Tangible Interactions with Intangible Heritage:
The Development and Design of
ʔeləw̓kʷ — Belongings

by
Reese Muntean

Thesis Submitted in Partial Fulfillment of the
Requirements for the Degree of
Master of Arts

in the
School of Interactive Arts and Technology
Faculty of Communication, Art, and Technology

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Abstract

Contemporary museums increasingly incorporate technology into exhibits, allowing visitors to engage with information in different ways and in greater depth. One such technology utilized is the digital tabletop. This thesis describes ʔeləw̓kʷ — Belongings, an interactive tangible tabletop at the Museum of Anthropology at the University of British Columbia. The tabletop was designed to communicate the continuity of Musqueam culture, convey the complexity of belongings excavated from an ancient Musqueam village site, and reconnect those belongings to traditional practices and oral histories through tangible interactions with the table. In this thesis, I offer a case study of the collaborative design process shared among the researchers, curators, and the exhibit Advisory Committee, and I highlight key design decisions that resulted from this collaboration, showcasing how cultural values can be shared through tangible interactions. I use this case study to contextualize three collaborative publications on ʔeləw̓kʷ — Belongings, the research outcomes of this project.

Keywords: Heritage; Intangible heritage; Indigenous knowledge; Case study; Tangible interface; Multi-touch table
To my family.
Acknowledgements

Special thanks to my supervisors, Kate Hennessy and Alissa Antle, as well as Sue Rowley and Jordan Wilson for all of their help and support. I would also like to acknowledge and thank the rest of the ʔeləw̓ kʷ — Belongings team: Brendan Matkin, Rachael Eckersley, Perry Tan, and Lisa Uyeda. And, of course, many thanks to the Musqueam Indian Band.
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<th>Acronym</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>HCI</td>
<td>Human-computer interaction</td>
</tr>
<tr>
<td>MOA</td>
<td>Museum of Anthropology at the University of British Columbia</td>
</tr>
<tr>
<td>MOV</td>
<td>Museum of Vancouver</td>
</tr>
<tr>
<td>SFU</td>
<td>Simon Fraser University</td>
</tr>
<tr>
<td>SIAT</td>
<td>School of Interactive Arts and Technology at Simon Fraser University</td>
</tr>
<tr>
<td>TUI</td>
<td>Tangible User Interface</td>
</tr>
<tr>
<td>UBC</td>
<td>University of British Columbia</td>
</tr>
</tbody>
</table>
# Glossary

## Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>cəsnaʔəm</td>
<td>An ancient village cite and burial ground of the Musqueam people near the mouth of the Fraser River in what is now known as Vancouver, Canada</td>
</tr>
<tr>
<td>?eləw̓kʷ</td>
<td>A həŋqəmiʔəm term meaning <em>belongings</em></td>
</tr>
<tr>
<td>həŋqəmiʔəm</td>
<td>The language of the Musqueam people</td>
</tr>
<tr>
<td>Musqueam</td>
<td>Or Musqueam Indian Band, a Canadian First Nation whose traditional territory occupies what is now known as Vancouver</td>
</tr>
</tbody>
</table>

## Pronunciation Guide

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ċ</td>
<td>“ts” + a little force adding a slight pop</td>
</tr>
<tr>
<td>ŋ</td>
<td>u in “but”</td>
</tr>
<tr>
<td>?</td>
<td>A consonant with no sound, like the space in “uh-oh”</td>
</tr>
<tr>
<td>ʷ</td>
<td>Like the English w but with a bit of a creaky or constricted sound</td>
</tr>
<tr>
<td>kw</td>
<td>Like an English k with a build-up of air pressure for a popping sound</td>
</tr>
<tr>
<td>ŋ</td>
<td>Like the English n but with a bit of a creaky or constricted sound</td>
</tr>
<tr>
<td>ḋ</td>
<td>Similar to “k” only farther back and slightly down your throat. The apostrophe indicates glottalization which builds up air pressure in your mouth so that there is a slight popping sound</td>
</tr>
<tr>
<td>ŋ</td>
<td>Like the English m but with a bit of a creaky or constricted sound</td>
</tr>
</tbody>
</table>
Chapter 1.

Introduction

The multi-touch tangible table is one technology that is entering into museum spaces and shows promise for creating new ways of engaging with tangible and intangible heritage. Digital technology has been and continues to be incorporated into museum exhibitions, allowing visitors to engage with information in different ways. These technologies are also used in heritage institutions to move beyond the focus on physical objects to address the challenge of safeguarding intangible cultural heritage—the traditions or living cultural expressions that are passed on from generation to generation (Kurin, 2004b; “UNESCO Culture Sector - Intangible Heritage - 2003 Convention,” n.d.). While there are examples of work examining both educational as well as cultural applications of digital tables using touch or tangible interfaces (e.g. Antle et al., 2011; Chu et al., 2015; Horn, 2013; Hornecker, 2008; Speelpenning et al., 2011; van den Hoven et al., 2013), there is still much to be explored. In this thesis, I examine the design process itself as a cultural collaboration and the potential for cultural values to be conveyed through interactions with a multi-touch tangible table.

This thesis is a cumulative thesis; I offer three peer reviewed contributions (two published, one in review) written by our research and development team, of which I am first author. As this was a collaborative project, I present these papers as the outcome of our research and development collaboration. However, as an original contribution, I present a case study of our collaborative design and development process, which adds important context to the publications.

This thesis presents the development and study of ḥeləw̓kʷ — Belongings, an interactive tangible table at the Museum of Anthropology (MOA) at the University of British Columbia (UBC) in Vancouver, Canada. ḥeləw̓kʷ — Belongings was developed
for the čəsnaʔem, *the city before the city* exhibition. The exhibition was a partnership among the Musqueam Indian Band, the Museum of Vancouver, and MOA along with the University of Waterloo. In three distinct yet related exhibitions, the institutions introduced visitors to čəsnaʔem, an ancient Musqueam village and cemetery near the Fraser River on which part of modern day Vancouver was built. The interactive tangible tabletop uses replicas of ancient belongings excavated from čəsnaʔem along with objects common in contemporary Musqueam life to share stories of the Musqueam community’s past and how their culture and traditional knowledge continue today (Muntean et al. 2015a; Muntean et al., 2015b; Muntean et al., 2016).

As previously mentioned, my research of ʔeləw̓kʷ — Belongings includes a case study of the collaborative design process that included researchers, curators, and Musqueam community members sitting on the exhibit Advisory Committee. This case study also touches on how the design goals of the development team were implemented in the tangible interactions with the tabletop and the contributions that were made to the field of tangible computing. I use this case study to contextualize three of the research papers that were written about and as a result of this collaboration.

This thesis and the case study of ʔeləw̓kʷ — Belongings addresses the following research questions: *What does collaboration look like when developing an interactive tangible tabletop to convey cultural values through tangible interactions? Can museum visitors learn cultural values through tangible interactions with a digital system?*

I address the first question in detail through my case study of the collaboration process. Shorter descriptions of the design process appear in the first two research papers that I present. The second question on the possibility to learn cultural values is examined in our visitor study, a description of which is included in the case study. The third research paper I present is largely the analysis of this visitor study.

With my co-authors I contribute to this space by identifying, describing and evaluating how to design in such a way that opens up opportunities for museum visitors to experience cultural values through their interactions with a tangible tabletop system. Our overarching goal is to support visitors to experience intangible aspects of cultural
heritage, such as a culture’s value system, as well provide them with digital information about that culture.

To position myself and the perspective of this thesis, my role in the development process of ᓄлежʷ — Belongings was primarily that of project manager. I also assisted in the interaction design and served as the project photographer when original images were needed.

In this thesis, *Chapter 2: Background & Related Work* begins with a review of related research in tangible computing and collaborations with Indigenous communities. *Chapter 3: Case Study* comprises a case study of the design process of ᓄлежʷ — Belongings, giving background context to the project, describing the design process, and discussing our research and work after the exhibit was installed. This case study touches on both the decisions made around the tangible designs and the importance of the collaboration as part of those decisions. *Chapter 4: Research Papers* introduces the three research papers on ᓄлежʷ — Belongings. Each paper has a different focus and audience. The first paper, ᓄлежʷ — Belongings: Tangible Interactions with Intangible Heritage, was published in the CITAR Journal for the Science and Technology of the Arts. It was adapted from a paper originally presented at a conference on Electronic Visualizations and the Arts, which draws many attendees from cultural heritage backgrounds. *Design Interactions in ᓄлежʷ — Belongings* is a pictorial, a new format of research presentation at Designing Interactive System that recognizes the value images and visuals can have in communicating academic research. *Designing Cultural Values into Interaction*, the final paper I present here, is in review. Written with the intention of presenting it at a human-computer interaction (HCI) conference, this paper details our visitor study, analyzes the tabletop, and offers design guidelines for communicating cultural values through tangible interactions. Lastly, in *Chapter 5: Discussion & Conclusion*, I will discuss the outcomes of ᓄлежʷ — Belongings and touch on the current and future work on this project.
Chapter 2.

Background & Related Work

ʔeləw̓ikʷ — Belongings sits at the intersection of tangible computing and the
digitization of cultural heritage, specifically the heritage of Indigenous communities in
Canada. As such I will describe the historical context of my research as it relates to
these fields of HCI and anthropology as well as situate the design of the tangible table
within current work in these areas.

2.1. Tangible Computing

In this section, I begin with a brief background on the history of tangible
computing. I then discuss some of the research that influenced our design, focusing on
the use of tabletops and tangibles in the overlapping areas of learning, conveying
values, interacting with cultural values, and applications in museum spaces. Lastly, I
review specific tangible and interactive surface exhibits that we discussed during the
early brainstorming sessions of the ʔeləw̓ikʷ — Belongings design team.

2.1.1. Beginnings

Rather than the now ubiquitous graphical user interfaces that use common
desktop metaphors of folders and windows to access digital information with the aid of a
mouse, tangible user interfaces seek to connect digital information back to physical
objects (Ishii & Ullmer, 1997). We designed ʔeləw̓ikʷ — Belongings to incorporate this
idea, using physical replicas of ancient and modern Musqueam belongings to connect to
the digital information on the tabletop display, which includes the stories and practices
surrounding those belongings. Yet as I will demonstrate in this thesis, we also take the
basic concept of tangible computing further, attempting to convey cultural values through these tangible interactions with the system.

Fitzmaurice, Ishii, and Buxton pioneered Tangible Computing with their introduction of the idea of Graspable User Interfaces. They developed a prototype called Bricks, which were small cubes that worked with a desk as input devices for a drawing program. Users would manipulate the virtual drawing tools through interactions with the physical objects. They saw the philosophy of Graspable User Interfaces as taking advantage of our everyday behaviors, well-developed skills of manipulating physical objects, and spatial reasoning, while also allowing for collaborative use among multiple people among other things (Fitzmaurice et al., 1995).

Ishii and Ullmer continued this exploration in their early work with “Tangible Bits.” They drew inspiration from ancient artifacts, or “historical scientific instruments” as they describe them, contemplating the way grasping and manipulating physical objects was valued and how we are largely losing these rich experiences with new digital technologies (Ishii & Ullmer, 1997).

Their explorations with Tangible Bits involved the augmentation of “the real physical world by coupling digital information to everyday physical objects and environments” (Ishii & Ullmer, 1997). They moved beyond the initial desk metaphor invoked in Bricks and investigated prototypes of networked and digitally enhanced whiteboards and rooms. They saw the future of TUIs involving interactive surfaces, coupling objects with the digital information that relating to that object, and ambient media like sound and light.

As Ishii reiterated in later work, “The key idea of TUIs is to give physical forms to digital information. The physical forms serve as both representations and controls for their digital counterparts. TUI makes digital information directly manipulable with our hands and perceptible through our peripheral senses by physically embodying it” (Ishii, 2008). By incorporating both interactions with physical objects and sensory experiences to which we have been accustomed long before computers, we can interact with digital information much like we engaged with information before it was digital.
These ideas and even some of the language used in early tangible computing research are echoed in our work on ᓂeləw̓ikʷ — Belongings. We immediately recognized the value in handling ancient belongings and the information that could be conveyed to visitors through this physical interaction. We also focus on reconnecting the intangible cultural heritage back to the tangible, and in the case of our project, this intangible heritage takes the form of digital information on the tabletop.

2.1.2. Learning About Culture Through Tangible Interaction

Since the early days of tangible computing, much research has been conducted around the use of interactive surfaces in schools, cultural sites, and museums. This work includes how and what people learn through interaction with touch tabletops and tangibles, how to design to support engagement, and how to encourage and sustain interaction (e.g. Allen, 2008; Antle et al., 2014; Antle et al., 2011a; Antle et al., 2011b; Block et al., 2015; Chu et al., 2015; Ciolfi & Bannon, 2003; Gammon, 1999; Horn, 2013; Hornecker, 2008; Hornecker et al., 2007; Jun & Lee, 2014). In this section I will describe some of this research and the relevance to our use of the tangible table to educate visitors and communicate cultural knowledge and values in a museum space.

Antle et al. conducted research on a tabletop application called Futura. Deployed at a cultural site for the 2010 Vancouver Winter Olympics, Futura was a multi-player simulation game to raise awareness of the complexities around sustainable development. Players worked together, each taking on a role in charge of food, shelter or energy supply, and the players would receive feedback as to the positive or negative effect their choices were making on the overall environment. Successful in encoding both learning and collaboration within the game mechanics and interface design, we saw a similar opportunity to encode the learning of cultural values in tangible interactions (Antle et al., 2011a). Antle continued work on another sustainability and land use game called Youtopia. Working specifically with children here, there were a number of studies examining how to design tangible systems to support collaboration and reflection around personal values (e.g. Antle et al., 2013; Antle et al., 2014; Fan et al., 2014). Given the museum setting of ᓂeləw̓ikʷ — Belongings, cooperative use was certainly a consideration. The idea of reflecting on values is tied to our own design considerations,
though we were primarily concerned with communicating Musqueam values. While this focus might encourage reflection on personal values, this was not our design goal. It is also important to note that Antle was one of the faculty members on the ʔeləw̓ kʷ — Belongings design and development team, so her prior research directly influenced the direction of our team. As I will discuss later on, we did interact with the Youtopia application during our first project meeting.

Hornecker’s research presented a field study of the Tree of Life, an interactive multi-touch tabletop exhibit at the Berlin Museum of Natural History that allows visitors to access information about various species of animals through a question-answer dialogue (Hornecker, 2008). Visitors could touch on different questions that appeared on the table to then see the answers. Hornecker noted that the easy and immediate understanding of how to interact was important (Allen, 2008), but the question-answer format did not engage users as deeply as hoped. Users simply jumped from one piece of information to the next. Hornecker and others recommended multiple layers of activity to lead to increased engagement and deeper understanding (Ciolfi & Bannon, 2003; Gammon, 1999).

Researchers have suggested other approaches to counter these issues of depth. One potential solution is to design activities that involve constructing and testing of hypotheses, discovery, and meaning making (e.g. Ciolfi & Bannon, 2003; Hornecker, 2008; vom Lehn et al., 2007). It is important that visitors experience some sort of early success and be rewarded for continuing exploration of the content (Allen, 2004; Ciolfi & Bannon, 2003; Gammon, 1999; Hornecker, 2008).

While these first examples focus on learning, researchers have continued to explore tangible interactions in other research areas such as culture and heritage applications. Some have looked at how cultural constructs could be incorporated into tangible interactions and while others have focused on learning about culture through interactions with the system.

Giaccardi and Palen examined how different media and technologies could be combined and how this interaction across media could support interactions among communities, spaces, and artifacts. Multiple interactive information and communications
technologies can work together to open up new ways for users to experience and think about heritage and cultural knowledge. The ways that users interact with these technologies can influence how they understand the socially produced meanings and values ascribed to artifacts (Giaccardi & Palen, 2008). Giaccardi and Palen did not focus on tangible interfaces specifically, but we see that by leveraging a tangible user interface with other technologies and media, cross-media interaction can facilitate the presentation and exploration of tangible and intangible aspects of cultural heritage together (Muntean et al., 2016).

Horn proposed an approach to interactions with tangible systems that builds on social and cultural foundations (Horn, 2013). He described using cultural forms or conventions that are related to recurring activities such as games and counting systems and often involve a physical artifact. These cultural forms can be incorporated into interaction design, especially in terms of the physical inputs in interactive systems. Horn and other researchers have shown that by evoking these cultural forms, designers can draw on users’ cognitive, physical, and emotional resources to create meaningful experiences with the system (Hornecker, 2008; Antle et al., 2011b; Speelpenning et al., 2011).

Horn’s research involved an analysis of a multi-touch table puzzle game in a natural history museum (not specified in the paper) that helped visitors understand evolution. Many children perceived this activity as a video game and relied on resources they would use for such an activity, such as turn-taking, close observation, and mentoring. Horn suggested that a high fidelity reproduction of the original cultural form is necessary for tapping into these practice-linked resources and explains that cultural forms can be good for learnability of a system, but not necessarily for usability. In this case, it was not clear whether children were learning more from the tabletop, or if the table was simply reinforcing how to play and win games. Horn called for more research into cultural forms and the exploration of cultural forms in different applications.

Chu et al. examined a tangible tabletop exhibit that was part of Mapping Place: Africa Beyond Paper, an exhibition at the Robert C. Williams Paper Museum in Atlanta, GA. The tabletop activity is based on the lukasa, a memory board of the Luba peoples of
Central Africa, which uses beads, shells, and carvings to represent parts of a story. The table aimed to convey abstract concepts of the lukasa through collaborative, tangible interactions and through the embedded, lukasa-inspired structure and logic (Chu et al., 2015).

After conducting a visitor study with children, they found that children who participated in a short lesson before using the tabletop were better able to make sense of the interactions with the table. Thus, when they had some background knowledge of the interactions from the lesson, they could better grasp the concepts when they were interacting with the table. Children who did not have the prior lesson interpreted visual elements and animations literally rather than abstracting their story elements as intended. The researchers warn that interaction and visual design choices can detract from the intended meanings, interactions, and interpretations (Chu et al., 2015).

2.1.3. Examples of Tangibles and Interactive Surfaces in Museums

The academic literature examining the intersection of tangible computing and culture is still growing. As such, when conducting background research during our design process, we looked outside of academic literature to best practices in museums. We gathered the following examples from personal experiences with the exhibits, online searches, and nominations to Museums and the Web’s Best of the Web Award. We similarly drew from these examples to see what was effective in addressing similar design issues and goals as well as where there was potential for further exploration.

1. Cleveland Museum of Art

The Cleveland Museum of Art has two multi-touch installations that we explored. One is the Collection Wall, a forty-foot wall displaying thumbnails of over 3,800 artworks in the museum collection. Visitors can touch on different artworks, and suggestions for other related works or genres appear. Visitors can then develop their own museum tours to use on their own devices (Alexander et al., 2013; Loesser, 2016).

We found this example particularly informative as we were considering how to represent the thousands of ancient belongings excavated from česnaʔem. Given the
size of the wall, it was quite impressive visually, and visitors could immediately see the scope of the collection and easily obtain details about individual pieces. Yet when it comes to collaboration, cooperation, and interacting with others, the wall, while it is a multi-touch screen that allows for many simultaneous users, is so big that visitors do not actually have to interact with one another.

