difficult due to other aspects of the XR development process such as deadlines, budgets, and so on; but it must be accounted for and the project must have the needed flexibility so that it may successfully implement what was planned. Good intentions are not equity.

Feedback

Although it has been repeatedly stated at this point that community members should hold key positions on the XR development team, there is still a need to obtain feedback from the wider community. The community collaborators on the team are integral to building culturally grounded and equitable XR projects, but no amount of community collaborators on a team will be able to reflect a community at large. Just as a community is not made of a few people, a XR cultural heritage exhibition should not be solely derived on the interpretation of a few people. This means that a structure for obtaining community feedback on prototypes must be a part of the process.

As typical with any sort of market or user research that a XR developer may be more familiar with, feedback collecting methods such as surveys, interviews, focus groups, and observation may be utilized. However, the proper and effective way to get feedback from communities may not be through standard methods of feedback. For example, in *Indigenous*

Research Methodologies (2012), Dr. Bagele Chilisa, a Botswanan post-colonial scholar, compares the difference between Western-based focus groups and the practice of talking circles. She writes:

“We have noted that one of the disadvantages of the Western-based focus group interview technique is that members do not necessarily have equal opportunity to be heard. Talking circles are based on the ideal of participants’ respect for each other and are an example of a focus group method derived from postcolonial indigenous worldviews. [...] In each of these occasions, a person is given a chance to speak uninterrupted” (p.213).

The main takeaway is that there are other methods or protocol for feedback that are preferred in a community as it is the goal for a collaboration with a community to not be uncomfortably extractive when an XR developer asks for access to their knowledge, opinions, and time.

Particularly for an XR developer, the case will be that they will need to bring XR hardware to the community or invite the community to where the XR hardware is housed. In both cases, it is important to recognize the developer’s role as a guest or a host, and treat the community with proper hospitality, as they are taking the time and energy to provide one with critical feedback.

As explained, just being someone from the community of the cultural heritage does not automatically grant expertise in any aspect of cultural heritage. When developing projects, obtaining feedback is still required as the diversity of knowledge and opinion within any community is vast, and one would do well to analyze feedback from those not within the same sub-communities of their own community.

However, there may be a case in which the community would not like to give feedback. This may occur in cases such as a community has reached a consensus to delegate authority to an expert or experts to collaborate with the development team. Feedback from the community should not be a requirement if the community does not want to give it. This must be determined by the XR developer.

An example for a code of conduct for researchers comes from a Maori research practice, called Kaupapa Maori. This code, that is included in *Decolonizing Methodologies* (1999), states the following conduct:

1. Aroha ki te tangata (a respect for people).
2. Kanohi kitea (the seen face, that is present yourself to people face to face).
3. Titiro, whakarongo... korero (look, listen... speak).
4. Manaaki ki te tangata (share and host people, be generous).

5. Kia tupato (be cautious).
6. Kaua e takahia te mana o te tangata (do not trample over the mana of people).
7. kaua e mahaki (don't flaunt your knowledge).

Each community will have different values which means the proper ways of asking for help, especially as someone who is not from the community, may be different. It is up the XR developer to learn what is proper through researching research methodologies and guidelines written and supported by the community of the cultural heritage, or through the support and collaboration of local community entities who may assist in mitigating community communication and feedback. Stated in LaPensée's SPEAR framework:

“Feedback from playtesting is not a finality, but rather an opportunity to better understand a game to both revisit design as well as inform future work. Indigenous cultural games come with a responsibility to continue the work, ranging from maintaining version updates for a particular game to looking for ways to support new games if that is an interest of Indigenous collaborators.”

The end-all goal of feedback and community communication is not just to get feedback so that the XR developer can claim it is “acceptable” by the general consensus of the community, but XR developers should strive to obtain feedback to fulfill their obligation of reciprocity they have to the community for sharing their knowledge. The resulting XR project should always be designed to have the capacity for broader community influence to guide the design, however, in the cases where the feedback is inapplicable to the cultural heritage topic for the current iteration of the project, as LaPensée points out, the feedback collected can act as relevant data to define future updates or even gauge future XR projects that are of interest to the community. Although this cited literature is not exhaustive on the subject of Indigenous guidelines, common values and principles shared within these recent publications created the foundation of the design waypoints: Positionally, Locality, Sovereignty, Responsibility, and Feedback.

My Prior Work

Before further discussing the methods of the formation of the equitable design framework, the background of an XR exhibition project that started this research must be shared for context. Wao Ki'i was inspired by a visit to teamLab's (teamLab, n.d.) various digital art installations that were housed in Tokyo, Japan at the time of visiting. Although they did not utilize virtual and augmented reality technologies, it is hard to argue that installations such as teamLab Borderless are not great examples of the capabilities of mixed reality environments. Through wall and floor projections, surround sound systems, body tracking and touch sensing, teamLab designed immersive spaces that showcased various art exhibitions as visitors travelled from room to room within the exhibit space. Inspired by the work of teamLab, a new lab within the University of Hawai'i system, named Create(x), was built within the Academy of Creative Media (ACM) building at the University of West O'ahu (UHWO) in collaboration Laboratory for Advanced Visualization and Applications for Advanced Visualization and Applications (LAVA). This lab was created with the intention to give students access to emerging creative media technologies and serve as their creations' exhibition space. The first system that was slated to be installed at Create(x) was a projection environment that was similar in implementation to TeamLab Borderless exhibits.



Figure 1 Create(x) projector system spanning three walls

The projector system within Create(x) projects onto three walls within the lab space that are 30 feet in width, and approximately 10 feet in height. Six ultra-short throw Optoma projectors are used to project across the three walls, in which edge blending is handled by three Geobox edge blending processors. The Geoboxes are connected to an Alienware Aurora Desktop.

Another peripheral, a 55" LG television was placed on a custom stand to create a display table for users to interact with. Touch capability was added to the display table through a PQ Labs touch screen overlay.

The Wao Ki'i software was created in the Unity game engine and includes a custom camera Unity asset created to manipulate the in-game camera rig's viewports to customize the size and position of the views within the scene across the three projected walls.