The Cleveland Museum of Art also opened Gallery One, a space in the museum set aside for integrating art and technology. Art works are displayed in the gallery, grouped thematically with other works that cross cultures, genres, media, and time. Each grouping had a large multi-touch screen in front of the arrangement, which would offer context and information about each piece along with games that engaged visitors with questions to encourage further contemplation (Alexander et al., 2013). This example was helpful to us in considering ways in which we could tie together seemingly unrelated pieces of a collection, along with how smaller games could be incorporated to encourage visitors to think more deeply about the pieces.

2. New York City Tenement Museum

One example of an interactive tangible tabletop incorporated into a museum exhibit was developed by Potion Design Studio and is part of the Shop Life tour at the New York City Tenement Museum. Visitors to the tenement museum first experience a guided tour exploring 97 Orchard Street in New York City’s Lower East Side and the immigrant businesses that over the years were located at that address. After the tour, visitors are led to the neighboring storefront in which the interactive tabletop is located. Visitors can then pick up items from the shelf and place them on the long “sales counter” to see photographs, listen to audio clips, and read newspaper articles about the store owners there (Mason, 2015; “Potion,” n.d).

The Shop Life tabletop showcased the stories relating to specific objects – one of our own goals for Ḫelawkw̓ – Belongings that will be discussed in Chapter 3. Yet the way the tabletop exhibit was designed, interactions among visitors were limited. Each person had their own section of the table with their own earpiece to listen to the stories, and there were multiple sets of objects such that no one needed to share or trade objects. Finally, the amount of time a visitor was actually holding and physically interacting with
the objects was quite short, as the only interaction with an object was to set it down on
the table or return it to the shelf. For our own tabletop, we hoped to encourage
interactions and conversations among museum visitors and to allow for rich tangible
interactions with ancient belongings.

3. Indian Pueblo Cultural Center

Housed in the Indian Pueblo Cultural Center in Albuquerque, *The Document Table* is a multi-touch table that allows visitors to explore significant events in the last hundred years of Pueblo history. An additional wall monitor is also used to display an interactive timeline that presents stories, videos, and photos at the visitor’s request. The multi-touch table and secondary wall monitor concept was similar to the design ideas discussed at our first meeting, with the focus on the multi-touch table and secondary display screens. Visitors can select, rotate, and scale documents on the table and view larger versions or associated video clips on the wall ("100 Years Exhibition at the Indian Pueblo Cultural Center | Ideum," n.d.). *The Document Table* only included one extra screen, though, so there would be no issues with competing sound or videos that might be an issue if we were to use multiple monitors. This led us to question our use of monitors for accessing content. Is one screen enough? How many would be too many? What is on the table vs. on the screens? Do multiple users need to somehow collaborate to initiate videos on the screen?

4. Reykjavík 871±2

The Settlement Exhibition is built around an archaeological find in 2001, the oldest relics of human habitation in Reykjavík dating back to before 871. The finding included a hall, or longhouse, that was preserved at its original location with the exhibition built around it. The archaeological findings are presented along with the traditional story of the settler Ingólfur Arnarson, a mythical narrative from the twelfth century, and there is a multi-touch tabletop that enables visitors to explore a model of the hall and access more information (Goodhouse, 2013). Much like our own project, this exhibition addressed the challenges of showcasing archaeological discoveries. The Settlement Exhibition also used intangible heritage in the form of familiar and traditional narratives to connect the ancient hall and other relics to the present day. While these
stories would be familiar to most Icelandic visitors, we had similar ideas to share Musqueam knowledge and intangible heritage through interactions with ancient belongings.

5. MoMath

The interactive floor at the Museum of Mathematics in New York City introduces different mathematical concepts to visitors in the gallery space. The floor recognizes where visitors are standing and uses the visitors in teaching math concepts. The system loops though different concepts, which are explained on the wall nearby. The floor successfully brings together strangers in the space, both young visitors who turn it into their own game and older visitors who are more interested in the mathematics underneath it. We similarly recognized a need to appeal to visitors of all ages (though university students would be the primary audience of our interactive tabletop) and the desire to encourage interaction and collaboration among visitors (Behseta & Dunn, 2015).

6. Additional Research

We also researched the use of gestures and Microsoft Kinects to interact with and manipulate museum pieces that cannot be touched (Brewster, 2001; Loh, 2015; (“Louvre exhibit becomes ‘better with Kinect,’ allows gesture scanning of ancient artwork | Polygon,” n.d.; Johnson et al., 2013; “New Mexico Museum of Art - The Baumann Marionettes Go 3D! - 2/27/13,” n.d.). Ultimately, we decided not to use gestures, and instead focused on actual tangible interactions with belonging replicas. We also reviewed the inclusion of mobile apps and social media (Charitonos et al., 2012; Hudson-Smith et al., 2012; (“Infinity of Nations | museumsandtheweb.com,” n.d.; Johnson et al., 2013). While the exhibits encourage the use of photography and tagging on social media, the inclusion of comments into the exhibit itself would be problematic. Public discussions, with the ability and invitation to comment while in the gallery, could then became part of the history and display of the objects. While this could enliven the exhibit (Would this make the living culture more apparent?), we also worried that the comments might detract from the Musqueam community voices that the exhibition as a whole sought to highlight.
2.2. Collaborating with Indigenous Communities

Rather than fitting neatly within academic theories of design processes, the development of ʔeləw̓kʷ — Belongings perhaps has more in common with this history of collaborative efforts between Indigenous communities and museums. The process of designing and developing ʔeləw̓kʷ — Belongings involved students and faculty at SFU, curators and designers at MOA, and input from Musqueam community members on the ḣəsnaʔem, the city before the city exhibit Advisory Committee. When presenting ʔeləw̓kʷ — Belongings, we often find that people make connections to theories of participatory design. While we certainly see the relationship, it is important to note the differences and distinctions.

Participatory design was developed in Scandinavia to address issues with workplace information technology. In this context, designers worked in collaboration with those who regularly used the technology in question (Björgvinsson et al., 2010). Iversen and others later described the need to revitalize the focus on values in participatory design, imploring designers “to view methods and participation as a means to achieving what we hold to be the ultimate ends of PD: a core engagement with values” (Iversen et al., 2012). Researcher and designers have also incorporated participatory design into the process of developing museum exhibitions, involving audiences in both the design process (Smith & Iversen, 2014) and designing for visitors’ co-creation of experiences within the exhibitions (Jun & Lee, 2014; Simon, 2010).

The development of ʔeləw̓kʷ — Belongings diverges from these theories of participatory design in development. As I will describe in the case study, the MOA exhibit highlighted the voices of Musqueam community members. As such, while we considered museum visitors during the design process, they were not involved, consulted, or invited to actively co-create during the exhibition.

Rather, ʔeləw̓kʷ — Belongings is an example of working towards the decolonization of museum exhibitions. ʔeləw̓kʷ — Belongings was designed in partnership with curators at MOA and the Musqueam Indian Band. Museums and Indigenous communities in North America have a complicated history, so I begin this section by discussing the more recent shift in these relations. I then continue with...
specific projects to develop networks and databases of traditional knowledge. I end by introducing the Reciprocal Research Network (RRN), which was one such database project that involved Musqueam and MOA and laid the groundwork for our own collaboration on ḣeləw̓kʷ — Belongings. This context is important to the case study and description of our design process, as this complex history both caused the need for such a collaborative exhibition and enabled it.

2.2.1. Relationships Between Indigenous Communities and Museums

The late twentieth century saw a paradigm shift in North American museology focused on building new relationships with First Peoples. In 1992 the Assembly of First Nations and the Canadian Museums Association worked together on the development of the Task Force Report on Museums and First Peoples (Hill & Nicks, 1992). This report was drafted in an attempt to repair the relationships between Canadian institutions and First Peoples and to move towards more open partnerships. The Task Force described the necessity of including First Peoples in the interpretation of their cultures by Canadian institutions, which in fact was calling for a change in the power relations between museums and First Peoples. The Task Force further called on museums to make their collections accessible by First Peoples and to create policies on repatriation of cultural heritage and ancestral remains. Similar mandates were underway in the United States with the 1990 passage of the Native American Graves Protection and Repatriation Act (NAGPRA) (Council of Canadian Academies 2015).

In the early 1990s, digital imaging, databases, and search technologies were rapidly advancing at the same time that Canadian museums were looking for ways to implement models of partnership with First Nations as called for in the Task Force Report (Phillips, 2011). These technologies provided unprecedented new tools for both reassembling dispersed collections and creating new forms of access to these collections of Indigenous cultural heritage (Muntean et al., 2015a; Muntean et al., 2015b). Furthermore, in utilizing these technologies to create such tools for museum collections, Canadian institutions and First Nations began collaborating in new ways. They were now working as design partners as well.
In this rebuilding of relationships between museums and contemporary Indigenous peoples, we mentioned that this includes the repatriation of ancient belongings and remains of ancestors. Yet it also means bringing fuller representations of intangible cultural heritage into museum exhibitions, which requires collaboration (Kurin 2004a). While objects have previously been the focus of museum collections, museums and communities are increasingly working together to reconnect the intangible forms of knowledge and traditions with these physical belongings in the museum collections and to share this knowledge with museum visitors (e.g. Hennessy et al., 2012; Hennessy et al., 2013; Hollinger et al., 2013; Leopold, 2013; Shankar & Hooee, 2013). Technology now often plays an important role in these collaborations.

In Clifford’s 1997 work *Routes: Travel and Translation in the Late Twentieth Century*, he includes a chapter on an experience he had nearly a decade earlier working with curators, anthropologists, and Tlingit community members at the Portland Museum of Art in Portland, Oregon. The group had gathered to reinstall the museum’s collection from the southern coast of Alaska and British Columbia, and while Clifford expected elders to discuss the pieces in the collection in a detailed way, they sang, told stories, and shared experiences and concerns. And these voices were to be presented with the physical pieces in the collections that were connected to these stories. From this experience, he writes about museums as contact zones, drawing on the term from Mary Louise Pratt who describes a contact zone as “the space of colonial encounters, the space in which peoples geographically and historically separated come into contact with each other and establish ongoing relations” (1992, p.6). Pratt notes that the conditions in these contact zones often include that of inequality, conflict, and coercion, and indeed, Clifford saw this consultation process as that of reworking and revisiting the relationship between the museum and the Tlingit people (Clifford, 1997).

There have also been warnings against the neocolonial potential in this way that the contact zone concept has been taken up by museums. Boast, while writing from a stance supportive of collaborations between institutions and Indigenous communities, further investigates the inherent asymmetry of power in these relationships that is often overlooked (Boast, 2011). He highlights Clifford’s cautioning that museums must go beyond consultation and cultural sensitivity and incorporate the actual sharing of
authority. Drawing on Geismar, Boast notes that the power still remains with those who have the property and capital and who also have the power to display (Geismar, 2008).

Digital fabrication is one such possibility for digital tools to support both the reconnection of intangible and tangible heritage and interactions with physical belongings, and the repatriation of cultural property from museums to communities of origin. The Tlingit Killer Whale Hat project used 3D scanning and fabrication technology to display the replica of a crest object that had been repatriated in a culturally appropriate manner (Hollinger et al., 2013). Since telling the story of repatriations in an exhibit can be challenging since the repatriated item is likely no longer available to display, the Smithsonian replicated the original hat, which had been repatriated from the National Museum of Natural History. When the replica was taken to Alaska to show the community, Tlingit dancers wore both the original Killer Whale Hat as well as the replica as a way to “put life into” the replica before it went back to the museum (Hollinger et al., 2013). Even though that was the first time a replica made by a museum was danced at a Tlingit cultural event, they did not formally bring it out as a crest object. The appropriate display of the Killer Whale Hat was finally possible after the replica had been produced, and also presented to the community.

2.2.2. Knowledge and Networks

I touched on physical and digital returns of ancestral remains and belongings in relation to museum exhibits and display, but naturally these issues also exist at the level of museum collections unseen to museum visitors. Historically, information included in museum records was often acquired in a discriminatory manner, discarding details from the communities from which the belongings were collected (Turner, 2015). As museum collections are increasing online (Geismar, 2013) and as digital information is increasingly expected to be open to the public (Christen, 2012), museums and anthropologists are taking up the challenge to create databases and content management systems that incorporate the knowledge traditions and cultural values of the Indigenous communities whose heritage is being organized and archived.
For example, Kim Christen worked with the Warumungu Aboriginal community in Central Australia on a management system for all of the digitally repatriated materials to which they now had access (Christen, 2011). Finding that the commercially available content systems lacked the specific levels of access that are culturally accepted and expected by the community, they created the Mukurtu Wumpurrarni-kari Archive. Users’ access to material would be based on their gender, age, and familial relations, mirroring the access they would have to that cultural knowledge in the community. For example, photos of certain types of ceremonies that would only involve male elders could similarly only be viewed by male elders in the archive. In this example of a collaboratively developed system, cultural protocols and traditional ways of knowing were designed into the archive, guiding the interactions visitors have with the archive in a culturally appropriate manner.

2.2.3. RRN

The Mukurtu Wumpurrarni-kari Archive is not the only collaboratively produced archive that incorporates Indigenous values and systems of knowledge. The Reciprocal Research Network (RRN) is one such digital museum network that greatly contributed to the genesis and development of ʔeləw̓íkʷ — Belongings (Muntean et al., 2015a; Muntean et al., 2015b).

Seeing a need for the proper infrastructure to support a collaborative museum model, in 2001 the Musqueam Indian Band, the Stó:lō Nation, the U’mista Cultural Society, and MOA applied for a grant to create a digital infrastructure for museums, researchers, and community members. The outcome was the RRN, an online research hub for accessing collections and information that are geographically dispersed (Rowley, 2013).

Along with simple digital access to collections, the RRN also supports different cultural systems of knowing. The network maintains and shares museum data about Northwest Coast collections, but community partners are also able to contribute their own information and stories about belongings. The RRN creates a virtual space to foster discussions around the collections, and community members can contribute to a fuller
record and understanding of the belongings in the collections than is present in the original museum records (Gibson & Turner, 2011; Rowley et al., 2010).

The RRN was a tool used by curators at all three of the čənəʔəm, the city before the city exhibits. The curators could share digital records of belongings from their institutions, decide in which exhibit belongings might be displayed, and collaboratively develop curatorial texts. For ʔeləwḵʷ — Belongings specifically, the RRN was used to select belongings for replication, seek approval from the exhibit advisory committee, and access digital image files.

Beyond the digital research infrastructure provided by the RRN that benefited the creation of ʔeləwḵʷ — Belongings, the collaborative relationship between the Musqueam Indian Band and MOA that was established during the development of the RRN greatly contributed to the success of the tangible tabletop project. With the Musqueam and MOA working relationship well in place, our team therefore had a solid foundation for our own collaboration designing a tangible interface that could part of the collection of belongings from čənəʔəm accessible to the public and connect those belongings to the stories of Musqueam culture (Muntean et al., 2015a; Muntean et al., 2015b).
Chapter 3.

Case Study

The design of ḥeləw̓kw̓ – Belongings was a collaborative process, with members from the Making Culture Lab and the Tangible Computing Lab at the School of Interactive Arts and Technology at Simon Fraser University partnering with the curators of the čəsnaʔəm – the city before the city exhibit at the Museum of Anthropology at the University of British Columbia.

In this chapter, I will start with general background information about čəsnaʔəm, the čəsnaʔəm – the city before the city exhibit as a whole, and the MOA exhibition specifically. I will follow with the case study of our design process, and will end with a description of the ḥeləw̓kw̓ – Belongings installation.

While some consider a case study as a choice of what is to be studied, I consider the case study as the methodology used to design and guide my research. Following the definition offered by Creswell, I am exploring “a bounded system (a case)… over time, through detailed, in-depth data collection involving multiple sources of information (e.g., observations, interviews, audiovisual material, and documents and reports), and reports a case description and case-based themes” (Creswell, 1998).

This bounded system encompasses the period of time in which we as collaborators were actively involved in the development, design, and research activities related to ḥeləw̓kw̓ – Belongings. It is important to note that the specific period of time begins with initial discussions around the possible collaborations, and ends at the time of the writing. Further data analysis and research publications are planned beyond the publication of this thesis. As mentioned in the introduction, my position as project manager offered me a great vantage point from which to collect data. I was responsible for creating the agendas and documenting the minutes for each meeting. I was in
attendance at nearly every meeting, again allowing me to observe the collaborative process. I usually photographed much of the process and maintained the collection of visual documentation. This collection of data enabled me to produce the case description that follows.

3.1. Background

3.1.1. čəsnaʔəm

Around two thousand years ago čəsnaʔəm was one of Musqueam’s largest village sites, located near the mouth of the Fraser River in what is now Vancouver, British Columbia. Archaeological evidence suggests people lived in this location uninterrupted for over three thousand years, and according to Musqueam oral history, their ancestors have lived there from time immemorial (Roy, 2010). Many in Metro Vancouver today, though, do not know that the area marked with railroad tracks, roads, and bridges on the way to the airport has such an historic significance (“Museum of Anthropology at UBC | čəsnaʔəm, The City Before the City at MOA,” n.d.).

čəsnaʔəm as a village site and burial ground has had a number of names over the years, gaining new titles as it transitioned into an archaeological site during British Columbia’s colonial project. In archaeological circles it has been known as the Great Fraser Midden, DhRs-1, and Marpole Midden. Between the late 1800s and today, archaeologists both professional and amateur, the general public, and looters have removed thousands of belongings from the ground at čəsnaʔəm. Now found in living rooms and museums, belongings from čəsnaʔəm are scattered around the globe (Roy, 2010).

Important to note is the use of the terms belongings here, as well as in the title of the tangible tabletop and further discussion of the work. Archaeologists commonly refer to belongings excavated from Musqueam’s village site as “objects” or “artifacts”, but the Musqueam people see them as still belonging to the ancestors who created them. The elders of the Exhibit Advisory Committee deliberately decided to change the terminology and language around what has been removed from čəsnaʔəm. We have thus adopted
the term ?eləw̓ikʷ, a hən̓q̓əmīʔən term meaning belongings, for the title of the tangible table exhibit and have similarly incorporated belongings in our own discourse around the project.

Jordan Wilson, one of the co-curators of the MOA exhibit and Musqueam community member, wrote about the nuances of the term and its adoption, noting that at first he viewed it as a correction of the language of Western discourse, which takes the ownership of these belongings away from the community, but he also realized it was more than that.

*The use of the term emphasizes the contemporary Musqueam connection to the tangible things themselves, but it also conveys that Musqueam have always been the carriers of these belongings' intangible qualities, including knowledge about the power they continue to hold, how they should be cared for, what should be said about them, how they should be presented (if at all), and how they fit into our ways of seeing the world.* (Wilson, 2016)

This union of tangible and intangible heritage was important in all three of the c̓əsnaʔəm – the city before the city installations, and I will touch on this again in the next section of the overview of the exhibitions.

Large collections of belongings from c̓əsnaʔəm are still located in Vancouver at the Laboratory of Archaeology (LOA) at UBC and at the Museum of Vancouver (MOV). There are some ornately decorated and undamaged belongings that were excavated, preserved, and presenting in exhibits and publications, yet most belongings from c̓əsnaʔəm are fragments of stone or bone. They may seem less exotic to a common viewer today, but these belongings would be important in the day-to-day lives of those who created them. Some of these belongings might appear less interesting than more aesthetically intriguing belongings like a heron blanket pin or a carved pestle, but they represent great ancestral knowledge and complex histories. Indeed, all of these belongings are of continuing value for the Musqueam community today. These belongings represent technologies used for daily activities, and speak to the wealth, resourcefulness, and detailed technological and cultural knowledge of the Musqueam ancestors at c̓əsnaʔəm (Muntean et al., 2015a; Muntean et al., 2015b).
Along with the importance of the belongings at čəsnaʔəm, the site itself is of continuing importance to the Musqueam Indian Band. In 2012, condominium developers planned to build a five-story building on privately owned land in the Marpole area of Vancouver, at čəsnaʔəm. The site had been named a national historic site in 1933, but that did not offer any protection against development of the land. After ancestral remains were found, Musqueam community members protested to stop the development. After nearly five months of protests, the Ministry of Forests, Lands, and Natural Resource Operations allowed the permit to alter the land to expire, noting that the new knowledge of the burial ground changed the lands’ heritage value. The Musqueam Indian Band was ultimately able to buy the land back from the developer to preserve it and turn into a park (Ball, 2013; Howell, 2013).

3.1.2. čəsnaʔəm, the city before the city

čəsnaʔəm, the city before the city is a partnership between the Musqueam Indian Band, the Museum of Vancouver, and the Museum of Anthropology at UBC, along with the University of Waterloo. In this series of three exhibitions, the institutions introduce visitors to čəsnaʔəm, each with a different focus.

The exhibition at the Musqueam Cultural Education Resource Centre & Gallery highlights the sophistication of Musqueam’s technology and culture both past and present. The Museum of Vancouver showcases ancient Musqueam belongings and ties them to the more modern histories of colonialism, heritage politics, and cultural resilience. The MOA exhibition, which includes the ʔeləw̓kʷ — Belongings tabletop, shares Musqueam values and worldview using media-rich installations told from the point of view of named Musqueam community members’ voices. The exhibition at MOA ran from January 2015 to January 2016. The exhibition at the Musqueam Cultural Education Resource Centre is ongoing, and the exhibit at the Museum of Vancouver is slated to run from January 2015 through January 2020 (“čəsnaʔəm, the city before the city,” n.d.).
In Wilson’s articulation of the importance of *belongings*, he also describes how each of the three exhibitions reunites the tangible and intangible elements of Musqueam culture. He notes,

> At MOV, ancient fishing and hunting gear is accompanied by video segments of community members discussing the importance of the Fraser River—the lifeblood of our community—to our community’s cultural activities and identity. At Musqueam, all belongings are shared alongside their contemporary equivalents, simply and elegantly revealing the continuity of practices and values. At MOA, “actual” belongings are forgone to emphasize the intangible, with the exception of replica belongings (ancient and contemporary), which can be placed on an interactive surface to navigate through narratives on Musqueam practices (Wilson, 2016).

While related and intertwined, each exhibition offered a unique approach to showcasing the history of Ʉəsnaʔəm, the contemporary lives of Musqueam people, and the tangible and intangible aspects of their culture that connect the past to the present.

### 3.1.3. MOA Exhibit

The MOA version of the Ʉəsnaʔəm, the city before the city exhibition took a more experimental approach to showcasing this long history as compared to those at Musqueam and MOV. Even though this was an exhibit of an ancient village and archaeological site and even though many of the belongings take from Ʉəsnaʔəm are physically housed at the Laboratory of Archaeology at UBC, the focus of the exhibit was on community knowledge and ways of knowing. In the design of the MOA portion of the exhibition, curators Susan Rowley and Wilson were rethinking archaeology and what it means to exhibit belongings.

It can be difficult for museums to interest visitors in the seemingly unimportant fragments from the past, and often only a carefully curated and well-preserved selection are exhibited. This type of selection and the presentation of related information may give visitors false impressions of what was common, valuable, available, and preserved. Rowley and Wilson discussed the challenges and opportunities afforded by exhibiting a fraction of the collection held in trust for Musqueam at LOA, but displaying a few would
force the curatorial team to select and interpret belongings in the way they were trying to avoid.

They also considered displaying the entire collection of belongings from čə_snəʔəm. Displaying all of the thousands of belongings would be a logistical challenge, though ideas of using digital displays and drawers were discussed. Furthermore, displaying belongings associated with burials and ceremonial use would be culturally inappropriate. Given the history of excavation processes at čə_snəʔəm, it would be nearly impossible to determine the exact provenance of particular belongings and thus how appropriate it would be to display (Muntean et al., 2015a).

After much debate and discussions with Musqueam exhibit advisory committee members, they determined the MOA exhibition would not feature any ancient belongings. The logistical constraints mentioned were certainly a factor, but there were a number of other reasons. čə_snəʔəm is not viewed as an archaeological site by the Musqueam community. It is commonly referred to as a former village and cemetery, and an important part of Musqueam’s extensive history. In fact, the excavations and removal of ancestors, and many other forms of Western research, have been viewed as contravention of cultural values and protocol and have resulted in long-term negative impacts on the community (Roy, 2010).

Rowley and Wilson were also attempting to challenge the meaning of an archaeology exhibit. MOA is known for collecting and displaying material culture, and visitors would likely expect to see ancient objects supplemented by plaques with information from academic experts and scientific views. But material culture is not equivalent to culture, and there is much more to Indigenous communities than artifacts. This exhibit highlights that academics and scientists are not the only voices with valuable information to offer.

ʔelə̱w̓ kʷ – Belongings was designed with these curatorial goals in mind, but we saw this tangible table as a way to speak to the belongings without taking focus away from the community voices. We drew inspiration from museological discourse in the late 1970s, which included the ideas that knowledge is social, that knowledge is shared, and that objects themselves embody knowledge. Indeed, “a necessary condition for the
generation of knowledge is engagement with objects” (Srinivasan et al., 2009). We felt that using replicas of belongings as a tangible interface would be the ideal way to access Musqueam community knowledge. Including only historic belongings, though, would risk falsely implying that Musqueam are a people of the past or that their practices, values, and traditions have diminished over time. As such, we included modern belongings, providing an opportunity for community members to share stories about their history, their culture today, and the teachings from their ancestors that join the past to the present.

Description of the exhibit

MOA visitors entered čəsnəʔəm, the city before the city from the Great Hall. The hall has dramatic fifteen-meter walls of glass overlooking a pond and outdoor sculpture complex. Inside are large house posts and carved figures from the Northwest Coast. After walking down a ramp into the Great Hall, visitors turned to the right and were led towards the O’Brian Gallery.

Visitors first entered a vestibule with a video welcoming them to the exhibition. The welcome was spoken in hən̓q̓əмиʔəm (the language of the Musqueam people), with English subtitles overlaid on scenes from modern day Vancouver. Visitors then walked through the doors to the main gallery space, a long room with a wall of windows on the left. The exhibit started with quotes, text, and images on the wall to the right. On the left, there were some viewing and listening areas with headphones around small touchscreens and projections on the windows.

As visitors moved through the gallery, there was a small room on the right containing the kitchen table audio installation. There was a table covered in a colorful cloth, with images, teacups, and a teapot. Empty chairs surrounded the table. Visitors were invited to enter, sit down, and listen to the voices of Musqueam Elders sharing stories and discussing issues. In fact, the voices were that of the Elders on the Exhibit Advisory Committee. Inspired by the long conversations that were had during the exhibit planning meetings, the curators suggested a dinner after which the Elders were recorded during their conversations. The recording was then edited to twenty-five minutes for the installation (Wilson, 2015). Next to the kitchen table room was an open
alcove for the ʔeləw̓kwʷ – Belongings tangible table with the table, a museum cart, and three wall monitors. On the other side of the alcove was another small room with a short film projected on the wall and a small seating area. At the end of the gallery space were couches where visitors could sit, watch video interviews, page through articles and newspaper clippings, and sign the exhibit guest book.

**Description of tangible table**

The ʔeləw̓kwʷ – Belongings interactive tangible tabletop stands in the center of the alcove in the middle of the exhibition (See Figure 1). The table displays a top-down view of a fish-cutting scene, with related resources and materials such as fishing net and wood for smoking situated around the fish-cutting table in the image. On the two long edges of the table are instruction cards. Each card offers an illustration to show how to activate the system by putting a belonging in one of the rings and uses short text to describe the different categories on the ring.

![Figure 1. ʔeləw̓kwʷ – Belongings Installation. Photo courtesy of the author.](image)

Along with the tabletop itself, the ʔeləw̓kwʷ – Belongings system comprises six replicas of ancient belongings excavated from cəsnaʔəm (net weight, adz, slate blade, harpoon, a decorated fragment, as well as a piece of cedar bark to represent everything that was not preserved), six contemporary everyday items of Musqueam life (ice cube, keys, status card, tide chart, quarters, and a Coke can), and two activator rings (See
Figure 2). The detailed replicas sit together with the contemporary belongings on a museum collections cart. Juxtaposed with ordinary items like keys and a crumpled tide chart, visitors are invited to pick up the ancient belongings to discover their importance. Conversely, seeing a Coke can on display encourages them to question how mundane modern objects are relevant to Musqueam culture.

Three monitors are situated on the walls surrounding the table and belongings cart; two of these are associated with the activator rings while the third displays photographs of the process of cleaning and filleting a salmon. The table itself shows a top down view of a fish-cutting table. On the table are a salmon, salmon fillets, a knife and sharpener, and an iPhone. Around the table are related supplies for fishing and fish preservation: fishing nets, firewood, an axe, a gas can, an oilcan, rubber boots, and a tote of fish (Muntean et al., 2015a; Muntean et al., 2015b).

Following the format of the rest of the exhibition, there are also quotes from Musqueam community members on the walls around the monitors. Here, the quotations focus on the concept of belongings.
3.2. Design Process

Now that I have described the background for the overall exhibition and the context for our tangible tabletop design, I will describe our design and development process for ḥələw̓ḵʷ – Belongings.

3.2.1. Development Team & Roles

ɬəsnaʔəm, the city before the city. Our development team members from UBC included Dr. Susan Rowley, graduate students Jordan Wilson, and Lisa Uyeda, with additional MOA support from Gerry Lawson, Nick Jakobsen, and Ryan Wallace. Our SFU School of Interactive Arts and Technology team was composed of Dr. Kate Hennessy, Dr. Alissa Antle, graduate students Brendan Matkin and myself, and undergraduates Rachael Eckersley and Perry Tan.

Rowley at the time was co-head of the Department of Anthropology at UBC, Associate Professor, and Curator of Public Archeology at MOA. She and Wilson, a Master’s student in the Department of Anthropology and a member of the Musqueam Indian Band, were the co-curators of MOA’s ɬəsnaʔəm, the city before the city exhibit. Along with designing the overall activity of the tangible tabletop, they were also in charge of assembling and creating the content for the table. Uyeda, a Master’s student in the School of Library, Archival, and Information Studies, assisted the team in adopting best practices in digital information, organization, and archiving. Lawson, coordinator of the Oral History Lab at MOA, aided the team with MOA-specific technical support, while Jakobsen and Wallace helped with needs related to the RRN and digital files from the collections.

Whereas the MOA/UBC team provided the content and support related to the museum, the SFU team members focused on the technical aspects of the development of ḥələw̓ḵʷ – Belongings. Again, all team members participated in the overall activity design of the table, but the SIAT team handled the interaction design, fabrication of the physical aspects of the tangible interface, and the programming of the tabletop.
application. Hennessy was an Assistant Professor, Director of the Making Culture Lab, and my senior supervisor for my research. Hennessy’s own work is focused on the collaborative development of culturally specific new media applications and installations.

Antle was an Associate Professor and Director of the TECI Lab, in which Brendan Matkin was also conducting research for his Master’s degree. Antle’s work in the TECI lab includes tangible computing and embodied interaction. Eckersley and Tan were undergraduate students who had previously completed work with Antle’s lab.

3.2.2. Genesis of Project

ʔeləw̓ikʷ – Belongings had its roots in a question not uncommon in graduate school: “On what will I write my thesis?” Hennessy and I were reviewing potential ideas for my Master’s thesis project. Hennessy, knowing that the ʔasnaʔam, the city before the city was the planning stages, suggested contacting Rowley to see if there was an opportunity to collaborate in some way as part of the upcoming exhibition. Hennessy and Rowley had worked together previously on the RRN project when Hennessy was a PhD student at UBC. We hoped to provide technological and developmental support if there was interest in a new media component to the exhibit.

Rowley invited Hennessy and me to attend a meeting of the exhibition planning committee in June 2014. We sat in on the meeting, which was held at the Musqueam Community Centre and attended by the curators from all three exhibits, along with the exhibit designers and filmmakers who were presenting their plans and proposals. From this meeting, Hennessy and I had a greater understanding of the focus of each exhibition, the specific look and feel of the spaces, the video interview content that would be available, and the plans for continuing education around the exhibits including teaching kits that would be available for school groups and possible hands-on cultural activities related to the exhibits.

During the planning meeting, excitement seemed to be building around a potential Heritage Vancouver Bus tour that would include the museums on their tour stops, and people where interested in finding other ways to encourage visitors to experience all three of the exhibitions. One initial project proposal based on this ideal of
connected visitors to all three locations was a mobile app that would offer a driving tour to all of the sites. Along with directing visitors to each exhibition, the location of the vehicle would trigger and play audio interviews with Musqueam community members telling stories related to the area. An interactive map with all of the audio stories, as well as additional photos and videos (drawing on content from the filmmakers, teaching kits, and RRN) would also be offered as an alternative to the driving tour when users are no longer on the road. Further interactions might have included the ability for users to post their own images and thoughts along the way.

Other possible collaborations identified included an augmented reality portion of the MOA exhibit or a website encompassing all three of the exhibitions. For the application of augmented reality to the exhibit, participants in the planning meeting discussed using binoculars within the Musqueam exhibition space to look out onto the land to view signs and sights in the landscape. We saw an opportunity here to implement this idea using tablet devices. Viewing the landscape through an iPad, visitors could then see information overlaid on top of the landscape with Musqueam facts, belongings, concepts, and videos of elders telling stories or youth giving information and explanations. A perhaps simpler approach to this collaboration might have been to create a website compiling the materials from the three exhibitions, offering an introduction to language and manners, playlists of the video content (and extended content that was filmed but not ultimately used in the exhibitions), and slide shows of belongings from the RRN. This website could be launched along with the exhibitions or after the Musqueam and MOA exhibitions close as a way to support and continue the MOV experience.

Lastly, we also suggested an interactive tangible tabletop installation. There was discussion during the planning meeting of incorporating 3D printed models of Musqueam belongings in the MOV exhibition that would be available for visitors to touch and hold. An interactive table could allow for items to be placed on the table and to prompt stories, accessing video content and information from the teaching kits. Again, discussions during the planning meeting often touched on maps and using maps for how people envisioned Musqueam in the past, present, future. An interactive tabletop could allow people to modify maps on the spot as well as access previous visitors’ maps.
With the experience and expertise of Antle in the area of tangible computing and the availability of the necessary hardware for such project within the TECI Lab within SIAT, the development of a tangible tabletop component of the MOA exhibition seemed like the perfect opportunity for collaboration. Hennessy confirmed Rowley’s excitement for such a venture and contacted Antle to discuss her interest. After these initial proposals had been discussed among Hennessy, Rowley, Antle, and myself, an initial tangible tabletop meeting was held August 7, 2014.

3.2.3. Initial Tangible Table Meeting

We held our first meeting at the SIAT campus, with Antle, Hennessy, Rowley, Wilson, Jakobsen, Wallace, Lawson, Uyeda, Mo Glymin (MOA IT), and myself, to decide whether the tangible table was feasible and discuss our next steps if we decided to move forward.

After introductions, we moved from the Making Culture Lab space to allow everyone to interact with the hardware that we would be using for the tangible table and to demonstrate Antle’s previous tangible work for our MOA guests. Antle had a Samsung SUR40 table that one could think of the table as a horizontal HD display with legs, though its capabilities extend beyond simply displaying media. With Microsoft PixelSense, which utilizes infrared sensors to detect objects on the screen, the table can identify blobs, fiducial tags, and up to 50 touch inputs. The ability to detect blobs and tags offers the possibility to support tangible interactions. By utilizing both the touch and tag reading functions of the table, we would have the opportunity to combine physical replicas of cultural belongings to additional media such as text, images, audio clips, and videos (Muntean et al., 2015a; Muntean et al., 2015b).

After walking through the Youtopia tabletop application, we all had a chance to interact with the system and discuss the table’s affordances and possibilities for using the table in the ćasnaʔem, the city before the city exhibit. Making certain that the Microsoft SUR40 table could both withstand the heavy use by museum visitors and that Antle could lend the table to MOA for the duration of the exhibition, we gathered back
around the Making Culture Lab table to brainstorm possibilities for using tangibles and
our goals for the project (which will be discussed in more detail in the next section).

During this meeting, once it was clear that we were ready to move ahead with
this project, we discussed the timeline and process for development. First, the timeline
was very tight, with the exhibition opening in January, just five months away. Antle noted
that this was less time that she would normally suggest, so we immediately scheduled
two weekly meetings for the core development team, with a check-in meeting on
Mondays and a working meeting on Thursdays. We also set a December 1 “kill date”
should the project not progress as quickly as it needed to for the January installation.
Lastly, we needed a project manager who was sensitive to the needs to the project to
ensure that this all came together. Given that this tabletop was my intended thesis topic,
it was suggested that I step into that role. We also discussed the major goals for this
project, which I will describe in further detail in the next section.

Before we ended the meeting, we laid the major action items and the next steps
needed. These included:

1. Identification of the Activity (Simply, what would visitors do with this
tangible table? What would it look like? How would people interact
with it?)

2. Development of Content (Tied very closely to the identification of the
activity, what would people actually be learning from this tabletop?
What form would the content take?)

3. Technical Team Assembly and Figure Out How to Make it Work
(Once the activity and content is determined, who and what would be
needed to realize these ideas?)

4. Graphic Design (What would the finished tabletop application and
area of the exhibition look like?)

5. Research (What has been done in the museum space? What should
we not be replicating? What can we improve on? Best practices?
What not to do?)

6. Ethics Applications (Musqueam Research Permit and UBC/SFU
ethics reviews would be needed to reference the content of the exhibit
in this thesis as well as to conduct the user study and evaluation in
the gallery)

7. Study Design (What will our research questions be? What is the best
methodology to explore these research questions?)
3.2.4. Initial Goals

During the first meeting, we articulated the overall goals for the project. Antle suggested we discuss what we hoped for from this project, sharing in a way that allowed for everyone to provide input based on their background and area of involvement with the table. In our own academic way of gathering around the table and sharing our experiences and viewpoints, we came up with nine related and sometimes overlapping goals to guide us through the development and design of the tabletop installation. We continued to refer back to these throughout our design process, and once the table was installed in the museum, we also derived our research questions from these goals to evaluate the design of the system and the project overall.