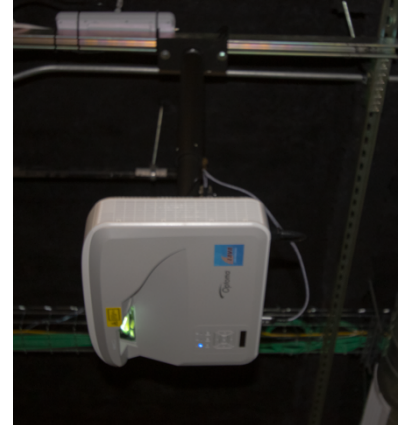


Figure 2 A ceiling mounted projector

The First Wao Ki'i Prototype (Wao Ki'i v.0.1)

The name of Wao Ki'i is based on the naming scheme of different regions of a mountain in Hawaiian, such as wao kanaka, wao akua, wao ma'ukele and so on. The word wao means "inland forested region," (Nā Puke Wehewehe 'Ōlelo Hawai'i , 2021) and the second word is used as a descriptor. So wao kanaka is the "inland region where kanaka (people) dwell."



Figure 3 The display table displaying the Wao Ki'i v.0.1 user interface

Wao akua is an "inland region where akua (spirits/gods) dwell." A clear visualization of these regions is illustrated in the book *Ancestral Places: Understanding Kanaka Geographies* (2014, p. 51). The word ki'i has many meanings, but it was chosen for its meaning of "image". Because the project is essentially a projection of digital images to imitate an inland forest, it was given the name Wao Ki'i. The initial Wao Ki'i team consisted of Ronnie Kauanoë, Kaila Foltz, Nurit Kirshenbaum, Katrina Turner, and Ross Turner, all student research assistants at the Laboratory for Advanced Visualization and Application (LAVA). However, due to graduation, employment, and other personal changes, the team diminished in size over time.

The experience of Wao Kī'i starts once one enters Create(x). The flora and fauna assets were designed and created by Kaila Foltz and myself.



Figure 4 'I'iwi bird model (created by Kari Noe), 2D 'ohi'a lehua tree sprite (created by Kaila Foltz)

Recordings of endemic Hawaiian birds were requested from the Macaulay Library (The Cornell Lab of Ornithology Macaulay Library, n.d.), so that each bird asset may produce accurate songs to aid in immersion and accuracy. After the initial sight of the immersive environment, the user may approach the touch display table, which includes an interface that shows the user a small character, tiles displaying Hawaiian words, and a tile board. Users will need to match the colored tiles to the tile board to generate Hawaiian sentences. There is no English on the board, so the colored tiles and tile board were developed for those to use the system without the need for translation. The meaning of these generated sentences controls the form and action of the small character that is displayed. In this way, if a user were to create the sentence “Lele ka ‘i’iwi nui,” the small character will turn into a large (nui) ‘i’iwi bird that will begin to fly (lele).

The intention of using no translation for the generated sentences is to encourage experimentation and discovery for users who are not fluent in Hawaiian. Through switching out the tiles in the correct positions, the character's form and actions will change, which will imply the definition of the various words to the user.



Figure 5 The display table user interface for Wao Ki'i v.0.1. Tiles are placed on the correlating slots on the board to visually program the character and its animations.

Once the user is satisfied with their sentence, they will be able to transfer their character to the wall, where the action and attributes to the character will be saved and will continue to live within the surrounding digital forest.

The design of the project was built around the metaphor that the more users successfully create Hawaiian sentences to create unique characters, the more diverse and abundant the digital forest becomes. The intention of the project was to not be a static experience for those who visit the lab, but also as a potential project for students of the Academy of Creative Media (ACM) to contribute to. Students may create art and animation assets to build the dictionary of possible word tiles within this system. The creation of these assets can potentially be worked into the curriculum of the ACM. This will allow Wao Ki'i to be an exhibition opportunity for a large amount of student work, and it will require the students to learn about Hawaiian endemic animals, which is not necessary for their creative media education, but grants them opportunity to become more familiar with the place where they are completing their education.

Upon reflection of the first prototype of Wao Ki'i, it was apparent that the exhibition was designed for those who are not fluent in Hawaiian, and many of the experiential and educational benefits were greater for those who are not familiar with Hawaiian language or endemic

animals. For someone who is familiar with the Hawaiian language and local environment, i.e., Kānaka Maoli and others who are from Hawai'i, there was little educational potential as the included terms were common. It is here where the development of the equitable design framework begun, and the creation of the design waypoints occurred.

Method

This thesis seeks to answer two questions, so there are two resulting products that have been formed through this research, the equitable design framework and an updated Wao Ki'i prototype. This thesis researches the questions: What are the actions and behavioral design patterns needed to be adopted by XR developers to create equitable projects for the community of the cultural heritage? And how do we apply these design patterns to current software development cycles of XR projects? To supplement the efficacy of the equitable design framework, which was first formed through the reviewed literature described in the Related Work section of this thesis, the interview component of this research project was established to explicitly identify the benefits of cultural heritage exhibitions to the communities of the cultural heritage. Kanaka Maoli professionals in various fields that create positive impact for their communities were interviewed to determine how they include ethical and equitable design in their own work, and to collect their impressions of the capacity of XR projects for Kanaka Maoli cultural heritage. In this way a 2nd iteration of the Wao Ki'i prototype was developed using parts of the equitable design framework where possible (limitations due to Covid-19 restrictions and protocol during the time of this research will be discussed more in the results section) and the themes generated from the interviews.

Interview Participants and Procedure

Eight (4 women, 4 men) interviewees volunteered their time to be interviewed. Potential interviewees were invited to participate in the study based on their profession as someone who produces community-impactful work, such as an artist, researcher, teacher, and so on; and that they are of Kanaka Maoli descent. Expertise in any field of technology was explicitly stated to not be a prerequisite to be interviewed.

For the eight participants, an hour was set to meet to conduct the interview over video conferencing to abide by Covid-19 safety regulations. A semi-structured interview style was used to allow for the participants to talk more freely on the topics of questioning where they felt most comfortable or knowledgeable, however, an interview guide was used to assure that similar data was collected from all interviewees as they were asked experience, opinion, and value type questions (Chilisa, 2012). As a part of the consent form to be interviewed, interviewees were able to specify whether to be made anonymous, have a chosen identifier, or to be named as an interview participant. An influence for this method was the way Meyer cited her interviewees in her doctoral thesis about Hawaiian Epistemology published in *Ho'oulu, Our Time of Becoming* (2016), in which she cited each interviewee by name, and by date of the

interview. However, to offer agency and privacy to those who may have wanted to contribute their thoughts and experience, the interviewee had the choice to choose their own identifiers or be left as anonymous.

During the interview, the conversations were recorded and transcribed, with parts of the interview redacted at the request of the interviewee if desired. A copy of the transcription was sent to the interviewee to approve before any part of the transcription could be used in this thesis. Each of the transcriptions were analyzed to create overarching themes of the interviews to find similarities in opinions across all interviews to determine values, goals, and desires. The results of this analysis helped further shape the design framework, as well as inspire changes to the Wao Ki'i. The interview guide consisting of the following questions:

To Determine Equitable Design Practices and Methods

1. What sort of impact do you intend for your work to have on your community?
2. What goals do you have for the individual who experiences your work?
3. What are measurements for success for your work?
4. How do you address and correct potential missteps or negative impacts from your work?

To Determine the Capacity of XR project for Kanaka Maoli Cultural Heritage.

1. What do you think any projects that seeks to transmit cultural heritage should do for the community?
2. What do you determine as strengths of XR technologies and/or cultural exhibition spaces?
3. What do you determine as shortcomings of XR technologies and/or cultural exhibition spaces?
4. Do you have any concerns over any particular Kanaka Maoli cultural heritage being displayed in an XR exhibition?
5. Can you give an example of a positive cultural heritage exhibition?
6. Can give an example of a negative cultural heritage exhibition?

Results

The Equitable Design Framework Pathway

The design waypoints are related to the steps of common models of the software development life cycle (SDLC)

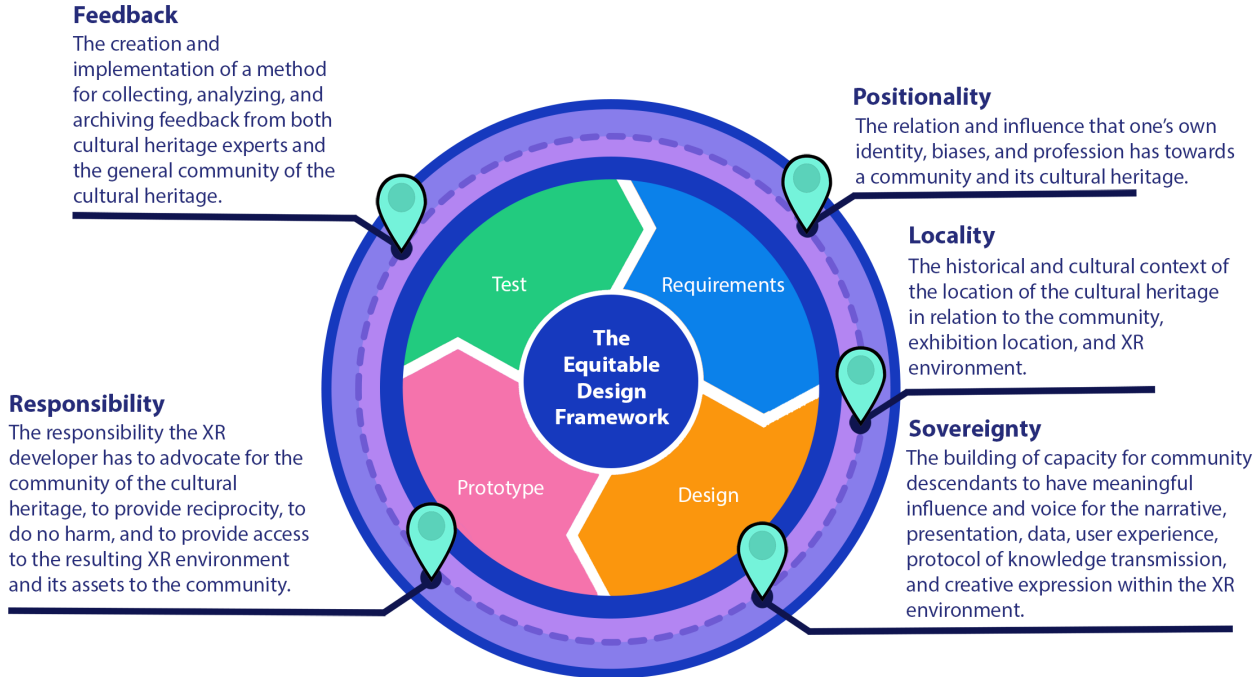


Figure 6 The Equitable Design Framework Pathway visualized

The design waypoints are related to the steps of common models of the software development life cycle (SDLC). For the purpose of this paper, the generalized steps of the SDLC, have been generalized to requirements, design, prototype, and feedback. As there are many methodologies developed for any sort of SDLC, the steps are fluid and are dependent on the project and development team. The waypoints can be placed in these generalized steps so they may be adapted to particular software development methodologies. More adaptive and iterative software design methodologies, such as agile methodologies, may prove more effective, as implementing community feedback effectively may benefit from the flexibility; however, future research is needed to answer which common software development methodology may best suit the equitable design framework.

The Design Waypoints for XR Cultural Heritage Exhibitions

Each waypoint contains considerations that can be applied to any general software development project, and also considerations particular for XR development. As each project

and community will be unique, the considerations and provided questions are generalized so that it can act as the foundation for the development of methodology that will be equitable to a particular community.

Waypoint 01: Positionality

The Requirements step in the SDLC is the entry point into the development process. The first iteration is the time when developers are creating models and documents outlining the design, technology, cost, and other requirements of the project. In the context of a cultural heritage XR exhibition, this is the time to reflect on the developer's positionality to determine what cultural expertise, community collaboration, and other relations development activities will be required of the development team to have the capacity to exhibit the cultural heritage equitably and accurately. On following iterations of the cycle, the Requirements step becomes the point in which the requirements of the project are re-evaluated according to the data collected in the Test step. In the same way, the XR development team must re-evaluate their relations to determine whether other community members and experts need to be brought on to the team, and measure whether their current relations have been properly maintained. The following are recommended questions to assist in the reflection and calibration of this waypoint:



Figure 7 Positionality Waypoint

Q1: What is the developments team's (or individual developer's) relation to the topic of cultural heritage?

-What biases may the team (or individual) have towards the cultural heritage?

Q2: What is the relation of the entity who is producing the XR project to the community of the cultural heritage?

-What influence does this entity have over the community?

-How will the history of this relation be addressed?

Q3: Who are the people who have the expertise in the topic of cultural heritage that are descendants of the culture?

-How will they be compensated for their expertise?

-How will their knowledge be explicitly credited?

Q4: Who has interest/experience/expertise in XR development related skills from the community of the cultural heritage that could be hired (either as a developer or intern)?

Q5: What knowledge or resources can be reciprocated to the general community who is sharing their cultural heritage?