1. Demonstrate the richness of information that is related to small pieces/fragments from čəsnaʔəm
2. Help visitors understand the whole, complex, and rich story attached to archaeological fragments of belongings
3. Reinforce Musqueam values and respect; communicate that Musqueam knowledge should be treated with respect
4. Belongings are more than beautiful objects; show significance of the fragments and the non-blockbuster belongings
5. Create a conversation between visitors
6. Facilitate storytelling; help people learn about a belonging but also about Musqueam detailed knowledge of the environment, space and land
7. Bring together academic archaeology and community voice
8. Interaction with the table should somehow challenge peoples’ assumptions
9. Communicate that there are thousands of belongings from čəsnaʔəm but we focus on only a few to tell their complex stories

3.2.5. Research of Best Practices

One of the first action items included researching examples of multi-touch tables and tangible computing in museum spaces. Some of these examples came from team members’ own experiences visiting these exhibits, while others were from reading and watching videos online. These examples were included in the Chapter 2, and they
helped us identify successes in previous exhibitions as well as where there might be opportunity for further exploration.

### 3.2.6. **What Meetings Looked Like**

The compilation of best practices occurred simultaneously with our month of meetings. During the month of August, we held two weekly meetings, and our core development team included Rowley, Wilson, Hennessy, Antle, and me. Our administrative meetings occurred on Mondays via Skype for general check in usually held via Skype with Uyeda joining to consult on standardizing documents, naming conventions, and copyright concerns. Longer, in-person design meetings were held on Thursdays where we gathered around Antle’s dining room table. Our design meetings were where we started to develop the idea for the actual activity and the content that would be needed.

During this first month, we discussed many possible ideas for activities. These included using maps on the tabletop to show how things have changed or simulations so visitors could image and build different futures. We ran into issues here around inaccurate or vague archaeological records and tying certain ideas and concepts to physical locations. Then Rowley and Wilson introduced the idea of the sturgeon fishing story to the team. It could relate to ancient belongings like a bone harpoon tip, contemporary things like permits and tide charts, and also to related stories from community members. Even while we were thinking in terms of using an underlying map as the image on the tangible tabletop, we liked the idea of sturgeon fishing with connected stories and belongings. Rowley and Wilson were tasked with developing a set of content related to fishing, which we could then fit to some of the activity models we were envisioning.

As we started to have a greater understanding of the kind of content that would be available, we began to group the content into categories, thinking that each category would require a different type of interaction to access it. Our early categories included Connections, Contemporary Issues, Archaeology, What is it, and History of Use.
After the first month of meetings, we also had a better idea of other people we would need to bring on board to complete the table. Antle suggested three students. Tan, an undergraduate student in SIAT, had been the programmer for Antle’s previous work with Youtopia. As he was familiar with the Microsoft SUR40 and possible technical issues we might have, he seemed like a natural fit for the role. Eckersley was also an undergraduate student who had experience with tangibles and interaction design from courses taught by Antle. We planned to bring her onboard to design the tangible aspects of the project and plan for their production and fabrication. Lastly, Matkin was an incoming Master’s student under Antle’s supervision with a background in new media and strong interest in tangibles who would help with visual and interaction design.

3.2.7. Interactions with Musqueam/Museum/Designers

As I mentioned in Chapter Two during the discussion of related work and theories, the design process of ḥəɬə̱w̓ʷ — Belongings was collaborative in nature, but not necessarily following the participatory design and codesign methodologies that designers may be more familiar with. Rather, the design process between Musqueam, the museum, designers, and researchers related more to the examples of institutions and indigenous communities working together to decolonize museum exhibitions. In the process of designing ḥəɬə̱w̓ʷ — Belongings, our team’s interactions with Musqueam included representation at the Exhibit Advisory Committee meetings, incorporation of Musqueam language and values in our process, and visits to Musqueam reserve land to collaborate with Musqueam community members on creating the photographic imagery we needed for the tangible tabletop.

Musqueam voices were showcased in the MOA exhibition, again highlighting this aspiration and serving as an indication of the shift in the relationship between MOA and Musqueam over the years. The Exhibit Advisory Committee was integral to ensuring that Musqueam’s voice and input came through in all of the related exhibitions. While we view our development process as a collaboration, out of the SFU members of our design team only Hennessy and myself attended a meeting of the Exhibit Advisory Committee. Rowley and Wilson were members of this committee and attended the weekly meetings, reporting on our work and asking questions on our behalf.
It is also important to note that while Wilson is a member of the Musqueam community and could offer his knowledge on certain subjects and concerns, he reiterated the fact that he could not speak for Musqueam as a whole. In these instances, he and Rowley would take our inquiries and concerns to the Exhibit Advisory Committee for input from Musqueam elders. In this way, while we as designers and researchers were not in direct contact with the elders and decision makers from the community, we directly understood the importance of respect and deference to the knowledge keepers and those in charge.

Even without direct contact with the Musqueam members of the Exhibit Advisory Committee, we still worked to embed values within our design team. This included the use of the term belongings and ensuring that the hən̓q̓əmin̓əm̓ language appeared properly in all documents as well as in the final installation. As I mentioned previously, we adopted the term belongings, which was being used by Musqueam and the Advisory Committee to discuss that which had been made by their ancestors and what was removed from their ancient village site. Our team followed Rowley and Wilson’s lead, adopting the term as well. This involved retraining our way of speaking and thinking, since we had been accustomed to using the terms object and artifact when discussing such things. When it came time to name the tangible table, we immediately chose ḥəlewkʷ, as for us belongings was such an important concept that defined the project. We also took great care in ensuring the hən̓q̓əmin̓əm̓ language appeared correctly throughout the design process. hən̓q̓əmin̓əm̓ was originally a spoken language and is now written using the North American Phonetic Alphabet, which does not render properly in many common fonts. As a result, the Exhibit Advisory Committee approved the abbreviation “csnm” for use when shortening cəsnaʔəm for use in file naming conventions (though cəsnaʔəm would be used in exhibit texts and writing). We used this abbreviation in our meeting agendas and notes, our design sketches, and even while no one would likely see it, we advised Tan to use csnm in the code. The proper rendering became a greater issue when publishing papers on ḥəlewkʷ — Belongings. In some instances we had to change fonts from the approved templates provided or send screen shots to the publishers to make sure the letters and symbols rendered correctly.
Lastly, I also visited Musqueam to take photographs for the tabletop. Many of the photos used for the tabletop (and in the rest of the MOA exhibit) were actually taken by community members, showing family, elders, and day-to-day activities. There were certain aspects to the design and portions of the content, though, that either required a staged shoot or images that were not available. I attended a weaving workshop at the Musqueam Cultural Education Resource Centre to photograph the activity, the traditional looms, and expert weavers from the community. Rowley, Wilson, and I also walked along the foreshore and nearby woods to photograph the area and important plants. Wilson and I also worked with the Musqueam Fisheries Commission to photograph the fish preparation process, which I will discuss in more detail in the next two sections.

3.2.8. Inspiration & Fish Processing

By the time that Matkin and Eckersley joined the development team, we had established that we would have both ancient and contemporary physical belongings with some sort of activator ring to manage all of the different belongings on the table. We had also modified the number of information categories and related interactions from five to four. Yet we still had not decided what the underlying digital display would be for the tabletop.

We had started with the map idea, but then realized some belongings might not have specific locations. This would be confusing to visitors, perhaps giving them a false sense of archaeological accuracy. We also considered having belongings match the material from which they were made (a belonging made from an antler would pair to a deer) or where it was used (the stone net weight was used in the river). We also considered using an illustration of a longhouse, but that would not support the representation of contemporary Musqueam life that the exhibit focused on. An ancient village scene would not work because we did not have that information and the project was not about archaeology anyway. We also considered simply going with a texture. In this discussion, we also came up with the idea of vignettes, tabletop scenes with a top-down perspective.
After much discussion around Antle’s dining room table, we landed upon salmon fishing. We were inspired by the fish cutting table of Sonny Williams of the Scowlitz First Nation, which I photographed as part of a project that the Making Culture Lab was working on up the Fraser River with the Stó:lō Nation (See Figure 3). Sonny’s fish cutting table was simply a blood-soaked towel covering a board, which was laid across an old backyard grill. As modest as this set up seemed, Sonny and his father swiftly cut and cleaned dozens of fish while telling us stories of fishing in the Stó:lō territory as we photographed and filmed.

Hennessy and I eagerly shared the photos with the tangible table team while we were discussing possible tabletop vignette scenarios. The activity of cleaning fish is one that would be unfamiliar to many people, so it would be interesting to visitors to learn about what was happening if we use such a scene for the underlying digital image. Many of the ancient belongings from ʔə̓snaʔəm were related to fishing, as well, and could easily interact with a more modern visualization of salmon processing. The team agreed that this type of fish cutting table would be a wonderful way of showing the continuity of Musqueam’s fishing culture and how these traditions are carried out today. The Exhibit Advisory Committee also liked this concept.
3.2.9. **Final Fish Image**

The development team decided that we would need to photograph a fish cutting table at Musqueam for this shoot. This also required us to finalize our selection of ancient and modern belongings, as well as the areas of the fish cutting table with which each belonging would pair. Rowley and Wilson were responsible for creating the content for the table, so it was ultimately their knowledge and suggestions that guided which belongings would be used based on the stories the table would communicate to visitors, and how these belongings would match up to the table.

Once we knew what elements would be included in the fish cutting image, Wilson contacted his uncle, who is part of the Musqueam Fisheries Commission, about helping with the photo shoot. After one of our design meetings, Wilson and I picked up camera equipment and headed to the Musqueam reserve. We met Morgan Guerin, another member of the Musqueam Fisheries Commission and one of the community members.
who contributed to the exhibitions, across the street from the band office at the community smoke house.

We selected a location to set up the table and camera, and Guerin began thawing a fish for us to use. Wilson and I began by photographing the additional elements of the image that would surround the table, then Guerin brought the salmon over and slowly began cutting the fish. The different parts of the image were later combined in Photoshop, resulting in the final image you see in Figure 4.

![Figure 4. The final fish-cutting image for the ʔeləw̓ikʷ — Belongings tabletop. Photo courtesy of the author.](image)

### 3.2.10. Replicating Belongings

Rowley and Wilson selected the six ancient belongings that we would be replicating, so these belongings needed to best tell the stories of Musqueam practices and continuity of culture. We also needed to decide just how we would be replicating the belongings, since allowing visitors to handle the actual ancient belongings would not be possible. Eckersley was in charge of researching and determining our best options for this process. She contacted both our SFU SIAT Solid Space Fabrication Lab as well as Vancouver MakerLabs to inquire about 3D scanning and printing.
The development team toured Vancouver MakerLabs to learn about the facilities and our options for working with them on the replicas. We quickly realized that the downside to the facilities available to us would be the low resolution 3D printing. The examples we encountered at MakerLabs (which would be similar to what we could accomplish at the SFU facilities), while visually satisfactory, would not be able to replicate the texture and feel of the belongings. The tangible experience of visitors was very important to us, and we knew we wanted higher fidelity replicas than scanning and printing could offer on our tight deadline.

Eckersley then explored our options for making molds ourselves or hiring a professional mold maker. Through the professional contacts of MakerLabs, we were able to meet with Raj Mariathasan, a special effects makeup artist who was skilled in prosthetics, where we discussed the project showed him some sample belongings, and reviewed his work. Given Mariathasan’s experience and schedule, our timeline and desired outcome, and the ability for the mold making to occur in MOA (rather than completing the process outside of the museum and taking the belongings out on loan), it seemed that molds would be the best option for us.
Figure 5. Mariathasan and Rowley cast replicas of ancient belongings. Photo courtesy of the author.

The Musqueam Indian Band gave permission for molds to be made of the original belongings. The mold making occurred over two consecutive weekends at MOA, with one weekend spent making the molds and one weekend primarily for the casts. Rowley and I were present to observe, help, and document the process (See Figure 5). We did come across some issues in creating the casts, as the intricate shapes led to some air bubbles. Mariathasan took the finished molds and created the casts at work where we had access to additional specialized tools.

Eckersley and I met with Mariathasan again to collect the molds and replicas. Mariathasan then further advised us on how to hand paint the replicas to create the most realistic appearance. Eckersley and I later met over the course of a week to prime and paint the belongings, referring to the images on the RRN to match the painting exactly to the original belongings.
Six modern belongings were also selected for use alongside the ancient belongings on the tangible table (See Figure 6). This was one of our key design decisions – to include both ancient and modern belongings as a way to show how common the ancient belongings were in everyday life and to get visitors thinking about their importance. Eckersley also worked to incorporate modern belongings into the realistic look and feel of the table. She ultimately decided to coat the modern belongings in resin or sealant achieving a realistic look and feel, but also giving them the durability to withstand the regular handling of being on display in a museum.

![Image of twelve belonging replicas](image)

**Figure 6.** The final twelve belonging replicas. Photo courtesy of the author.

Lastly, each belonging needed a fiducial marker on the bottom to interact with the table. Despite being small in size, this connection to the table had great importance in the proper functioning of ʔeɬəw̓kʷ — Belongings. It was through these tags that the SUR40 table recognized each belonging and that the tangible interactions could take place. Yet our development team did encounter some difficulties in designing these tags.

Eckersley was in charge of the initial design of the fiducial markers, which are patterns of white dots on a black background that the table can detect and identify, while I worked with her on the fabrication of the tags. One of the design challenges was to keep the fiducial markers inconspicuous, so as not to take attention away from the belongings themselves, but the markers still had to be recognizable to the table.
Based on suggestions by Tan, who was familiar with the fiducial markers from Antle’s previous work on the *Youtopia* tabletop application, Eckersley modified the original square shape. She trimmed the edges to decrease the overall size of the markers, and for some of them, she was able to cut the marker in half.

Once we were sure of the size of the fiducial markers, we also needed to make sure the IR sensors of the table could recognize the tags. This meant that we needed to test the materials that we were using. For instance, some types of black paper had fibers that that table would pick up, thus interfering with the clear reading of the white dot pattern. We investigated IR paints, which turned out to be too costly and difficult to acquire with enough time for testing. Instead we tested combinations of tinted acrylic bases, paper tags, and paper coatings.

Even after this testing, we encountered issues with the markers behaving properly with the *ʔələw̓kw̓ — Belongings* system. At first we thought this was due to the way the markers and belongings were designed. Because the belongings were slightly raised off of the table, there was light reflecting under the belongings. The brightness of the table also seemed to be a factor. The initial version of the code may have contributed as well, though, and the problems we had with the tags improved after we updated the code.

### 3.2.11. Connecting the Digital to the Physical

As we focused our design around the fish cutting image and the final set of twelve belongings, we also had to determine how exactly visitors would access all of this information and how it would be organized. We had established that there would be an activator tool for the belongings, and some sort of digital interface that would connect each belonging to its four categories of information.

From insight drawn from Antle’s previous work, we knew the activator tool would help control the belongings on the table and limit the number of possible belongings in use at any given time. Controlling the belongings would be necessary given the physical size of the table and our plans for having information appear on the table next to the belongings; there simply would not be enough room if more than a few belongings were
in use. Limiting the number of activator rings would also encourage interaction and collaboration among visitors, which we wanted to emphasize.

We had discussed a number of options for the design of the activator tool. At one point, we had thought about using a cedar base that all of the belongings could fit into, though that was ruled out. We quickly realized such a base would block the underlying image, and putting the belongings on a pedestal of sorts would lose the authenticity we were trying to achieve. We were also trying to incorporate cultural forms into the design of the activator ring, but nothing seemed appropriate. The spindle whorl would have been the wrong scale and context, using an ancient bracelet would have been confusing with the other belongings, and tying the Musqueam logo would have been too much branding. Even simple tree rings felt a bit contrived. Our preferred design ended up being the simplest: a ring with hən̓q̓əmíʔəm terms etched into it.

To reconnect the day-to-day cultural practices to belongings both ancient and modern, we focused on the following concepts: stem təʔiʔ (What is this?), təɬəʔet (Understanding it), snəʔ eyəɬ (Teachings since childhood), and cyəʔes (Having stories). These are the four categories etched into the activator rings (the translations slightly modified to fit the size of the physical ring) and that appear in the digital ring interface around the physical ring (See Figure 7).
Each category is accessed through a different set of interactions with the table. When a visitor successfully completes the interactions, information will appear on the table in the form of text, contemporary images, historical documents, and quotes from community members (In the original design, images and quotes would appear on the monitors around the table as well). These interactions include putting a belonging into the ring to learn about belongings’ form and function (What is this?), connecting the belonging to its corresponding portion of the fish-cutting table image (Understanding it), matching ancient belongings with its modern personal item (Teachings), and ultimately unlocking stories from Musqueam community members about the process of learning and their traditional culture (Having stories).

The information that appeared for each belonging came from a variety of sources. Some were historical images and documents, while others were photos both old and contemporary provided by Musqueam community members. I took additional photographs as needed. The quotes from community members came from interviews for the exhibition that were filmed by Elle-Máijá Tailfeathers. The videos accessed when visitors completed the first three categories were also edited from these interviews.
The connections between the belongings and the table, and between ancient and modern belongings can be quite complicated. To simplify this web of connections and information, an example of two of these belongings and how they pair together are detailed in a flowchart in Figure 8.

**Figure 8. Interaction flowchart for ʔeləłw̓kʷ — Belongings**

This flowchart depicts the ways in which the ancient adz and the contemporary Coke can are introduced, connected to one another, paired to areas of the fish-cutting table, and overall share stories from community members. When you first place one of these two belongings in a ring on the table, text and images appear explaining that the belonging is a Coke can along with information about the Coca-Cola Company or that it is a jadeite adz that was used for carving. In the *Teachings* category, the Coke can and adz pair to one another to tell the story of historic trade routes of the Musqueam and Coast Salish people along with a comparison to contemporary global trade networks. For *Understanding it*, the Coke can matches to the salmon fillets to reveal information.
about the changes in traditional Musqueam diet brought about by issues such as access, overfishing, and pollution. When visitors connect the adz to the axe, its modern counterpart, they learn about how the adz was traditionally used, the long history of carving, and the importance of carving in the community. Text and images appear to share the stories of building boats and long houses. When a visitor is able to complete the interactions for *What is this?*, *Teachings*, and *Understanding it*, they can then access *Having stories*, which plays a video of a community member sharing their own stories and lived experiences with the historical traditions and contemporary issues that were raised in the previous categories.

### 3.3. Beyond the Installation

Our work with ʔeləw̓kw̓ — *Belongings* was not complete at the opening of ʔəcsmə̱m — *the city before the city*. We did have a working version of the tabletop application installed for the opening, but given our short timeline for its completion, we planned for continued work, updates, and improvements on the table along with visitor studies and academic paper publications. I will now describe the opening of the exhibition, the state of tabletop at this time, our continued work over the course of the exhibition, and the studies we conducted.

#### 3.3.1. Opening

All three institutions planned their opening events for the same week of January 2015, with MOV’s event on Wednesday, Musqueam’s on Friday, and the MOA opening in the afternoon Sunday, January 25 from 1-4p.m. Over 800 people came through the doors at MOA on the day of the ʔəcsmə̱m — *the city before the city* opening. People gathered in the Great Hall for to hear Musqueam elders, community members, and the director of MOA speak. There were also performances by the Coastal Wolf Pack, a group of traditional Coast Salish singers and dancers, and hands on demonstrations of wool weaving and cedar bark rope making.
3.3.2. Continuing Improvements

ʔelew̓ikʷ — Belongings was installed on time and ready for the opening. Yet we had not been able to thoroughly test the tabletop application before the exhibition opened, and we knew there were certain concerns we wanted to address. With the exhibition running for one year, we planned to update and study the table over the course of the exhibition.