Waypoint 02: Locality

The Locality waypoint may occur in either the Requirements or the Design step of the SDLC, as there is much to consider at this waypoint. The waypoint is split into three subcategories. Locality of Creation (LoC), the context of the origin place of the cultural heritage. Locality of Experience (LoE), the context of the place in where the exhibition will be held. Locality of the Extended Reality (LoXR), the context of the environment of the extended reality. At this point in first iteration of the cycle, members of the community of the cultural heritage should already be

well established onto the development team. It is through these conversations of the fully formed team where the last of the requirements to build the capacity to exhibit the cultural heritage will be defined, as well as the first opportunity for the establishment of methods for the implementation of local protocol, consent, and expression by those of the community of the cultural heritage. On later iterations of the cycle, it is at this waypoint where these methods will be adapted to any new requirements or feedback that was created during the past iteration. The following are recommended questions to assist in the reflection and calibration of this waypoint:

For the LoC:

Q1: What is the history of the cultural heritage topic in the locality?

-Have there been past exhibitions of this cultural heritage topic, how might they be improved?

Q2: In what ways does place play a role in the development and continuing practice of the cultural heritage topic?

Q3: What is the history of the community in the locality, both in a local and global context?

--Have there been past exhibitions of this community, how might they be improved?

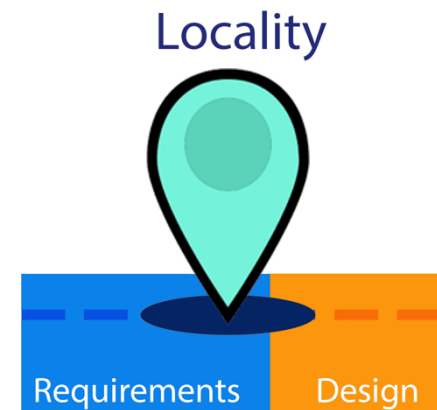


Figure 8 Locality Waypoint

Q4: What are design values and methods that are present in local artistic traditions and aesthetics?

Q5: What is the local pedagogy of the cultural heritage topic?

Q6: How will a relationship be built with the community and its cultural heritage experts?

For the LoE:

Q7: Where can the XR project be experienced fully?

Q8: Are there limitations to distribution, accessibility, and content of the XR project that needs to be established to keep in line with cultural protocol?

Q9: What digital or non-digital components are needed in an XR exhibition for the cultural heritage topics to be properly presented?

For the LoXR:

Q10: How does a culture's ontologies affect the presentation, expression, and treatment of elements within the XR project?

Q11: How will existing protocol of a cultural heritage topic be translated into the XR environment?

Q12: What is the intention and goals of the user experience within the XR environment in relation to the cultural heritage topic and its community?

Waypoint 03: Sovereignty

The most straightforward way to provide equity to a community is to provide cede authority over aspects of the XR cultural heritage exhibition development. This includes the capability of members of the development team who are from the community to have authority and contributions to each aspect of XR development such as the writing, art, UI/UX design, and so on. Also, the community members should have the ability to decide how data and intellectual property derived from cultural heritage or ancestral knowledge be

protected, shared, and housed. At the Design step, these considerations and perspectives will be critical in shaping the overall design to build, distribute, and preserve the exhibition. At each iteration, the Sovereignty waypoint should be the point in which the development team should have discussions of the goals for the community impact of the exhibition and how the team will



Figure 9 Sovereignty Waypoint

reach these goals. The following are recommended questions to assist in the reflection and calibration of this waypoint.

Q1: In what ways can ancestral knowledge and contemporary creative expression influence the various parts of XR development from aesthetics, writing, sound design, programming, and UI/UX?

Q2: How will the project be designed to protect the data and intellectual property of the community (or individuals) who has shared their cultural heritage?

Q3: How will the exhibition be made accessible to the community of the cultural heritage?

Q4: What social impact may the XR project have on the community of the cultural heritage?

Q5: What will the community of the cultural heritage gain access to, and be able to engage in through this XR project?

Waypoint 04: Responsibility

At this waypoint, it is important to be mindful what elements of the design make it into the prototype and how they may change. As typical in the software development process, due to budget, time, and other constraints that arise, elements of the design may need to be cut or altered during the Prototype step. As this happens, it is important that the development team is still meeting its responsibilities to the community. These responsibilities include the authority over topics described in the Sovereignty waypoint,

reciprocity, and to do as little harm as possible. This is a critical point in the development cycle, as it is easy to ideate the ways that the elements of the XR environments can be equitable; however, it is another challenge entirely to successfully implement them into the release of the exhibition. At every iteration of the Prototyping step, the development team should evaluate and prioritize what must be included in the XR environment and ensure that proper protocol and relations are still being properly managed. The following are recommended questions to assist in the reflection and calibration of this waypoint:

Q1: What will be the process to determine the priority of equitable elements of the exhibition?



Figure 10 Responsibility Waypoint

Q2: In what ways will the data, knowledge, and experiences from the creation of a prototype of the XR project be preserved and shared?

Q3: How will all generated datasets from the project be shared/given to the community after the lifetime of the XR project?

Q4: In what ways can the exhibition further provide a platform for the community to advocate for themselves?

Q5: Has proper reciprocity been given to the community (and individuals) who are involved in the exhibition?

Q6: How will the development team mitigate unanticipated harm?

Waypoint 05: Feedback

As expressed repeatedly, it is assumed in this framework that there are members of the community on the development team to contribute to the requirements, design, and prototype steps of the development cycle; however, it is still crucial to collect feedback from the general community if they are willing. As no culture is made up of one person, the perspectives of members of the community on the development team will not cover the expanse of their own community. So, during the Testing step, a method

to collect community feedback must be established. This can take the form of informal user studies to more targeted user studies of particular sub-groups of a community. In any case, the methodology of the user study should be designed to not be extractive of the community, and if possible, shape the methodology off of methodologies already established by the community for qualitative studies. The following are recommended questions to assist in the reflection and calibration of this waypoint:

Q1: How will the process of obtaining feedback from the community on the design of the XR Project be facilitated?

Q2: Who in the community will be asked to give feedback?

Q3: How will feedback be documented and analyzed for current or future use?

Q4: Can feedback be made accessible to the community?



Figure 11 Feedback Waypoint

Interview Themes

Interview themes have been grouped by Waypoint for ease of analysis and discussion. Each theme is paired with summaries of the general ideas that arose from critical sections derived from the interviews.

Theme Group 01, Positionality:

Six out of the eight interview participants explicitly spoke about the importance of recognizing positionality, be it the positionality of others, or their own positionality when it comes to their field of expertise. Four participants shared explicit examples of experiences with projects where they described the development team as well-meaning but lacked the cultural knowledge and/or the cultural sensitivity to create content for effective cultural transmission. Those who addressed their own individual biases all mentioned that there must be collaboration with others to better address their own biases in their work. One participant mentioned that their own position as a man was a factor into what they had the authority to speak about, and that they felt that it is important to make space for other voices:

“I am limited as a man. The fact that I’m a man, there are some stories that I shouldn’t be telling. That’s probably the simplest way I can put it. One of the reasons why I was tempted to go into Hi’iaka, it is the story we need to tell. Keaomelemele, these are amazing stories and they’re about women and as it happens, I’ve learned that the storytelling tradition was predominantly women. Women were the storytellers, so I want to get back to that as quickly as possible. I want to help facilitate, so I think that’s probably the safest way to say it. There are stories that I cannot tell as a man that are reserved for women” (Enos S. , 2021)

The general thoughts on positionality seemed to indicate that the participants hold positionality as a measure for whether they or others are correct in their authority to design, speak, or teach for projects relating to culture heritage. The mentioned solutions for those who lack the proper position are to shift the focus of the cultural heritage topic to a generalized level of understanding, to find those with expertise to lead the design of the project, or to not do the project at all.

Theme Group 02, Locality:

Within the participants, many recognized that their professional practice stems from a Western tradition of practice which they then adapted to fit their cultural values, as Western practice is what is commonly taught within the schools and universities that many of these

participants studied at. In terms of design relating to cultural heritage, seven out of the eight participants remarked that they look to the past, as in analyzing ancestral knowledge, to aid in the foundation of their work. In one particular interview it was expressed:

“Understanding the ancestral models of computation, ways to mnemonically remember vast swaths of data and encode it in the things he's saying. People would have to have the right kaona [understanding] to get the right type of clearance to access those data sets. Otherwise, they are just hearing stuff about flowers. So, we had these methodologies of capturing data, looking at the process of kilo [observation], and looking at landscapes where everything is coded. Like the color of the plants, the things we saw weren't just colors and movements, they are are indicators of these broader systems and you have to kind of track these things, hold that knowledge and then transfer it accordingly to those who can show the proper training.” (Enos K. , 2021)

Kaona, is a device often used in Hawaiian poetry that refers to the hidden meaning of references within a work. The closest English equivalent is the use of metaphor. It is defined as “understanding” because to “have kaona” means that one can understand the intention of the references within a work. To be able to understand, one will have to have been taught the encodings. To understand how to utilize kaona is out of the scope of this thesis to explain on a deeper level, but it is an example of a particularly Hawaiian device that has been extended from oral tradition and used in contemporary forms of Kanaka Maoli creative expression and design. It is through the use of kaona and other ancestral frameworks that participants find ways to innovate contemporary praxis and method to create the projects related to their expertise.

All participants defined that their measurement of success in the design of a project was that the project had some form of impact on the larger community, whether it was through inspiration, behavior changes, accessibility to knowledge, or creating capacity. However, due to the differences in their fields of profession, the way the community is intended to be impacted is different. For example:

“I think success would be that the community is using [a technology]. And that it would be able to continue on without me for many years to come. So, continuity is a huge one, and usability” (Anonymous, 2021).

“How can we build a nation, how can we build anything, how can we help our people if we don't have a vision of a different future that we can imagine how things can be different. And so, for me that is the sign of success. That if people start imagining” (Kuwada, 2021).

“So, I guess for me it's actually changing behaviors is probably my measurement. Changing behaviors, changing how people think and then that changes their behavior” (Kamelamela, 2021)

When asked particularly about XR and immersive exhibitions (as not every participant has experience with XR technology), seven out of the eight participants gave remarks that the value of XR is its ability to support place-based learning approaches. The value lies in the ability to give context to places where cultural significance may have been lost or forgotten:

“I read about Pu’u Kukui before I went about it, and I read about it after, and I look at pictures of it, and it’s cool, but to actually have all of your senses engaged, it shapes your body in a lot of different ways. While we were on Pu’u Kukui we interviewed a woman named Pulama Collier, and she was talking about this idea of mo’oike, mo’ike it’s mo’o and its ‘ike, and if you look it up in the dictionary. Mō’ike is this way you interpret dreams and stuff like that. But what she was talking about mo’ike was as this feeling you get when you experience the way your ancestors did. Like if you see, maybe you know all of the mo’olelo [history] of an area, and it talks about a mo’o [water spirit] of a certain area, and you come upon the rock formation, which is one of the things they saw as the mo’o in their time. So that feeling of connection that you get, as being a part of the lineage of people who experienced that story or experienced that thing, I think that is an important thing that you can really tap into with those augmented realities or virtual reality stuff” (Kuwada, 2021).

However, a participant did remark on the limitation of XR environments:

“Place based learning, [...] I get to take my students out to all of these different places whether it's the lo'i, or the taro patches, or on the farm, or on the wa'a [canoe], or in the ocean. I get to physically be present with them and work directly with the mud and all of the things, the intricacies of fishponds and even the community practitioners there, and I think about it and I'm like; There's no way you could ever digitally create this experience because there's so many variables that you would never be able to model all of, or even I don't know, A.I. it out” (Anonymous, 2021).

But the participant goes on to say:

“[...] resources funding is always a huge problem for all of these different place-based learning experiences that I go on. And I think that VR/AR could be used to simulate it and begin to teach the students in a- to teach younger students or those who are just learning like the foundations, the basics of place-based learning. Because often when you tell people to go and what they say kilo, or observe, right they just look. They don't

know what they're looking at or how they're looking at something and why it's important to look at that. So, what we have to do is we have to be like, here is your one little screen you are going to look in this one foot by 1 foot every week until you see change. But I think with technology you can do that really quickly and you can speed up the process and that's an affordance that you have" (Anonymous, 2021).

The balance between its utility and limitation as a reflection of reality seems to be a general design concern by both those who are familiar with immersive technology and those who are not. However, for a culture whose pedagogy values place-based learning, even at the current level of presence that XR technology affords, the technology can be potentially useful.

Theme Group 03, Sovereignty:

A common remark that has already been addressed towards Kānaka Maoli and other Indigenous cultures is the impression that they are relegated to the past. However as one participant expresses:

"They say look at these people, these stone age Hawaiians, they are trying to keep us in the past. They are anti-science and anti-progress and all of that, and all of the stuff you heard. And I was like really, we don't live in the past, we live in the future, our whole culture is geared towards imagining the future. You can't live as part of the land; you can't be a part of the land and not be future oriented. Any time you plant a seed you are banking on the future, that is the idea. And so, it was a reframing of this idea that, yes, we pay attention to this culturally, we pay attention to our history, because it is what allows us to move forward in the future" (Kuwada, 2021).