The successful and busy opening provided us with a wonderful opportunity to observe both adults and children using the tabletop at peak capacity. While we knew the gallery would not be as crowded during regular hours, we were able to identify which tasks we needed to prioritize. One week after the opening, we held a meeting at MOA on the weekday they were closed to visitors. We gathered around the table to discuss our next steps, both immediate and less urgent.

Some of these more urgent fixes included troubleshooting the speakers, which would shut off after a short period of time. There were bugs in the software that needed to be fixed. The fiducial markers needed to be coated to better handle wear and tear, and other belongings needed slight modifications to withstand regular handing in the museum. Our longer-term goals included rewriting the program to better handle the events that are triggered when visitors use the belongings on the table and to revisit the interface design. We quickly addressed the more immediate needs, but our longer-term action items took more time to complete.

Rowley’s presence at the museum was essential for knowing what was working with the table and what was not. In this way we learned that the system was crashing regularly, an issue that Tan was able to resolve. We also discovered that the images that were supposed appear on the monitors when visitors accessed the different categories were delayed and could prevent the community member video clips from playing. As mentioned, we originally had other content for the monitors that would appear as visitors worked through the first three categories of the ring. For example, when the basic What is this? information appeared on the table, the monitor would show other related belongings from LOA. When Teachings, and Understanding it were accessed, the monitors would show still photos along with quotes from community members. We
ultimately decided to remove the additional images to ensure the videos could play without any problems.

We had also initially considered placing the belongings around the edge of the table, potentially using a string to physically connect them to the table. We found the museum cart to be very effective though. Underneath each belonging on the cart was a small Ziplock bag, one of the very same ones used to store belongings in the collection of the Laboratory of Archaeology. Inside the bag was an image of the belonging and the belonging’s name in hən̓q̓əmiʔən. Visitors themselves would keep the area tidy by placing belongings back on top of their proper place on the cart.

There were also some aspects of the table that we hoped to implement after opening but were unable to. One of these was the inclusion of hən̓q̓əmiʔən audio clips. We used hən̓q̓əmiʔən terms wherever possible, but many people do not know what the symbols of the North American Phonetic Alphabet sound like. Our original plan for the table would have made it possible for visitors to touch all of the hən̓q̓əmiʔən words, and the table would play an audio clip of the spoken hən̓q̓əmiʔən. We had planned to find the audio clips for the specific words on the tabletop through the UBC First Nation and Endangered Languages Program. The way the recordings were originally made, however, would make it difficult for us to find and create the specific clips we needed without additional support.

During the summer, once we had a modified and more stable version of the application, we ran the planned visitor study to see how well we met our design goals. This visitor study was conducted in August 2015 and will be described later on. After this initial study, Matkin worked closely with Tan to rebuild the software, made changes to the interface, and undertook a second study in December 2015 and January 2016. The details of this study will be included in Matkin’s thesis, forthcoming.

3.3.3. Sharing Our Research

After the exhibition opened, čəsnəʔəm – the city before the city was gaining recognition and awards, including the 2015 Governor General’s History Award for Museums, the 2015 Public History Award from the Canadian Historical Association, the
2015 Charles Redd Award of the Western Museums Association for Exhibition Excellence, and the UBC Library 2016 Innovative Dissemination and Engagement Award. Rowley and Wilson were keeping quite busy with media engagements discussing the exhibition overall. At the same time, those of us from the design team at SFU began exploring opportunities to share our work and our research on ʔeləw̓kʷ — Belongings as well. This included magazines, conferences, journal papers, presentations, and photographic exhibitions. Some included more traditional forms of academic research such as qualitative research studies, but we also presented work in newer and more exploratory formats for research including pictorials.

Some of the early publicity for ʔeləw̓kʷ — Belongings occurred through SFU channels. Antle and Hennessy were interviewed for SFU News, which offered more visibility for our project within the SFU community. I also presented on our design process at an SFU graduate research seminar on Indigeneity. Presenting alongside researchers working on Indigenous issues in the education system and problems facing Indigenous species of butterflies, I was again able to introduce our process and project to a broader SFU audience and begin thinking about how to best explain our complex system in presentation format.

We were able to publicize our work in a longer article for BC History Magazine, which also showcased the table on the cover. This article briefly described the history of the project and offered an overview of the tangible table while touching on the ways we addressed the complex history and contemporary issues in our design.

A series of photographs that I took for the tabletop were selected to be part of the Vancouver Capture Photography Festival 2015. As part of the festival, the Canada Line collaborated with čəsnaʔem – the city before the city to showcase Musqueam-related photography at each of the Canada Line Skytrain stations from the Vancouver International Airport to the downtown Waterfront Station. Hennessy had been invited to curate the selection that would be installed at Waterfront Station, so together we edited a series from the photographs I had taken while working with Wilson and the Musqueam Fisheries Commission, and Hennessy wrote a curatorial essay to contextualize the photographs.
The installation was titled *snəwəyəɬ (teachings)*, and the series of images showed the tools and technologies used in the processing and preserving of salmon, such as axes, hoses, containers, knives, sharpeners, and the smokehouse. Also shown were the natural resources at the heart of this activity: wood for generating smoke and heat from the land on Musqueam territory and salmon harvested from the Fraser River. Much like the continuity of culture that we highlighted in the tangible tabletop, *snəwəyəɬ (teachings)* expressed how these teachings guide the fishing technologies that are used to feed and sustain Musqueam families. Salmon and their life cycles have been intricately connected to Musqueam life ways for millennia, and the ancestral knowledge that has stewarded salmon and the river itself continues to be shared today.

We also presented our research in more traditional academic venues such as peer reviewed conference proceedings and journal articles. Our first conference presentation was at Electronic Visualisation and the Arts (EVA) London, 2015. While there is a strong presence of electronic artists at the conference, nearly a full day showcased the work of cultural heritage scholars. Our paper presentation of *ʔeləw̓kʷ — Belongings: A Tangible Interface for Intangible Cultural Heritage* won the Ashgate Publishing Best Presentation Award.

We later extended our EVA paper to include some of our initial visitor study findings and published it in CITAR Journal of Science and Technology of the Arts at the end of 2015. We also submitted and presented our work in the new image-focused pictorial track at Designing Interactive Systems (DIS) in Brisbane, Australia, June 2016, in our work *Design Interactions in ʔeləw̓kʷ — Belongings*. Lastly, we are finalizing a new paper on our visitor study, which will be submitted to one of the leading human-computer interaction conferences. These three works will be described and contextualized in more detail in the following chapter.

3.3.4. Visitor studies

Three main visitor studies of *ʔeləw̓kʷ — Belongings* took place during the run of ʔəsnaʔəm – *the city before the city*. The first study was conducted by UBC students, while the second and third studies were conducted by Matkin and myself. The second
and third studies informed further iterations and updates to the tabletop application, and will also serve as the foundation of Matkin’s master’s thesis work. I will describe the second visitor study to help contextualize the research papers I will present in the next chapter.

**Initial UBC Visitor Study**

UBC museum studies students conducted an initial visitor study of ḵ̱eləw̓kʷ — *Belongings* and also the Kitchen Table portion of the exhibit was conducted by in March 2015. Researchers interviewed 11 people and 36 people filled out questionnaires in the gallery space over the course of one week.

People tended to prefer the interactive exhibit style over conventional presentations, however they would have liked more clarity in the instructions for the tangible tabletop. Along with larger, clearer instructions to improve visitors’ learning and overall experience of the tangible table, the researchers also noted that some visitors suggested a museum attendant could be stationed near the table to offer assistance.

While this study was valuable to us in that the UBC researchers were unbiased and unfamiliar with our design, the study did not impact our own studies, which were focused on evaluating the success of specific design decisions and strategies.

**SFU Visitor Studies**

As I discussed in the previous chapter, one of our very first collaborative activities was to outline our goals for the tabletop. Our initial list had nine key points. As Antle, Matkin, and I began to plan the visitor study, we streamlined these goals to better reflect the design aspects of the table that we wanted to evaluate. We reframed these as five interrelated design goals that were intended to enable visitors to experience cultural values through their interaction with ḵ̱eləw̓kʷ — *Belongings*. These revised design goals included:

1. **Draw in Visitors.** Our first goal was to draw visitors into the space and interact with the table. Since the table was part of the larger exhibition, we needed to attract people and encourage them to engage with our system.
2. Learn about Musqueam Culture. We wanted people to learn something new about Musqueam people and the continuity of their culture.

3. Understand Richness of Belongings. We also wanted visitors to understand the richness of information about Musqueam’s ancient belongings including how they were used and how important they were in daily life.

4. Understand Complexity of Stories. We wanted visitors to understand the complexity of information related to belongings excavated from čəsnaʔəm. These belongings and the practices associated with them carry stories about Musqueam cultural practices past and present.

5. Experience Cultural Values. Our goal was to have visitors experience values through their interaction, rather than explicitly telling them about Musqueam cultural values.

For this study specifically, our overall research question was: What are effective design strategies that enable visitors to directly experience cultural values while they interact with indigenous knowledge using a tangible tabletop system? Through the design process, we developed strategies and made choices to achieve the design goals, which then informed our study interview questions.

The visitor study of ʔeləw̓ kʷ — Belongings was conducted in the MOA gallery space where the tabletop was installed during August 2015. The study included observations and open interviews with twenty-four visitors and took place over the course of two weeks. Signs alerting visitors to the study were posted at the front desk of the museum as well as near the tabletop. We collected data from eleven men and thirteen women ranging in age from eighteen to over fifty years old.

As researchers, we observed visitors using the table, taking notes on visitors around the table. When a visitor was able to put a belonging in a ring to access What is this? and had spent at least two minutes at the tabletop (a benchmark inspired by Block et al., 2015), one of us would approach the visitor and ask them if they would be willing to participate. If the visitor agreed, we would step aside as they continued their exploration of ʔeləw̓ kʷ — Belongings. Visitors would occasionally decline to participate, some giving reasons relating to time or English language ability. If they agreed, when visitors had finished using the tabletop, they filled out a brief questionnaire collecting
demographic information and completed a structured interview lasting 10-20 minutes seated in the gallery space.

We formulated the interview questions to explore visitors’ experiences related to the design goals described in Section 3.2.4. This would allow us to draw preliminary answers about how to design effectively such that visitors can directly experience cultural values through tangible interactions. We asked visitors about their experiences in order of their interactions with the system, from the entering the space and engaging with the table, to learning basic information, and later to deeper learning and the experience of cultural values.

In terms of the way our study and interviews were structured around these goals, our observational notes provided insight on how visitors entered the space and began engaging with the table (or did not). Once we began the interview, our first questions addresses what exactly visitors learned about Musqueam culture and how they learned this (e.g. *What was something that surprised you about Musqueam culture that you didn’t know before?*), which related to our second design goal. We asked questions about what visitors thought the objects represented, why they thought we called them belongings, and if they saw any relationships between the four categories on information for each belonging (e.g. *While using the table, you placed different objects in the ring. What do you think those objects represent?*). These questions related to our third and forth design goals. Lastly, we asked visitors about what they learned around the values of Musqueam people and also how they learned this (e.g. *Can you describe what you learned about Musqueam values that you didn’t know before? How did you learn this?*). We also followed this up by explicitly telling them that one Musqueam value is that cultural knowledge should be treated with respect and then asked visitors to describe if/how they might have experience that with the tabletop.

Interviews were audio-recorded and later transcribed. Antle, Matkin, and I individually analyzed the transcriptions using open coding, drawing out emergent themes. During this individual process, we each went through two passes of the interview transcripts. In the first pass, we identified themes, looking for those that related design features with visitor responses or behaviors. We placed particular emphasis on
common, interesting, unexpected or indicated problems with the design. In the second pass we more clearly formed a description of the themes and looked for relationships among them. We then later met as a group to compare themes that we had identified. We had inter-rater agreement on all except one, for which we discovered we had used different terms to describe the same elements. Without delving too deeply into the analysis (which is included in Designing Cultural Values into Interaction in Appendix C), I will give an overview of our findings in relation to our design goals.

Our first two basic goals were that people would be drawn into the area with the table, interact with the tangible table system, and learn something new about Musqueam culture. We found that three design features contributed to achieving these goals. The visually interesting salmon cutting slide show on the wall-mounted monitor and the fish-cutting image on the tabletop were successful in bringing people into the space and conveying basic information about Musqueam life. The belongings also attracted visitors and immediately informed them about Musqueam culture with the mix of ancient and modern belongings. In particular, all participants understood that the Musqueam people were a fishing society in the past, that they still live in Vancouver today, and that they carry on these fishing traditions.

The second two design goals were about visitors gaining a deeper understanding about the richness of information represented by belongings beyond the basic identity and function and about the complex stories and present day issues related to the belongings. Three design features were particularly successful in achieving these goals, with the juxtaposition of ancient and modern belongings, the high fidelity of the replicas, and the complexity of the interactions needed to access all four categories of information about each belonging.

The final design goal was that visitors would experience Musqueam cultural values through their interactions with the table. The values we focused on were that cultural knowledge should be earned and treated with respect, the importance of the hən̓q̓̑əmin̓əm̓ language, and the notion that belongings still belonged to the ancestors. Without meeting our first four goals, it seems unlikely we would have met this goal. As visitors entered the section of the exhibition with Ḵ̓eləw̓向往 — Belongings, interacted with
the belongings, and began to see the complexity of information available, they were cued to these cultural values. We purposefully made the replicas available for visitors to touch and handle, which would normally be enclosed behind glass and only be accessible to museum staff. We identified the activities and information categories on the activator ring and the digital ring interface using both the həʔqəmíʔəm language and English, created depth and breadth of content through non-linear layers instead of linear game levels, and showed progress so that visitors could see how much information they could potentially learn about a belonging. People did indeed recognize and understand values in their interactions with ḥełəw̓ kʷ — Belongings, specifically in the care they took with handing the belongings and the time and effort spent with exploring the table and the categories of information.
Chapter 4.

Research Papers

In this chapter I will introduce and draw up the case study to contextualize three of the papers we collaboratively wrote on ʔeləw̓kw̓ — Belongings. From the design process I described, these papers are the research outcome of the collaboration. Each paper appears in full in Appendices A, B, and C.

To address the appropriateness of including collaboratively written works in my thesis, I will note that I was lead author for all three of these papers. Naturally I received input and support from Hennessy and Antle as my supervisors, Rowley and Wilson as curators and colleagues, and from Matkin as a fellow designer and researcher. Their support and input on these papers is similar to their support and input on this thesis as a whole.

4.1. CITAR Paper

We published ʔeləw̓kw̓ — Belongings: Tangible Interactions with Intangible Heritage (See Appendix A) in the CITAR Journal of Science and Technology of the Arts at the end of 2015. As I noted in the previous chapter, the basis for this journal article was the award-winning paper that was well received at EVA London earlier that summer.

The EVA paper was our first academic paper written on ʔeləw̓kw̓ — Belongings; in fact, we submitted an abstract for acceptance before the exhibition even opened. As such, the paper focused more on the concepts and ideas that we were concerned with during the design process. In this paper, we discussed the design of the interactive tabletop, specifically highlighted the tensions between fragmentation and continuity that
become apparent in discussions of access and preservation of intangible cultural heritage in the digital age.

In the CITAR journal article, we kept this initial exploration of the tangible tabletop interface as a response to the desire to reconnect fragmented collections and physical belongings from čəsna?əm with Musqueam intangible cultural knowledge. We then extended the original paper to include some of the findings of our first visitor study, specifically focusing on aspects of the visitor study as they related to continuity and fragmentation. This includes our goals to convey continuity of culture and the complexity of information around each belonging. This updated article was published in CITAR Journal of Science and Technology of the Arts at the end of 2015.

4.2. DIS Pictorial

We also presented our research in newer, more exploratory forms of academic publications. Specifically, we submitted and presented our work in the new pictorial track at Designing Interactive Systems (DIS) in Brisbane, Australia, June 2016. DIS explores the various dimensions of design as an activity and is attended by designers, design researchers, ethnographers, psychologists, and engineers. This visual research format of the pictorial recognizes the importance of photographs, illustrations, diagrams, flowcharts, and sketches in scholarship. With so many photographs from the design process of the tangible table, we had much imagery to work from.

We focused our pictorial, Design Interactions in ?eləw̓ kʷ — Belongings (See Appendix B), on the key interactions between our development team and the Musqueam cultural knowledge we were trying to convey through the table. We also visualized the main interaction sequences required of the visitor when exploring the tabletop.

As for the interactions with Musqueam cultural knowledge, we highlighted two key examples of such collaboration: our photo shoot with the Musqueam Fisheries Commission and the time spent with the ancient belongings to faithfully replicate them. This also provided an opportunity to share additional photographs we had from these processes. While I was photographing Guerin cutting the fish, Wilson was also
documenting the shoot overall. As for the making of the belonging molds, both Rowley and I attended during the two weekends while Mariathasan worked. Again, I photographed the entire process.

We also visually described the main interaction sequences with the table. Since this was a pictorial format, rather than using words to explain the interaction patterns, Matkin and I developed the flowchart in Figure 8 to depict how the belongings connected to one another and the table.

4.3. HCI/Tangible Computing Submission

At the time of this writing, we are continuing to edit our paper detailing the first visitor study. This goals and scope of this study are in line with research presented at the ACM Conference on Human Factors in Computing Systems (CHI), one of the leading HCI conferences. This is where we plan to submit Designing Cultural Values into Interaction (See Appendix C).

With this focus in mind, the paper is framed as a design rationale and evaluation. The August 2015 visitor study that I describe in the Chapter 3 serves as the foundation for this paper. We first outline our design goals and requirements based on the exhibition context. We then describe the system, offering examples of why we made certain design decisions before introducing the visitor study itself. We then share our results, looking at how visitors responded in terms of engaging with Musqueam culture, understanding the richness and complexity of the belongings, and recognizing Musqueam values. Finally, we offer seven related design suggestions for designers who are employing a tangible interface in the context of learning about cultural heritage.
Chapter 5.

Discussion & Conclusion

5.1. Summary

This thesis contributes a case study of the collaborative design process of researchers, designers, curators, and the Musqueam Indian Band in the development of ʔeləw̓kw — Belongings. This case study then offers the background for the research papers, both published and forthcoming, that serve as the research outcome of this tangible tabletop collaboration in an academic context.

One of the research questions I address in this thesis is: What does collaboration look like when developing an interactive tangible tabletop to convey cultural values through tangible interactions? The case study I present directly responds to this question, as do two of the research papers presented.