The ability to be able to control the narrative and perception of your own community to a mainstream audience reflects how the world perceives and treats that culture. Some participants felt there still exists a belief that Indigenous cultures automatically reject any forms of contemporary technology. One participant believed this to be contrary. To give context, the history that the participant was referring to was the creation of nationalist anticolonial Hawaiian-language newspapers such as *Ka Hoku o ka Pakipika* that arose in the 1860s (Silva, 2004). The utilization of the printing press gave voice to Kānaka Maoli of the time, and act as sources to understand the past to Kānaka Maoli of today.

"We use technology to give people voice, and that was the thing about the newspapers was, to give people voice. So, I think that is a neat thing to think about during these kinds of exhibition processes and stuff like that. Who are you giving voice to? And who

gets the opportunity to speak? Are we helping these older things to speak to the present again? I think that is a good thing” (Kuwada, 2021).

Without community involvement, these important contexts may not be shared in the resulting project.

“Putting the communities voice in the forefront, and the community can be defined as the people of the place, the people of the practice. Their guidance and editorial support should definitely be the check, not the tokenism, but the actual integration of visions and ideas, not at the end but from the beginning” (Kamelamela, 2021).

Participants who have an art background also spoke about the freedom of expression that should be afforded to an individual of a cultural heritage:

“I feel like we are so worried how much we lost, and... there is always this idea that there is so little culture left that we have to hold on to everything we have, and it really stifles our creativity and our ability to grow our culture. [...] Hawaiians appropriated new technology and new ways of storytelling and making their voices heard” (Kuwada, 2021).

“The line between ‘traditional’ and ‘contemporary’ is a colonial construct. That line is drawn, over and over again, to ensure that we remain in past. Can this boundary be hacked? Can it be bent and twisted; can it be reinterpreted? If I wrap a twinkie inside some ti leaves and present it as ho‘okupu that’s probably not gonna fly right? Is this simple recombination of material enough to unsettle conventional understandings of ‘traditional’ and ‘contemporary?’ For me, ultimately, it’s a question of intention. What are your intentions? When we call on new modes of expression—introducing ‘contemporary’ media into ‘traditional’ practice and ‘traditional’ media into ‘contemporary’ practice—are our intentions to grow our culture? Change is vital to survival. We must embrace the transformational potential of blurred boundaries” (Broderick, 2021).

Four out of five participants spoke about the future imaginary, that is, imaging futures to help define current day actions. For one participant, they expressed that an imagined future was the main inspiration for their work:

“When you see kids like laughing and playing in ‘Ōlelo Hawai‘i [the Hawaiian language] that’s... that’s the thing, we need to strive to make it. Kids laughing and playing in ‘ōlelo Hawai‘i. I just see a really bright positive future where the problems that we have now, the hardships that we’ve been through, are able to heal and we can imagine futures that are amazing” (Bright, 2021).

Theme Group 04, Responsibility:

Participants once again emphasized the importance of the awareness of Hawaiian culture and language as a living culture. One participant shared the story:

“It is not as cool to have something from a living culture, because they could just make it tomorrow and you don't get the special experience by seeing a luhe'e [octopus lure] that someone made yesterday. They got them in their car trunk or something like that. But the museum experience is that. 'Oh, I saw the one remaining thing of this culture', right? My old housemate's dad was from Canada, he introduced me to several of his friends as one of the last people who speak Hawaiian. And I was like, I'm not this, there are thousands of us. But it is this idea that there are probably not many left, and it's a bigger deal if I'm one of the last Hawaiians” (Kuwada, 2021).

Participants felt that there is importance to responsibly utilize Hawaiian culture and knowledge in truthful and unharmed ways. One participant expressed that there will always be abuse and appropriation of culture:

“There's gonna be stuff that doesn't make people feel good. There's gonna be content that preys upon the frailty of the human condition, right? And exploits it. I think we have to be ready for that and we have to have a thousand alternatives. It gets back to the idea of the stories we tell ourselves, if we only have dystopian stories then we are going to have a dystopian future” (Enos S. , 2021).

Another participant brought up an example of the abuse of knowledge:

“People have gone into the state archives and ripped out pages of books and manuscripts and I feel like awareness of going to different places or going to learn different things may provide people with the access to be like, 'oh I know where this is now, I can go get that.' You know like this is the most secret area to Hawaiians, ok, let me go mess it up” (Kamelamela, 2021).

The conversation of who, what, when, where, why, and how knowledge can be shared is an important context to factor into the design of any project. However, as there is a risk in the sharing of knowledge, it also strengthens the continuity of knowledge by having it accessible, as one participant notes:

“I think you can also encapsulate a lot of the knowledge that can hopefully be recorded and stay there for after we pass on. I think about the technologies that Larry Kimura [A professor of Hawaiian Language] used, in that he was just doing phonographic recordings of the elders back then and at the time it was like, “you shouldn't be recording

anybody.” But those are pieces of the culture that are highly prized now” (Anonymous, 2021).

All participants shared some examples of how their own work or how they imagine XR can advocate for the Hawaiian community. One particular participant’s response summarized the need for advocacy for the Hawaiian people to reclaim agency over the executive control of their communities:

“I think if you are deploying your ancestral framework in a performative way that allows you titular power, meaning you'll be the top person in an advisory commission. Who gives a shit frankly? The game we're showing up for is: how do we create executive control? How does a community sign its own paychecks and sign its own diplomas, and then sign the paychecks and diplomas of others so that we are empowering others who may not be from our community or have our direct genealogy, but who aspire to live in Hawai'i? Who aspire to be here and empower others to our ancestral systems? To remove from this narrative of being vanquished and dying off, and center ourselves in the narrative of agency. That we are vibrant, we are alive, we are adaptive, and we can support others. That we are allowed to make decisions on our own behalf. So that's kind of different ways you think about it, deploying ancestral frameworks into contemporary structures to allow us agency and reclaiming executive control. But then the most important part of our restoration of agency is that by reclaiming that space we are providing a platform for future generations' right to abundance and not just taking up their space now and patting ourselves on the back and screwing the next generation out of a future” (Enos K. , 2021).

The overarching conversations around the responsibility of one to their own community, or a foreigner’s responsibility to a community they are essentially presenting is complex and requires much context to determine what is right. However, the participants seem to agree that there is a responsibility to present the truth, manage knowledge ethically, and to always advocate for the community.