The background on museum collaborations with Indigenous communities along with the development of the RRN highlight the continuing relationship between the Musqueam Indian Band and MOA that allowed for this project and this case study to even occur. The case study itself describes our design process, noting in particular the aspects of our process as well as design choices that occurred as a result of our collaboration. This case offers new descriptive detail to the existing literature and research in the areas of collaboration with Indigenous communities and tangible computing. The collaboration was the result of, and contributed to, an historic and award-winning exhibition. This case study will inform those who are designing for heritage institutions, museums, or with indigenous communities, or who are interested in časnaʔam – the city before the city. It also offers a close look at the design process for tangible computing when an important layer of cultural knowledge and values are added.
Two of our papers also addressed this question of what such a collaboration might look like. Our first paper, ᓲเอกʷ — Belongings: Tangible Interactions with Intangible Heritage (Muntean et. al, 2015a), was an overview of the tabletop, written shortly after the exhibition opening. Here we detailed the history of čəsnaʔəm and the project, addressing the issue of fragmentation and dispersal of ancient belongings and museum collections along with the issue of how to convey continuity of culture. We then describe how we incorporated these ideas into the tabletop design. Design Interactions in ᓲเอกʷ — Belongings (Muntean et. al, 2016), our DIS pictorial, shifts focus from the ideas that came from the design process to the actual activities and visual documentation of the design process.

The second research question that this thesis explores is: Can museum visitors learn cultural values through tangible interactions with a digital system? The case study includes the first visitor we conducted to test this. We observed and interviewed visitors in the museum gallery to see and hear about their experiences interacting with the tangible table and Musqueam cultural knowledge and values. Our final paper, Designing Cultural Values into Interaction (unpublished), presents and analyzes the data collected from the visitor study. They could name specific details they learned about Musqueam culture and understood the long fishing history of the community. They could recognize the complexity of information about the belongings, and many understood the specific value of treating cultural knowledge with respect from their experience with the tabletop. We found that while there was room for improving our system, visitors can and did learn Musqueam cultural values through their interactions with ᓲเอกʷ — Belongings.

Another question we often considered when discussing the design of ᓲเอกʷ — Belongings is: Was the design successful? Yet there are different ways address this question. The idea of success in this project differs whether we consider the design as the final outcome or the design as the process.

In terms of the design outcome, the ᓲเอกʷ — Belongings tangible tabletop itself, we drew on previous research to support our design and final installation. Our overall concept of the traditional practice of salmon fishing evokes the idea of cultural forms (Horn, 2013). While fishing might not be a familiar practice to all of the visitors, the
concept clearly conveyed the importance of the activity to Musqueam culture and could draw on visitors cognitive, physical, and emotional resources and reactions (Hornecker, 2008; Antle et al., 2011b; Speelpenning et al., 2011). Through this fishing concept, we drew visitors into the space and then invited them to engage with the information through the exploration of different layers of information (Allen, 2008; Ciolfi & Bannon, 2003; Gammon, 1999; Hornecker, 2008). Moving beyond a simple question-answer format, we designed for visitors to explore the depth and complexity of the multimodal information (Giacarrdì & Palen, 2008). We encouraged this exploration by designing early successes into the system, such as basic What is this? information appearing when a visitor puts a belonging into a ring (Allen, 2008; Ciolfi & Bannon, 2003; Gammon, 1999; Hornecker, 2008). These early successful interactions also serve to teach visitors basic background information and context to then uncover and understand the more complex interactions and meanings in ʔeləw̓kʷ — Belongings (Chu et al., 2015).

Our design decisions were based on both our specific project goals and requirements and influenced by these concepts drawn from related research. Based on the visitor study described in this thesis and analyzed in Designing Cultural Values into Interaction, we were able to communicate the complexity of belongings, continuity of culture, and the values of earning knowledge and treating cultural knowledge with respect. In terms of our design goals then, we were successful. As described in further detail in the paper, we do recognize some limitations in the tabletop at the time of the August 2015 visitor study. The key limitation I am referring to is that the system was too difficult. While we intentionally designed the system to be complex and difficult to help convey ideas of treating knowledge with respect, learning through trial and error, etc., we needed a better balance between the level of challenge for visitors and their ability to understand how to use the tabletop. Matkin addressed this limitation in the modifications he made before the visitor study conducted December 2015 through January 2016, and further analysis of this study is in progress.

This concept of success changes as we shift focus from the tangible tabletop design to the collaboration process with the Musqueam Indian Band and MOA. Our collaboration on ʔeləw̓kʷ — Belongings is not necessarily a model of this idea of museums as a contact zone (Clifford, 1997), but the collaborative design of the tangible
Tabletop certainly exists within the context of Musqueam and MOA's relationship that extends far beyond consultation. Reflecting on the warnings of Boast, we see that Musqueam and MOA have worked together to avoid a neocolonial relationship (Boast, 2011). Over the years the two revisited ideas of ownership and stewardship of ancient belongings and applied for funding together for joint projects.

Wilson addresses the activities and gatherings of the Exhibit Advisory Committee in his thesis. He speaks from the perspective of a curator, focusing on the process of gathering with Musqueam Elders to address questions, concerns, and overall development of the exhibitions. Highlighting these power relations in the context of planning ʔə̲snaʔəm – the city before the city, he writes:

To my mind, this approach is a result of the agency and authority of the advisory group members; as curators or 'researchers' we simply respected their leaderships and depth of knowledge. In other words, we did not afford them power as much as they commanded it by refusing to be reduced or undervalued as informants or suppliers of data. Simultaneously, this gathered together approach is also a result of the community steering the overall exhibit development: this process was established to adhere to the Musqueam community protocols, of which listening to Elders is critical. The approach we used—gathering together and listening to Elders—is as much a result of Musqueam asserting its agency as it is the exhibit partners (MOV, MOA, and the University of Waterloo) relinquishing power and decision-making capacities (Wilson, 2015, p. 20).

While Wilson speaks to the overall development process of ʔə̲snaʔəm – the city before the city, in this thesis, too, I describe how Musqueam voices become the authority in ʔə̲leə̲w̓kʷ — Belongings as part of MOA's installation. The process of designing ʔə̲leə̲w̓kʷ — Belongings involved working with both the community and the museum to highlight Musqueam voices, values, and concerns, and to offer another opportunity to rework relationships that have been historically marked by inequality and asymmetrical power structures. Success here does not necessarily mean perfection in the activities around collaboration or the outcome of the project overall; instead this continuing relationship, this exhibition partnership, and the existence of this project at all are indications that First Nations, museums, and educational institutions in British Columbia are open to reflection on the history of their relationships and reimagining what these relationships can be moving forward.
While we consider the development process and overall design successful, we do recognize there are areas where we faced constraints or could have improved. One example is the delays in updating the table after it was installed. We waited for the system to be rebuilt before revisiting the interface design and running visitor studies. Once the improvements were made late in the year, the early and informal review of our second round of studies indicated that the updated system was easier for visitors to use. While MOA is a research institution, and we did learn much from our visitor study, it would have been more effective overall to have made these revisions sooner so that more visitors would have benefited from the updates.

Another limitation we recognize is that while we have a visitor study examining our design goals, Musqueam community members never evaluated ʔeləw̓kw̓ — Belongings. For research purposes, interviewing First Nations can complicate the ethics approval process at the university level. This was considered at the time of the ethics application, but we ultimately decided to streamline the process by focusing on the design goals rather than lengthen the process of applying for ethics approval at two institutions. As stated before, though, the design process was successful because of this collaboration with the Musqueam community; yet, seeking feedback on the project remains a direction for future work.

5.2. Ongoing Research

We conducted our final round of visitor studies shortly before the close of ̕əsnaʔəm — the city before the city at MOA. This second visitor study was conducted to examine the changes we made to ʔeləw̓kw̓ — Belongings after our first study. At the time of this writing, Matkin and I are in the process of analyzing these interviews. This study and analysis will form a portion of Makin’s own Master’s thesis.

MOA is also continuing to work on ʔeləw̓kw̓ — Belongings. Jacobsen and Wallace have begun investigating how we might turn ʔeləw̓kw̓ — Belongings into a website or app. While this would not be able to replicate the important tangible aspects of the tabletop, the content—the important and complex narratives around the belongings and the Musqueam stories that relate to them—could still be explored and
shared. Furthermore, a website or app would help to provide documentation of our system overall. In presenting our work on \( ?e\l\a\w\k\w - Belongings \), we have found that it is often difficult and time consuming to explain the system when video documentation or the opportunity to interact with the information in some way is more effective.

### 5.3. Conclusion

I have been involved in the development, design, and evaluation of \( ?e\l\a\w\k\w - Belongings \) for just over two years at the time of this writing. My position as project manager, photographer, designer, and researcher has offered me a unique perspective, or set of perspectives, from which to build a case study of this tangible table design process. As part of my role, I was present for the majority of design activities of the tangible tabletop, observed the inner workings of the design team, visually documented the process, and kept detailed notes in the form of meeting minutes and email correspondence. From the data collected during this process, I was able to build this case study in which I address the following questions: *What does collaboration look like when developing an interactive tangible tabletop to convey cultural values through tangible interactions? Can museum visitors learn about a culture through tangible interactions with a digital system?*

Through my description of the design process, I detail what our process was like for such a collaboration with an in-depth look at the development of \( ?e\l\a\w\k\w - Belongings \). Because this tabletop was designed as part of the award-winning \( c\es\n\a\m - the city before the city \) exhibition, we see this case study as of particular interest to two distinct groups: those in heritage institutions or who are working with indigenous communities as well as interaction designers looking who are interested incorporating and communicating cultural values and traditional knowledge.

From this case study, I then introduce three research papers that were collaboratively written during this process. These papers each address different aspects of our project’s contribution. We explore the metaphors of fragmentation and continuity that are woven through the history of archaeology in British Columbia and through the design of the tangible tabletop. We showcase key moments of interaction during the
design process and within the final system itself. Lastly, we evaluate the success of our design decisions and overall goals through a visitor study, resulting in recommendations for designers when cultural values and intangible heritage are involved.

While there may have been some limitations, we see the design itself and the collaboration as a whole as a success. We met our overarching design goals of supporting visitors’ experiences of Musqueam cultural through tangible interactions and the showcasing of Musqueam voices while contributing to the larger movement of decolonizing museum practices and striving for a more collaborative museum model.
References


Appendix A.

CITAR Article: Tangible Interactions with Intangible Heritage
7eləw̓ kʷ – Belongings: Tangible Interactions with Intangible Heritage

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ABSTRACT

7eləw̓ kʷ – Belongings is an interactive tabletop using a tangible user interface to explore intangible cultural heritage. The tabletop was designed for the čəsnaʔam, the city before the city exhibition. This exhibition is a partnership of three major institutions in Vancouver, BC, examining the significant ancient village site on which part of Vancouver was built, as well as Musqueam culture and community today. The tabletop uses replicas of Musqueam belongings excavated from čəsnaʔam, as well as contemporary objects that are a part of everyday Musqueam life to access information about the long history of salmon fishing and the continuity of related knowledge at čəsnaʔam. The design of 7eləw̓ kʷ – Belongings highlights the tensions between fragmentation and continuity that are central to discussions of access and preservation of intangible cultural heritage in the digital age. In this paper we discuss the tangible tabletop interface as a response to the desire to reconnect fragmented collections and physical belongings from čəsnaʔam with Musqueam intangible cultural knowledge.

KEYWORDS

Tangible interaction; intangible cultural heritage; digital heritage; Museum of Anthropology; Musqueam Indian Band; čəsnaʔam.

1 INTRODUCTION

7eləw̓ kʷ – Belongings is an interactive tangible tabletop on display at the Museum of Anthropology (MOA) at the University of British Columbia in Vancouver, Canada and was developed for the čəsnaʔam, the city before the city exhibition. Using replicas of ancient belongings excavated from čəsnaʔam and everyday objects in contemporary Musqueam lives, the table shares stories of the Musqueam community’s past and how their culture and traditional knowledge continues today. Susan Rowley, Jordan Wilson, and Lisa Uyeda at MOA worked with Kate Hennessy, Alissa Antle, Rachael Eckersley, Perry Tan, Brendan Matkin, and Reese Muntean at Simon Fraser University’s School of Interactive Arts and Technology to develop the tabletop application.

čəsnaʔam, the city before the city is a partnership among the Musqueam Indian Band, the Museum of Vancouver, and the Museum of Anthropology at UBC (MOA), along with the University of Waterloo. In three unique but related exhibitions, the institutions introduce visitors to čəsnaʔam, an ancient Musqueam village and cemetery on which part of modern day Vancouver was built. The exhibition at the Musqueam Cultural Education Resource Centre & Gallery highlights the sophistication of Musqueam’s
technology and culture both past and present. The Museum of Vancouver showcases ancient Musqueam belongings and ties them to the more modern histories of colonialism, heritage politics, and cultural resilience. The MOA exhibition, which includes the ʔelel̓w̓ikʷ – Belongings tabletop, shares Musqueam values and worldview using media-rich installations and told from the point of view of named Musqueam community members’ voices. The exhibition at MOA runs from January 2015 to January 2016.

Archaeologists generally refer to the material culture they excavate as “artifacts” or “objects”. Our Musqueam collaborators understand these items to have been created by, and to continue to belong to, their ancestors. For this reason we refer to them as ʔelel̓w̓ikʷ, a hən̓q̓əmin̓əm̓ term meaning belongings. By reframing Musqueam’s material culture using this term, we emphasize the continuity of intangible forms of knowledge that are intrinsically connected to belongings. The belongings from čəsnaʔəm connect contemporary Musqueam people to their ancestors and their snaweyət (teachings received since childhood).

2 | CONTEXT: čəsnaʔəm, THE CITY BEFORE THE CITY

čəsnaʔəm was one of Musqueam’s largest village sites approximately two thousand years ago. Archaeological evidence suggests people lived there for over three thousand years, and according to Musqueam oral history, their ancestors have lived at the mouth of the Fraser River from time immemorial (Roy, 2010). The čəsnaʔəm village site and burial ground has had a number of names over the years as it shifted from burial site to archaeological site during British Columbia’s colonial project. In archaeological circles it has been known as the Great Fraser Midden, DhRs-1, and Marpole Midden. Many in Metro Vancouver today would not even realize that the area around the railroad tracks, roads, and bridges on the way to the airport has an historic significance.

Between the late 1800s and today, professional archaeologists, amateur archaeologists, the general public and looters have removed thousands of belongings from the ground at čəsnaʔəm. From living rooms to museums, belongings from čəsnaʔəm are literally scattered across the world. In Vancouver, there are large collections at the Laboratory of Archaeology at UBC and at the Museum of
Vancouver. While a number of ornate, intact belongings were excavated, preserved, and disseminated through exhibits and publications — for example, a zoomorphic blanket pin — the vast majority of the belongings removed from čəsnaʔam are fragments of stone or bone, and are often seen as less exotic or mysterious to a common viewer (see Figure 2). While these belongings may appear less significant than more aesthetically intriguing belongings, they represent complex histories, deep ancestral knowledge and are of continuing value for the contemporary Musqueam community. Additionally, these belongings, which in many ways represent technologies used for daily activities, speak to the wealth, resourcefulness, and detailed knowledge of the Musqueam ancestors at čəsnaʔam.

The tangible interface developed for the ʔełəw̓ kʷ – Belongings takes inspiration from the tensions between fragmentation and continuity that underscore all three exhibitions. As both metaphor and physical process, fragmentation includes the colonial appropriation and division of Musqueam territories and resources, the removal of belongings and ancestors from čəsnaʔam, and the natural and inflicted degradation of the belongings themselves. Fragmentation is also represented in the vast collections of Northwest Coast First Nations belongings in museums around the world, the majority of which were acquired during a period following the implementation of the Indian Act (1884) in which the Indigenous populations were at their lowest ebb (Phillips & Johnson, 2003). Such collecting practices were justified by a ‘salvage’ paradigm, based on assumptions on the part of the colonizers that Indigenous peoples were doomed to vanish.

Today, museums are challenged to build new relationships with contemporary Indigenous peoples, including the repatriation of belongings and ancestral remains. At the same time, museums are struggling to find ways to bring representations of intangible cultural heritage into the museum space (Kurin, 2004). Continuity of intangible forms of knowledge, languages, and traditions is in tension with their historical fragmentation, just as the prioritization of objects as the focus of museum collections has contributed to the fragmentation of tangible and intangible heritage.

Explorations in digital fabrication and tangible interactions have highlighted possibilities for digital tools to support both the reconnection of intangible and tangible cultural heritage, and real interactions with physical belongings. For example, the National Museum of Natural History’s Tingit Killer Whale Hat project used 3D scanning and fabrication technology to appropriately display the replica of a crest object that had been repatriated in a culturally appropriate manner (Hollinger et al., 2013). The University of Southern California’s Interactive Art Museum took advantage of the PHANToM haptic device to enable visitors to handle 3D digital models so that objects that were too fragile, or even delicate in a cultural sense, could be made available for fuller appreciation and understanding (Brewster, 2005). The Mejby Stone at Aarhus University animates an ancient rune stone by projecting the story and the translation of the stone’s inscription back onto itself (Bøsballe & Halskov, 2010).

Developments in interactive media and the creation of new digital museum networks are providing curators, software developers, and First Nations communities with new tools for the reconnection of fragmented collections with intangible forms of cultural knowledge, and their representation in museum exhibitions. One such digital museum network, the Reciprocal Research Network, greatly contributed to the development of ʔełəw̓ kʷ – Belongings and is discussed in the next section.

3 NEW RELATIONSHIPS, NEW NETWORKS

The development of the ʔełəw̓ kʷ – Belongings tabletop exhibit has roots in a paradigm shift in North American museology focused on building new relationships with First Peoples. In 1992 the Assembly of First Nations and the Canadian Museums Association joined together to develop the Task Force...
Report on Museums and First Peoples in order to work towards repairing the fractured relationships between Canadian institutions and First Peoples and to move towards open partnerships. The Task Force described the need for the inclusion of First Peoples in the interpretation of their cultures by Canadian institutions, calling for a change in the power relations between museums and First Peoples. The Task Force further pushed museums to increase access to collections by First Peoples and to create policies on repatriation of cultural heritage and ancestral remains. Similar mandates were underway in the United States with the 1990 passage of the Native American Graves Protection and Repatriation Act (NAGPRA) (Council of Canadian Academies 2015).

As museum anthropologist Ruth Phillips (2011) has noted, in the early 1990s, digital imaging, database, and search technologies were rapidly advancing at the same time that Canadian museums were looking for new ways to implement models of partnership and collaboration mandated in the Task Force Report. Phillips asserts that new technologies provide unprecedented new tools for both reassembling and creating new forms of access to dispersed collections of Indigenous cultural objects.

Recognizing in 2001 that museums did not yet have the infrastructure to support such a collaborative museum model, the Musqueam Indian Band, the Stó:lo Nation, the U’mista Cultural Society, and MOA applied for a grant as research partners to develop a digital infrastructure for museums, researchers, and community members. The outcome, the Reciprocal Research Network (RRN), creates an online research forum enabling community members, researchers, and institutions to access collections and information housed in different geographic locations (Rowley, 2013).

The RRN aims to support different cultural systems of knowing. Along with maintaining and sharing museum data about Northwest Coast collections, community partners are able to contribute their own knowledge about belongings. By creating a virtual space to share and foster discussions around the collections, the RRN community can contribute to a greater understanding of belongings than is present in the original museum records (Rowley et al., 2010). The RRN was used by curators at all three of the Musqueam, the city before the city exhibits to share digital records of belongings from their institutions, to collaboratively develop curatorial texts, and to connect intangible knowledge to tangible belongings.