Theme Group 05, Feedback:

Some participants shared common critiques they’ve received on projects they have worked on or they emphasized the importance of receiving feedback from a diverse community of people. All participants expressed that feedback is valuable and needed for their own practices as no one person can make a project that will please every single member of a community. As one participant explains it, the feedback, positive or negative, is important data

to be used in the act of “kilo-ing,” as they explain it, “you see what's happening and you're able to form conclusions, and even then, you talk to people, you test those things out and then you make changes” (Bright, 2021). To kilo, means to observe. So “kilo-ing” as the participant describes it, is the skill of observing data and determining effective solutions based on all available data. Most participants seemed to feel that a strong relationship with the community afforded good faith that in the case where some part of the project may have a negative impact, that they will have the opportunity to learn from it and continue to do better in the next iteration or next project.

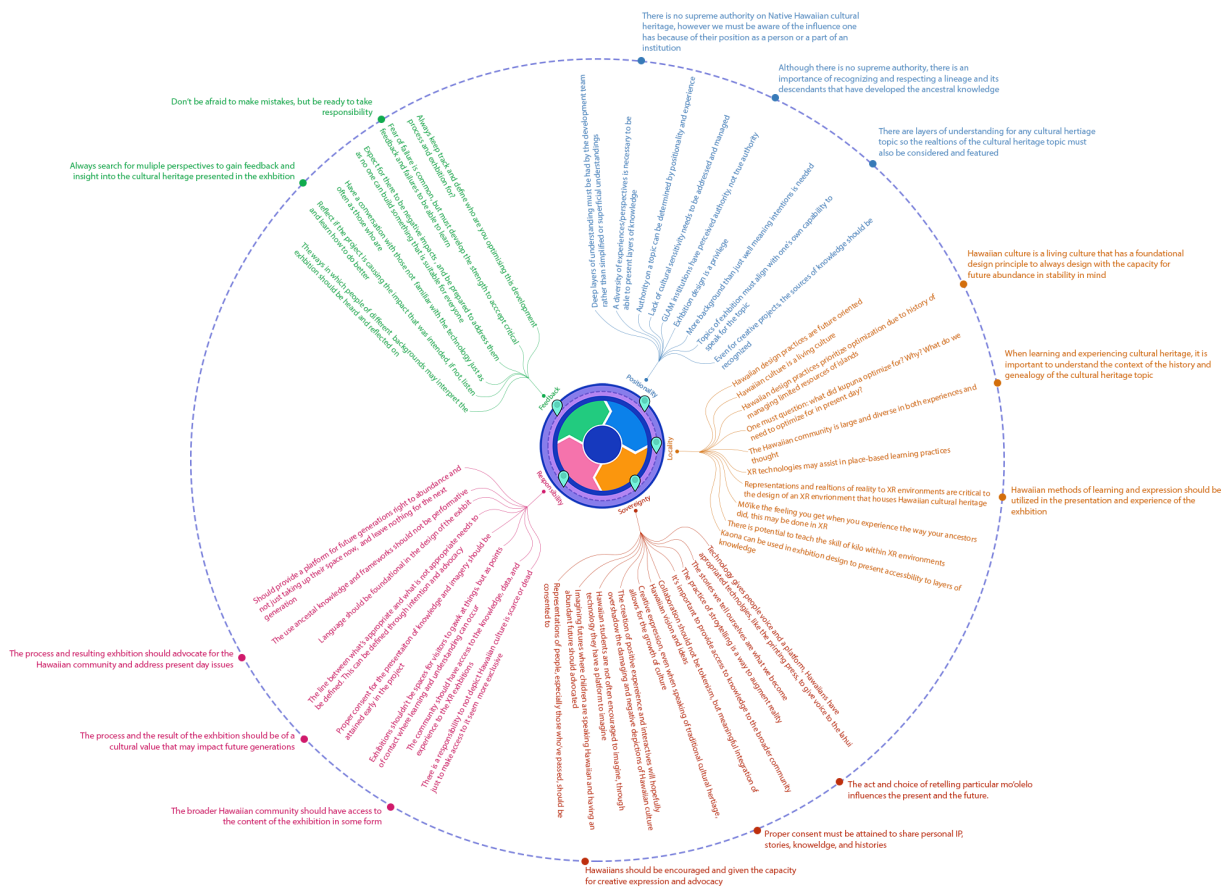


Figure 12 The Equitable Design Thematic Codex (For Kanaka Maoli cultural heritage)

The resulting thematic codex is a model of the overall themes and assumptions gathered from the interviews related to the waypoints of the equitable design framework. This model allows one to start to understand the particular values, beliefs, and possible protocol that are held within the interviewee group. As this is a small interview size, this of course is not meant to claim a permanent and accurate model of the broader Hawaiian community, but rather serves

as an example of a process of analysis and modeling to build a foundational understanding from. For this thesis, the topics of question were exhibition design and XR, but this same process of analysis may be used to model any specific cultural heritage topic in relation to the equitable design framework. The resulting codex shown in Figure 12 led to feature and method changes for Wao Ki'i v.0.2.

Wao Ki'i v.0.2

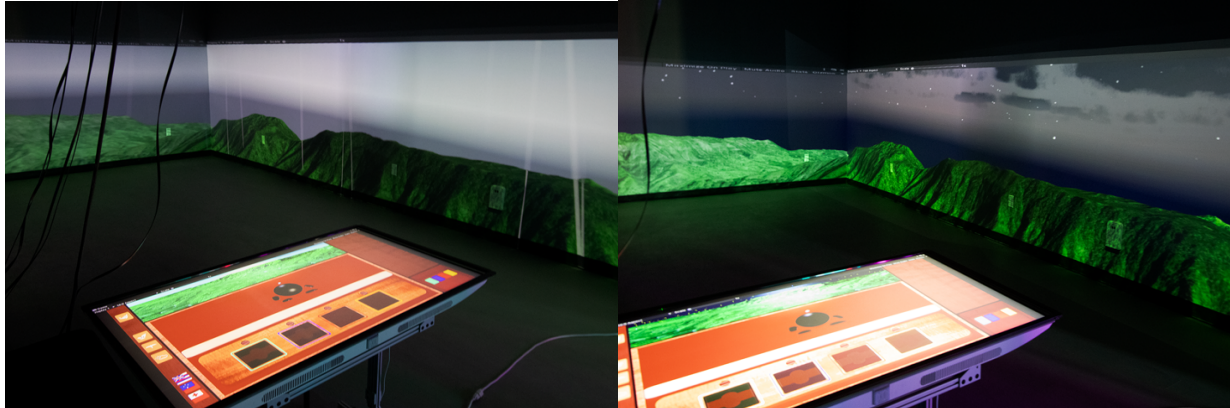


Figure 13 Different scenery in Wao Ki'i v.0.2

Based on reflections the equitable design framework as well as the thematic codex derived from the interviews, the methods and features within Wao Ki'i v.0.2 were changed. However some considerations were already present in the first iteration of Wao Ki'i, and will be stated so in Table 1. As stated earlier, someone who is from the community of the cultural heritage will not have all of the skills, knowledge, and experience to create exhibitions that are meant to represent their entire community. Even if they may be more culturally sensitive than a foreign developer, they will still need to conduct the same procedure to ensure they are building the greatest capacity for equity and meaningful impact for their community.

Table 1 Comparison Table of Wao Ki'i v.0.1 and Wao Ki'i v.0.2 features

Waypoint	Themes from Codex	Original Feature	Feature Change
Locality	Hawaiian culture is a living culture that has a foundational design principle to always design with the capacity for future abundance and stability in mind	-Hawaiian language is a main component of the exhibition, and the UI was created so familiarity with Hawaiian must be developed to learn from the system, thus promoting its use and understanding	-no change
Locality	When learning and experiencing cultural heritage, it is important to understand the context of the history and genealogy of the cultural heritage topic	-A fictional forest was created for the environment for the system	-Actual environments in Hawai'i that are related to the flora, fauna, and weather are created
Locality	Hawaiian methods of learning and expression should be utilized in the presentation and experience of the exhibition	-Not addressed	-Expanded the type of terms (to both fauna and weather) and their presentation to be more in line with methods of experiential learning and kilo practices
Sovereignty	The act and choice of retelling particular mo'olelo influences the present and the future	-Not addressed	-Inclusion of extinct fauna, and listing their conservation status to aid to raise awareness of what has been lost and what is endangered so users understand the importance of the content.

Sovereignty	Proper consent must be attained to share personal IP, stories, knowledge, and histories	-No personal IP, stories, knowledge, or histories are included in this version	-No personal IP, stories, knowledge, or histories are included in this version, however, future contributors will retain all rights to the assets created within the exhibition
Sovereignty	Hawaiians should be encouraged and given the capacity for creative expression and advocacy	-The backend of the project was built so that new assets can easily be added by contributors that can be generated and exhibited in the environment	-no change
Responsibility	The broader Hawaiian community should have access to the content of the exhibition in some form	-not addressed	-Still in development. 360 video of the exhibit has been recorded, but ways to better document and share mixed reality spaces is being researched.
Responsibility	The process and the result of the exhibition should be of a cultural value that may impact future generations	-not addressed	new goals of exhibition: -familiarize endemic flora and fauna & Hawaiian weather terms - Create an opportunity to encourage development of skills in 3D/2D art to contribute to the exhibition -Document process to better refine the equitable design framework for future XR exhibitions and projects

Responsibility	The process and resulting exhibition should advocate for the Hawaiian community and address present issues	-not addressed	-The exhibition has the potential to speak about conservation of Hawaiian endemic species. Further research into conservation initiatives are being researched to possibly be referenced in the exhibit
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Within Table 1 there is a lack of considerations from both Positionally and Feedback. The reason is that due to the fluctuating restrictions currently in place because of Covid-19, the capability to better collaborate and gain experiential feedback from community members has only recently become open at the time of writing this thesis. Also, the location of Wao Ki'i, at the Academy of Creative Media building at the University of West O'ahu, is still under construction and has not been officially opened to students or the public. With these restrictions, collaboration and experiential feedback capability was limited, but plans to recruit students and faculty collaborators are in motion but are not ready to be reported in this thesis. As future work, another iteration of Wao Ki'i will be made to follow the full framework once it is safe to do so. For this reason, these considerations and changes are not listed. This is also the reason why Wao Ki'i is referred to as a prototype, as future collaboration and feedback will inevitably change the system. The important takeaway from these results is the process of analysis, reflection, and modeling that one may adapt to their own software development methodology to better improve the equitability of their XR cultural heritage exhibitions.

Conclusion and Future Work

Through prior work in the field of cultural heritage XR exhibition, the need for a better understanding of how XR could benefit the communities of the cultural heritage arose. A clear model to build upon to develop unique methodologies to create cultural heritage exhibitions is the goal of the equitable design framework. The resulting framework and models were created through the analysis of both related work in various fields for the ethical collaboration with Indigenous communities and cultural heritage. Particularly for XR, factors such as data sovereignty, ontology, pedagogy, community accessibility, and experience preservation are unique considerations for the development of an XR environment.

The equitable design framework is a paradigm shift away from typical design goals of cultural heritage exhibition design. Rather than be truly user-oriented, the equitable design framework asks the developer to adapt their design process to embed equitable practices into their desired software development methodology. As many participants in the interviews shared: developers typically have good intentions, but do not have the cultural sensitivity to create effective projects. This equitable design framework contributes to the broader discussion of ethical design and inclusion of underrepresented communities in projects that are ongoing in the software engineering field. It also introduces explicit questions and behavioral design patterns as a way to embed a better sense of cultural sensitivity and reciprocity to one's own design methods.

As this framework does ask the XR developer to cede creative expression and some authority to the community of the cultural heritage for aspects of the development process, it may be perceived as an odd approach. It may bring a developer discomfort to trust someone who does not have the same software development background and expertise as they do to make these decisions. However, it is important to recognize that this is a similar feeling that community members and practitioners of a cultural heritage may feel towards the developers who are designing the exhibition for their cultural heritage.

This is why building a genuine relationship is important, as enough trust needs to be fostered so that all involved may push past their discomforts and meet on equal ground where a exhibition that is both valuable to the XR developers and the community can be created.

Future work for this thesis includes improving the confirmability and extendibility of the equitable design framework through a larger interview participation size, and the support of co-researchers for the triangulation of encoded qualitative data. There is also the opportunity to study which particular software development methodologies are well suited for the equitable design framework so that a more formalized methodology may be proposed. A user study on

the perceptions of Wao Ki'i relating to knowledge transmission would also aid in the development and support of the efficacy of the equitable design framework. This framework may also be extended to other Indigenous communities to confirm the universality of the framework as a base to build more culture-specific equitable software development methodologies. This work was intended to be foundational, and it is the hope that future adoption and iterations of this framework will lead to the creation of XR cultural heritage exhibitions that are innovative, equitable, and ethical.

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