With the established relationship between the Musqueam Indian Band and MOA, and the collaborative research infrastructure of the RRN well in place, our team therefore had a solid foundation from which to design a tangible interface that could make at least a fragment of the large collection of belongings from Musqueam accessible to the public and connect those belongings to the intangible stories of Musqueam culture through contemporary voices.

4 CURATING CONTINUITY

New museological discourse in the late 1970s included the ideas that knowledge is social, that knowledge is shared, and that objects themselves embody knowledge. Indeed, “a necessary condition for the generation of knowledge is engagement with objects” (Srinivasan et al., 2009).

It can be difficult for museums to interest visitors in the seemingly unimportant fragments from the past, and usually only a carefully curated, well-preserved selection of ‘treasures’ are exhibited. MOA curators Susan Rowley and Jordan Wilson discussed the challenges and opportunities afforded by exhibiting a fraction of the collection held in trust for Musqueam at the UBC Laboratory of Archaeology (LOA), all the collection, or none of the collection. After debate, and discussions with Musqueam exhibit advisory committee members, they determined the MOA exhibition would not feature any ancient belongings.

A number of factors influenced the decision. Displaying all of the thousands of belongings removed from Musqueam and housed at LOA would be a logistical challenge. Displaying a few would force the curatorial team to select and interpret belongings in the way they were trying to avoid. Certainly displaying belongings associated with burials and ceremonial use would be inappropriate culturally, but given the history of excavation processes at Musqueam it would be nearly impossible to determine the exact provenance of particular belongings and thus how appropriate it would be to display. Wilson, a co-curator as well as a member of the Musqueam Indian
Band, furthermore noted that from the community’s perspective, ʔəsnaʔəm is not viewed as an archaeological site, rather, it is commonly referred to a former village and cemetery, an important part of Musqueam’s extensive history. In fact, the excavations and removal of ancestors, and many other forms of Western research, have been viewed as contravention of cultural values and protocol, and have resulted in long-term negative impacts on the community (Roy, 2010).

Rowley and Wilson were also attempting to challenge the meaning of an archaeology exhibit. As MOA is known for collecting, displaying, and interpreting material culture, visitors would be expecting to see ancient objects supplemented by academic experts’ scientific views. The curators wanted to convey that material culture is not equivalent to culture; there is much more to Indigenous communities than art and artifacts. Displaying only the historic runs the risk of falsely implying that Musqueam are a people of the past or that their practices, values, and traditions have diminished over time. Rather than focus on the tangibles, MOA highlighted the intangible values, worldviews, and teachings of Musqueam culture.

While ʔeələwkw* – Belongings was designed with MOA’s curatorial philosophies in mind, the table’s development team saw the tabletop exhibit as an opportunity for incorporating tangible technology within the museum space to tell the greater stories of Musqueam history. It could show how the importance of ancient belongings is not about their form and function but rather their connection to the ancestors and the teachings (sənəwəyəh) that were handed down through them. These sənəwəyəh are part of everyday life, in the past as well as in the present. By using replicas of ancient belongings that would have been common in the past to visualize the story of Musqueam’s history of knowledge and culture from long ago, we could similarly show the culture and practices of today through contemporary everyday items.

51ʔələwkw* – BELONGINGS

ʔeələwkw* – Belongings is a tabletop application for the Samsung SUR40. The SUR40 is a horizontal HD display with legs. Using Microsoft PixelSense, which utilizes infrared sensors to detect objects on the screen, the table can detect blobs, fiducial tags, and up to 50 touch inputs. The ability to detect blobs and tags extends the table’s possibilities beyond a simple touchscreen and offers the ability to support tangible interactions. By utilizing the touch and tag reading functions of the table, we have the opportunity to combine physical replicas of cultural belongings to additional media such as text, images, audio clips, and videos.

The tangible interface of the system comprises six replicas of ancient belongings excavated from ʔəsnaʔəm (net weight, ceilt, slate blade, harpoon, a decorated fragment, as well as a piece of cedar bark to represent everything that is not preserved), six contemporary everyday items of Musqueam life (ice cube, keys, status card, tide chart, quarters, and a Coke can), and two activator rings (see Figure 3). The replicas, cast from molds and hand painted by members of our design team to resemble the originals, sit together with the contemporary belongings on a collections cart. Juxtaposed with ordinary items like keys and a crumpled tide chart, visitors are invited to pick up the ancient belongings to discover their importance. Conversely, seeing a Coke can on display encourages them to question how mundane modern objects are relevant to Musqueam culture.

Three monitors are situated on the walls surrounding the table and belongings cart (See Figure 4); two of these are associated with the activator rings while the third displays photographs of the process of cleaning and filleting a salmon. The table itself shows a top down view of a fish-cutting table. On the table are a salmon, salmon fillets, a knife and sharpened, and an iPhone. Around the table are related supplies for fishing and fish preservation: fishing nets, firewood, an axe, a gas can, an oilcan, and a tote of fish.
When a visitor places a belonging in one of the rings on the table, basic information about the belonging and its use appears on the table. Additional images of similar belongings from the LOA collections database appear on the ring’s monitor so visitors can see other examples of this type of belonging.

Visitors can connect the belonging to its related area of the fish-cutting image. When the correct section of the image is located, information about the belonging’s use and place in Musqueam culture appears. An assortment of images, quotes, documents, and text will tell the story of how the belonging functions in Musqueam life (long ago or today) and why it is important. Some of the connections made between the belongings and the underlying image are more expected than others, but they work together to show the complexities of their interrelated histories.

The value of the two quarters, for instance, is symbolic. Two quarters are used in ceremonial contexts to thank people who have contributed in particular roles. The quarters match to the iPhone in the image, because while recognizing that we live in a time where information is literally at our fingertips, Musqueam people keep their spiritual and ceremonial lives private from those outside of the community.

As mele? – Johnny Louis explains in a quote that appears on the table when a visitor connects the physical quarters to the iPhone on the digital tabletop,

> it’s just a part of us, part of our life and traditions, and then one of the very few things we have left. So we have to protect it, so it doesn’t get carried away.

Visitors can further explore the belongings by connecting an ancient belonging to its contemporary match to learn about the continuity of Musqueam culture from the past to present day, learning what has changed and what has remained. When visitors connect two seemingly unrelated belongings from the past and present day, again, a series of texts, contemporary images, historical documents, and quotes from community members appear on the table. Through this assemblage of information, visitors gain insight into the history of Musqueam culture and how their traditions remain part of their everyday life.
The slate blade and ice cube are two such belongings that match up to tell a larger story about their importance in fish preparation and preservation (see Figure 7). In the past the slate blade was used to process fish for drying, smoking, and cooking, while today fish are often preserved through freezing, in addition to traditional methods. The fragments of information that appear on the table when a visitor discovers this match tie the concepts of everyday fish preservation into the greater issue of fish conservation and sustainability. The quotes, images, and historical documents describe how overharvesting by commercial interests and environmental changes have had a dramatic impact on the salmon, sturgeon, eulachon, shellfish, and other culturally significant species.

In one quote that appears when a visitor connects the slate blade to the ice cube, community member Secoleax’ - Morgan Guerin explains salmon fishing and issues in the region.

The sockeye salmon run is species-specific and year-specific for every one of the four-year cycles. There are four cycles of them and two cycles being off and two cycles being on. Two years of abundance and two bad years. They used to historically of course be all good years except when the rockslide triggered during the railroad construction at Hell’s Gate in 1914 collapsed one whole run.

The information is quite specific, but it also conveys a larger message about Musqueam life today. Musqueam’s traditional ways have been fragmented by colonialism, yet in the case of their traditional ways of fishing, they are actively working to increase the salmon stock, collaborating closely with other Indian Bands as well as Canada’s Department of Fisheries and Oceans.

Once a visitor has fully explored a belonging through these interactions and activities, they gain access to a short video of a Musqueam community member sharing their own lived experiences, often relating important moments of learning about history and teachings.

6 | EVALUATION

Curatorial goals and Musqueam values led the design process of 7elaw̓k’ – Belongings. In our early development and design meetings, we outlined what we hoped to achieve in the tabletop exhibit. We wanted visitors to understand the role that ancient belongings played in the lives of Musqueam ancestors, but also how the teachings about the belongings and the embodied practices are still important today. Key design decisions were made to convey these ideas. The inclusion of both ancient and modern belongings, the fish-cutting image, and the multiple categories of information for each belonging were designed to speak to the tensions between fragmentation and continuity.

The two sets of belongings, both ancient and modern, help to show the continuity of Musqueam culture. As noted previously, the curators were concerned that by showcasing only the ancient belongings, visitors engaging with the table would associate Musqueam with the past, when the exhibition at MOA was really about the Musqueam people today. With ancient belongings sitting on the table along with modern items such as keys and a Coke can, visitors are encouraged to think about and explore the connections between the past and the present. The fish-cutting image, too, is a modern display of traditional Musqueam practices. By interacting with the belongings and the table, visitors could learn about the evolution and sustainability of Musqueam’s fishing practices and technologies over time.

Another design feature includes the four categories of information that can be accessed for each belonging. Rather than simply telling what each was used for, the table reveals quotes from community members, photographs, and documents. The multiple categories build on one another, giving visitors a greater understanding of how each particular belonging has
an impact on daily life in the past and present as well as related issues affecting Musqueam life. This wealth of information helps visitors see the belongings as more than historical fragments.

Once *ʔele̓w̓kʷ* – Belongings was installed, we conducted an interview-based visitor study in the gallery space at MOA during a two-week period to see whether our design decisions helped us achieve our goals for the table and what we hoped visitors would take away from the experience. Twenty-four visitors participated in the study by interacting with the table, completing a questionnaire with demographic information, and sitting down for a 10-20 minute structured interview.

Participants were asked questions relating to our research questions. These focused on a number of our design considerations including these ideas of fragmentation and continuity. We asked participants what they learned about Musqueam culture and how they learned this (e.g. What was something that surprised you about Musqueam culture that you didn’t know before?) as well as what the belongings represented, why we used the term belongings, and if they saw any connection among the four categories or information for each belonging (e.g. While using the table, you placed different objects in the ring. What do you think those objects represent?).

The interview sessions were audio-recorded and later transcribed. Three researchers individually reviewed the transcriptions, analyzing them using open coding to find common concepts and themes. These researchers came together to compare findings to ensure the validity of the coding.

While the study included research questions to guide the evaluation of four of our main goals, here we focus on the extent to which the table communicated information that helped visitors to better recognize the continuity of Musqueam culture despite historical and ongoing colonial dynamics of fragmentation.

We found that participants understood the concept of continuity in relationship to Musqueam people and their traditions. 17 participants shared information they learned about Musqueam culture, and 13 discussed cultural continuity in their responses.

There’s hardly ever a distinct line between ‘Oh, this is the culture before, there’s the culture now.’ There can be broad strokes with that. But when you come down to the details, you have that element of stuff... from before, and you have elements that are new, and they do have to co-exist. – P18

The combination of modern and ancient belongings assisted in this understanding of continuity. Even if participants were not able to successfully match an ancient belonging with its contemporary counterpart in the tabletop activity, the inclusion of the contemporary belongings on the museum cart helped convey that idea to visitors.

They’re a changing culture. It’s sort of something I gleaned just by looking at the objects on the table in the first place. When you approach it and you see a harpoon and a Coke can together, you almost don’t need the table. – P22

We also wanted visitors to gain a fuller understanding of the importance of the ancient belongings. Beyond information that might be found on a familiar didactic label, it is important to show not only how belongings were used in the past but also how the culture engaged new technologies and how Musqueam people today continue to use these traditional practices in the contemporary landscape. The fish-
cutting image on the tabletop, the different categories of information for each belonging, and the combination of historic and contemporary content helped us show how much could be learned from what some might overlook as a historic fragment.

One visitor describes how interacting with the belongings on the fish-cutting image broadened their understanding:

It isn’t just an object in isolation. It’s an object that connects to other objects, like the people, other functions. It has a functional reason for being there. It doesn’t exist in isolation. – P06

Along with context from the image, each belonging had four categories of information to explore, and these categories were visible whenever a belonging was inside a ring. One visitor describes these categories as

Different levels of depth to the conversation… so one was just a description of the object or belonging and then an application of it, how it was used, and then how it connected to something else. – P17

Another explained,

It seemed almost like an intricate web. On the onset, it seems like they’re four separate things that you kind of click on, and then after while you play around with it a little bit, and you start realizing that no, they’re all connected. – P18

Each of these categories told the story of the belonging through fragments of information. Old documents and modern regulations, historic images and smartphone photos from contemporary Musqueam families, and stories from ancestors and well as elders today were interwoven to tell the story of the Musqueam people through their belongings and fishing practices.

7 CONCLUSION

In our efforts to create a tangible interface for the exploration of intangible cultural heritage, Belongings has taken inspiration from the tensions that exist between historical fragmentation of cultural heritage collections (including colonial collecting practices, looting, geographical dispersal, and removal of belongings from intangible cultural life) and the ongoing role of belongings in the continuity of cultural knowledge. It builds on decades of work in the North American museum community and Native American and Canadian Indigenous communities to build new relationships. This has more recently included the collaborative development of digital museum networks such as the Reciprocal Research Network that facilitate collaborative research, access to digital representations of belongings, and the re-connection of geographically dispersed First Nations belongings. Digital networks like the RRN provide resources for the development of projects like Belongings.

The tangible interface further responds to the challenge of representing the significance of fragments and everyday belongings, and their connections to contemporary Musqueam culture, in the museum space. Replicas of belongings provide the opportunity for museum visitors to spend time with Musqueam belongings from časnaʔam and to
interact with them in a way that the exhibition of real belongings would not allow.

**Tei 'ewk** - Belongings encourages interactions between visitors, the sharing of information, and the informal discussion of the intangible knowledge being shared about Musqueam belongings. Significantly, our initial evaluation of the table has shown that visitors enhanced their understanding of the continuity of Musqueam culture and values through their interactions with replicas of belongings and associated intangible forms of knowledge, such as photographs and videos of contemporary Musqueam community members. In doing so, we suggest that such an understanding of the continuity of culture may begin to counter historical processes of fragmentation, which included the separation of tangible and intangible forms of knowledge, and the removal of heritage collections from their communities and territories of origin.

In reframing what archaeologists refer to as “objects” or “artifacts” as Musqueam belongings, we support a growing movement aimed at decolonizing museum practices and creating a collaborative museum model. While engaging with issues of access, preservation, and continuity of culture that are central to discussions of digital heritage, the overarching goal of this project has been to communicate Musqueam cultural values through interaction with belonging replicas and the voices of community members, building a greater understanding of Musqueam’s past and present.

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**REFERENCES**


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Dr. Alissa Antle is an Associate Professor in the School of Interactive Arts + Technology at Simon Fraser University, Canada. Her research focuses on embodied human–computer interaction and child–computer interaction and proceeds through the design and evaluation of tangible and multi-touch surfaces, and interactive environments. Dr. Antle holds Bachelor degrees in Systems Design Engineering and Liberal Arts from the University of Waterloo, Canada and a Ph.D. from the University of British Columbia, Canada. Before returning to academia, Dr. Antle spent eight years in the new media industry working as a senior designer, executive producer and consultant.

Dr. Susan Rowley is an Associate Professor in the Department of Anthropology and a Curator at the Museum of Anthropology (MOA) at the University of British Columbia. She is a member of the Reciprocal Research Network (RRN) Steering Group. Most recently she was a member of the exhibit team for *czasna?em*, the city before the city and co-curator for the exhibit at MOA. Her personal research interests include public archaeology, material culture studies, representation, repatriation, intellectual property rights and access to information on cultural heritage.

Jordan Wilson is a graduate student and co-curator of the exhibit *czasna?em*, the city before the city, at the Museum of Anthropology. He’s of European and Indigenous ancestry, and a member of the Musqueam First Nation. He is currently in the Masters in Arts program in the Department of Anthropology, University of British Columbia. His research interests include community collaboration and Indigenous-museum relationships, issues of representation, material culture studies, Indigenous art history, community/oral history, and Indigenous/community-based research. Jordan has spent time researching and receiving training at the Smithsonian Institution in Washington DC, the University of Tromso in Norway, and at the Indian Arts Research Center at the School for Advanced Research in Santa Fe, NM.

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Appendix B.

DIS Paper: Design Interactions in ʔeləw̱kʷ — Belongings
Design Interactions in Ṯələw'kw' — Belongings

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Abstract
Our pictorial visually describes Ṯələw'kw — Belongings, an interactive tangible tabletop installed in the Museum of Anthropology at the University of British Columbia. The tabletop was designed to communicate the continuity of Musqueam culture, convey the complexity of belongings that were excavated from Musqueam's ancient village site, and reconnect those belongings to traditional practices and oral histories through tangible interactions with the table—all while highlighting that cultural knowledge should be treated with respect. In this pictorial, we will show how the design process was shared among researchers, curators, and the exhibit Advisory Committee and highlight some of the key design decisions that came out of this collaboration.

Authors Keywords
Tangible interaction; intangible cultural heritage; digital heritage; Museum of Anthropology; Musqueam Indian Band; ḃəsənəm.

ACM Classification Keywords
H.5.2. Information interfaces and presentation (e.g., HCI): User Interfaces, Evaluation/Methodology.
Introduction

Belongings is an interactive tangible table at the Museum of Anthropology (MOA) at the University of British Columbia in Vancouver, Canada and was developed for the čəsnaʔəm, the city before the city exhibition. The exhibition is a partnership among the Musqueam Indian Band, the Museum of Vancouver, and MOA along with the University of Waterloo. In three unique but related exhibitions, the institutions introduce visitors to čəsnaʔəm, an ancient Musqueam village and cemetery near the Fraser River on which part of modern-day Vancouver was built.

Using replicas of ancient belongings excavated from čəsnaʔəm and everyday objects in contemporary Musqueam lives, the table shares stories of the Musqueam community’s past and how their culture and traditional knowledge continue today. In this pictorial, we will show how the design process was shared among researchers, curators, and the exhibit Advisory Committee and highlight some of the key design decisions that came out of this collaboration.
Speaking of Belongings
Archaeologists generally refer to the material culture they excavate as “artifacts”. Our Musqueam collaborators understand these items to have been created by, and to continue to belong to, their ancestors. For this reason we refer to them as 'x̱al̓əł̓ə, a həqʷənəḿəxʷh term meaning belongings. By reframing Musqueam’s material culture using this term, we emphasize the continuity of intangible forms of knowledge that are intrinsically connected to belongings.

Relationships and Networking
Today, museums are building new relationships with contemporary Indigenous peoples. This includes repatriating belongings and ancestral remains that were dispersed in collections around the world during a period following the implementation of the Indian Act (1884) in which the Indigenous populations were at their lowest ebb [7]. Museums are also struggling to find ways to represent intangible cultural heritage in the museum space [4]. The development of the ‘x̱al̓əł̓ə — Belongings’ tabletop exhibit has roots in a paradigm shift in North American museology focused on building new relationships with First Peoples [1] and addressing these challenges of showcasing and safeguarding intangible cultural heritage [11].

One of the reasons we were even able to produce this work is the continuing relationship between the Musqueam Indian Band and MOA. Particularly successful in laying the groundwork for ‘x̱al̓əł̓ə — Belongings’ was the collaborative effort among Musqueam, the S̱L̓y̱reetings Nation, the U’mista Cultural Society, and MOA to create the online portal known as the Reciprocal Research Network (RRN), which makes dispersed collections of ancient belongings accessible digitally to communities and researchers [8, 9]. The thumbnail photos below show some of the belongings excavated from čwámən that are in the Laboratory of Archaeology, housed at MOA, accessed through the RRN during the ‘x̱al̓əł̓ə — Belongings’ design process, and incorporated into the final tabletop installation.
The "ol눠k" — Belongings team looks through ancient belongings that are part of the Laboratory of Archaeology at MOA.

Development Process and Goals

Susan Rowley, Jordan Wilson, and Lisa Uyeda at MOA worked with Kate Hennessy, Alissa Antle, Rachael Eckersley, Perry Tan, Brendan Matkin, and Reese Muntean at Simon Fraser University’s School of Interactive Arts and Technology (SIAT) to develop the tabletop application. With a tight deadline and only five months to complete the project, we immediately scheduled weekly two-hour in-person meetings. The meetings were initially used for brainstorming, activity design, and presenting ideas and work. Outside of these meetings Rowley and Wilson would gather and organize the content for the table (e.g., historical images, quotes from Musqueam community, information about fishing) and check in with the elders on the Advisory Committee regarding our progress. SIAT students would hold additional meetings during the week to design the visuals, graphics, and interactions, as well as write the code. During the first meeting, we outlined a number of goals for the tabletop. In this pictorial we will touch on some of the decisions we made to achieve our goals of helping visitors understand the complex stories connected to belongings and communicating Musqueam values and cultural knowledge.
Inspiration

Once we had the basic idea for a tangible table top and knowing that we had certain goals in mind to showcase the stories of belongings and also highlight the continuity of Musqueam culture, we needed an activity and focus to bring this all together. We landed upon salmon fishing. Many of the ancient belongings from čə̓ə̓mi were related to fishing, an activity that is still an important part of life today. We were inspired by the fish cutting table of Sonny Williams of the Scowlitz First Nation – shown here – which was photographed as part of a project that Hennessy and Muntean were working on up the Fraser River with the Sto:lo Nation.
Replicating Belongings

As we came up with the concept of the interactive salmon cutting table, we also needed to select physical belongings that would interact with the table, incorporating ideas from tangible computing as well as museological discourse around objects themselves embodying knowledge. Indeed, we agreed that “a necessary condition for the generation of knowledge is engagement with objects” [10].

Rowley and Wilson selected the six ancient belongings that best tell the stories of Musqueam practices and continuity of culture. The Musqueam Indian Band gave permission for molds to be made of the original belongings. Replicas of belongings provided the opportunity for museum visitors to spend time with Musqueam belongings from čəsən̓əʔəm and to interact with them and handle them in a way that the exhibition of real belongings would not allow.

One of our key design decisions was to include both ancient and modern belongings as a way to show how common the ancient belongings were in day-to-day life and to get visitors thinking about their importance. Six modern belongings were also selected. The juxtaposition of the ancient and contemporary belongings were effective in that people would explore unfamiliar belongings while the modern belongings would encourage them to question how how they are all relevant to Musqueam culture [5, 6].

Our process of recreating belongings: exploring our options, selecting ancient belongings, making molds, and sealing and painting the final replicas.
Interactions with Belongings
The final set of belongings includes six ancient (adz, slate blade, cedar bark, net weight, decorated piece, and harpoon) and six contemporary belongings (Coke can, ice cube, quarters, keys, status card, and tide chart). The physical interactions with these belongings and the digital tabletop helped visitors connect the histories of the belongings to one another as well as to present-day issues, showing just how complex these stories can be. The belongings serve as entry points and inputs for interacting with the tangible table. These belongings, along with activator rings, enable different sets of interactions to reveal layers of multi-modal information [2], evoking cultural forms [3] and revealing complex stories about each belonging’s place in Musqueam life and how the related practices have shifted and were sustained over time.
The System of Belongings

To reconnect the day-to-day cultural practices to belongings both ancient and modern, we focused on stem lsâl (What is this?), lowyil (Understanding it), mmwuyey (Teachings since childhood), and nyulnu (Having stories). These are the four categories etched into the activator rings and that appear in the digital ring interface. Using these concepts, we led visitors through a series of interactions to learn about belongings’ form and function (What is this?), connect belongings to the fish-cutting table image (Understanding it), match ancient belongings with modern personal items (Teachings), and ultimately unlock stories from Musqueam community members about the process of learning and their traditional culture (Having stories). An example of two of these belongings and their connections are detailed in a flowchart on the following page.
What Is This
When you first place a belonging in one of the rings on the table, basic information appears on the table. Here, text and images appear explaining that the belonging is a Coke can or that it is a jadeite adz used for carving.

Teachings
Each ancient belonging pairs to a modern belonging, and when visitors enter the teachings category they will be prompted to make that connection. The Coke can and adz pair in this way to tell the story of historic and contemporary trade routes.

Understanding It
In the Understanding It category, visitors match a belonging to its corresponding area on the fish cutting table. The Coke can matches to the salmon fillets to access information about the changes in traditional diet brought about by issues including access, overfishing, and pollution.

Having Stories
Once a visitor explores the first three categories of information, the monitor associated with the ring plays a video of a community member sharing stories about learning cultural practices and their own lived experiences.

Understanding It
When visitors connect the adz to the axe, its modern counterpart, they learn about how the adz was used, the long history of carving, and the importance in the community. Community members share their grandparents’ stories of building boats, and images and text show the structure of the long houses.
Conclusion

The flowchart on the previous page aims to clarify how belongings connect to one another, to the underlying fish cutting image, and to the community voices that reveal the intangible heritage associated with them. These connections and interactions are made with each of the twelve belongings. It is a complex web of relationships, but this was also what we wanted to convey to visitors. In taking the time to interact with the tabletop and navigate these complexities, we are sharing with visitors the ideas of earning knowledge and that cultural knowledge should be treated with respect.

These belongings – the tangible interface – respond to the challenge of representing the significance of both archeological and everyday belongings in a museum space. The choice of ancient and modern belongings for the tangible interface further highlights cultural continuity and how ancient belongings connect to contemporary Musqueam life. While engaging with the belongings, visitors are engaging with Musqueam cultural knowledge, but also issues of access, preservation, and continuity of culture that are central to discussions of digital heritage.

* Photo ©Jordan Wilson
References


Photography

All photography ©Reese Muntean unless otherwise noted.

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Appendix C.

In Review: Designing Cultural Values into Interaction
Designing Cultural Values into Interaction

ABSTRACT
Museums continue to incorporate technology into exhibits, allowing visitors to engage with information in different ways and in greater depth. Our paper describes Petewk—Belongings, an interactive tangible tabletop installed in a cultural heritage museum. The tabletop was designed to communicate complex and narrative information about Musqueam culture including ancestral belongings. Rather than focusing only on content and interface design, we wanted visitors to also experience cultural values through their interactions with the system. We present five interdependent design goals that enabled us to meet these objectives. We describe the design strategies related to each goal and evaluate our approach through a user study. Through our design and evaluation we produced implications for tangible tabletops in museum exhibits that support visitors to experience of cultural values through tangible interaction.

Author Keywords
Intangible cultural heritage; indigenous heritage; museums; tangibles; digital tabletops; value-based design.

ACM Classification Keywords
H.5.2. Information interfaces and presentation (e.g., HCI): User Interfaces, Evaluation/Methodology.

INTRODUCTION
Museums continue to incorporate technology into exhibits, allowing visitors to engage with information in different ways and in greater depth. Digital technologies are also being used in museums to move beyond a focus on tangible heritage objects to address the challenge of safeguarding intangible cultural heritage—the traditions or living cultural expressions that are passed on from generation to generation [23, 34].

The multi-touch tangible table is one such technology that is moving into museums. While there are examples of work examining both educational as well as cultural applications of digital tables using touch and/or tangible interfaces, there is still much to be explored. Researchers have investigated a range of topics related to tabletop design for museums. The primary focus of much of this work is on how and what visitors learn through interaction with tabletops (e.g., [1, 2, 3, 8, 9, 17]), how to design to support visitor engagement (e.g., [4, 7, 22]), and issues around initiating and sustaining interaction in public spaces (e.g., [10, 18, 20]).

What remains unexplored yet is critical to the design space of tabletops for cultural heritage in museums, is how to present intangible elements of culture. In this paper we ask: How do we design to support visitors to experience intangible cultural ideas, like values? Our research questions is: What are effective design strategies that enable visitors to directly experience cultural values while they interact with indigenous knowledge using a tangible tabletop system?

In previous work [24, 25, 26] we discuss the process of designing our tabletop with different collaborators. In that paper we described the process that enabled us to design a tabletop installation that responded to the desire to reconnect fragmented collections and physical belongings from čsenaqam with Musqueam intangible cultural knowledge. In this paper, we focus on our design rationale and evaluation that resulted in generalizable design strategies that can be used by researcher and designers of tabletops who want to support users to experience intangible elements of culture, like values. We begin this paper with a summary of related work in cultural HCI and tabletop design that informed our work; we outline our five interdependent design goals; and we describe the design strategies and decisions made to achieve these goals. Next we present our visitor study used to explore and revise our design approach. We present our results and design guidelines derived from what we have learned. We end with a discussion of the broader implications of this work for the design space of tangible tabletops and intangible cultural heritage.

RELATED WORK
We situate our work in design for digital cultural heritage, touch on participatory design process, and then discuss main works that have informed our approach to design.

Cultural Heritage & Digitization
Giaccardi and Palen explain that our sense of belonging, identity, and culture are defined by physical and social settings [11]. Evolving information and communications technology can allow multiple media and interactive technologies to work together to open up new ways for users to experience and think about cultural heritage. The
ways that users interact with these technologies can influence how they understand the socially produced meanings and values ascribed to an artifact. Multimodal or cross-media interaction can facilitate the presentation and exploration of tangible and intangible fragments of a cultural heritage together, and allow new ways to engage with specific cultural values. Indeed, there are a number of examples of collaborations with indigenous communities on multimodal projects that allow for archiving, storytelling, and interacting with cultural heritage (e.g. [14, 30]). Our work contributes to this new design space by exploring how we can use the unique features of tangible touch tables to convey both tangible and intangible cultural knowledge to museum visitors.

**Designing with Indigenous Stakeholders**

Designing with indigenous stakeholder involves similarities to and divergences from theories of participatory design and co-creative experiences (e.g. [6, 21, 22, 29, 32]). In particular, the process is informed by the shifting relations between museums and Indigenous communities [12, 13, 14, 15, 16, 27, 28, 31]. In previous works we described our design process for this project. (e.g. [24, 25, 26]). We summarize two key points from this work below in our Design Requirements section.

**Tabletops in Museums**

Horn describes an approach an approach to tangible interaction whereby designers can evoke cultural forms [17]. Cultural forms are "social constructions or conventions that are linked to recurrent patterns of activity" such as counting systems, games, or currencies, and often involve a physical artifact. Horn and others have shown that cultural forms can be used for interaction design, especially with regard to physical objects in interactive systems in order to utilize users' cognitive, physical, and emotional resources to increase usability and create meaningful experiences for both users and observers [4, 17, 19, 33].

One of the exhibits analyzed by Horn is a multi-level game on multi-touch table in a natural history museum. Many children instantly recognize this as a video game and utilize previously associated resources such as couching, turn-taking, intent observation, and mentoring. Although it is unclear if this helps children learn the intended information, it does help them learn how to play and win the game. Horn suggests that a high fidelity reproduction of the original cultural form is necessary for creating practice-linked. Horn proposes that further work with cultural forms require novel applications with new tools and/or technologies.

**Mapping Place** is a museum exhibit that introduces cultural concepts through the combination of a multi-touch table and an interface of physical objects [8]. Installed in the Robert C. Williams Paper Museum in Atlanta, **Mapping Place** is based on an interpretive story-telling device called a *Lukasa*, which utilizes beads, shell fragments, and carvings on a wooden board to guide stories and record history. The tabletop activity teaches the African Luba peoples' mapping practices and perspectives through embedded, Lukasa-inspired, cultural logic and structure.

Chu et al. found that participants who received a lesson before interacting with **Mapping Place** demonstrated better conceptualization and utilization of abstraction and symbolism in ways more similar to the Luba, though the study does not attempt to test the exhibit in a 'walk up and play' museum environment [8]. The researchers recommend further exploration of how tangible systems reflect the content and context of cultural interactions and caution that design decisions can mislead users and lead them to make unintended interpretations.

Hornecker presents a field study of the *Tree of Life*, an interactive multi-touch tabletop exhibit at the Berlin Museum of Natural History that allows visitors to access information through a question-answer dialogue [18]. The exhibit focused on playful engagement and different levels of information access, and whole family interaction.

The question-answer format did not engage users as deeply as hoped. The study showed that there were not enough layers to allow users to delve deeper; users jumped from one piece of information to another. Others have recommended design approaches that may alleviate these issues. For example, presenting activities that initiate construction and testing of hypotheses, discovery and meaning making (e.g. [9, 18, 35]). It is important that visitors experience early success, by for example, being able to understand the properties of an object as quickly as possible. It is also important that visitors are rewarded for persisting in exploring content [1, 9, 10, 18]. Finding a balance between drawing visitors in and enabling them to persist and gain deeper understanding is key [9, 10, 18].

**DESIGN REQUIREMENTS AND GOALS**

**Belongings** was developed through a collaborative design process described in [24, 25, 26]. This project emerged in the context of long-term collaboration between the Museum of Anthropology at the University of British Columbia and the Musqueam Indian Band and was designed in collaboration with members of the Musqueam community. The design of cultural values into the interactions that define **Belongings** would not likely have occurred outside of this collaborative relationship and an ongoing commitment to decolonizing museum exhibition and communication practices. We propose that a collaborative design process with key cultural stakeholders is a requirement for value-based design.

The development team worked to incorporate Musqueam cultural values into aspects of the development process including all related documentation and communications, and of course, the design of the tabletop activity, interactions, and interface. One such example of this focus on cultural values is evident in the use of the term "belongings" in the title of the tangible table and
throughout this paper. While belongings excavated from čəsna'um are more commonly referred to as “objects” or “artifacts”, the Musqueam see them as still belonging to the hands that created them. As such, we adopted the term ṣelw̓aḵʷ, a hən̓q̓əmin̓q̓ term meaning belongings, to discuss what has been removed from Musqueam’s village site. We propose that considering and reflecting cultural values throughout the design process is a requirement.

In addition to these two requirements, we propose five interrelated design goals, that when met, enable visitors to experience cultural values through their interaction with a tabletop system.

**Design Goal 1 [DG1]: Draw in people**
In line with previous work (e.g. [2, 20]) our first goal was to draw in people to the space and initiate interaction with the table. Since the table was to be placed in a small alcove that was part of the larger exhibition, we needed a way to attract visitors into the space, and encourage them to engage with our system.

**Design Goal 2 [DG2]: Learn about Musqueam Culture**
We wanted people to learn something new about the Musqueam people, culture, and identity both past and present. Our learning goal was for visitors to understand that Musqueam is a contemporary society that has existed in the region for thousands of years.

**Design Goal 3 [DG3]: Understand Richness of Belongings**
Building on the basic knowledge in DG2, we also wanted visitors to understand the richness of information about the belongings excavated from čəsna'um, including how they were used, and how common these items were. In line with trends designing exhibitions for cultural heritage (e.g. [Giacciardi]) and the notion of cultural forms [17], we wanted to display the ancient belongings in such a way that people could interact with them physically rather than passively view them behind glass.

**Design Goal 4 [DG4]: Understand Complexity of Stories**
Building on DG2 & DG3 and addressing issues raised in [18] about lack of depth and in about the importance of understanding the complexity of value-laden content [2], we wanted visitors to understand some of the complexity of information related to belongings excavated from čəsna'um. We envisioned this as enabling visitors to learn about the stories related to each belonging. This goal addresses the issue put forward by the curators that by displaying ancient belongings visitors might mistake material culture to be the same as culture, resulting in an impression that ancient belongings mean that the Musqueam culture is only about the past. Our goal was for visitors to understand that each belonging represented a story that connected the past and present in Musqueam culture.

**Design Goal 5 [DG5]: Experience Cultural Values**
Rather than telling visitors about culture values, our goal was to have visitors experience values through their interaction. This approach is in line with our previous work that demonstrated that enabling visitors to make their own interpretations about values through interaction had a greater impact than simply telling them about values [5]. Based on our prior work, we also proposed that exposing visitors to cultural information would lay a foundation, similar to the prior lesson in [8]. Learning basic information about Musqueam culture provides context for visitors to experience values through interaction. We determined the values we wanted to focus on during the development process working with the curator and representative of the Musqueam nation. The most important value we wanted visitor to experience was that Musqueam cultural knowledge should be treated with respect. Other values included the importance of hən̓q̓əmin̓q̓ language, the acknowledgment of belongings as still belonging to the ancestors who created them, and that access to culture knowledge is not given freely but should be earned. Our goal was for visitors to experience these four values through their interactions with the table.

**SYSTEM DESCRIPTION AND DESIGN RATIONALE**

Three major systems comprise a Samsung SUR40 table, three monitors, twelve replicas, and two activator rings. The physical installation occupies part of the exhibition space with three walls, with one monitor on each wall (see Figure 1). One monitor plays a series of photographs detailing the process of cutting and cleaning a fish. The remaining monitors are each associated with one of the ring tools. The table itself sits in the center of the space, displaying an image with a top-down view of a fish-cutting table. A rolling museum cart is located nearby with twelve physical belongings for use on the table: six ancient belongings (ceł, slate blade, cedar bark, net weight, decorated piece, and harpoon) and six contemporary belongings ( Coke can, ice cube, quarters, keys, status card, and tide chart).

The monitors are intended to contribute to our goal of bringing people into the space [DG1]. The main monitor facing the gallery incorporates rich visuals with the slide show of a fish being cut and cleaned. The two side monitors have colored borders to match a specific ring and display an image with all twelve belongings. They also play videos of Musqueam community members when visitors unlock special stories from exploring the belongings on the table.

Figure 1: Museum setup of ṣelw̓aḵʷ — Belongings.
Salmon fishing is used as an overall theme for the table, because it has been part of the Musquean way of life for thousands of years, supporting DG1 and DG2. Thus, the image on the table incorporates the fish from the slideshow in a vignette with related contemporary tools. Different items appear in the image including the bloody fish, fish fillets, knives, an axe, a woodpile, an iPhone, an oilcan, a gas can, a fishing net, boots, pavement, and a tote of fish. While the image serves to bring people over to the tabletop and offer a sense of Musquean identity, each of these areas of the image also matches to one of the physical belongings. Not all of the images and belongings are related to fishing, but fishing is the overarching theme and lens for much of the information.

The belongings sit next to the tabletop on their own museum cart. Like cultural forms [17], the ancient belongings were designed to look and feel as similar to the originals as possible [DG3]. However by allowing visitors to learn about the ancient belongings by directly handling them physically we break with traditional social practices around museum artefacts, which are typically behind glass. Because they would be handled, we made sure that the look, texture, and weight were as close as possible to that of the original belongings.

With permission from the Musquean Indian Band, molds of the original belongings in the Museum of Anthropology were made and replicas cast. The molds and material allowed us to approximate the texture and weight of the originals. The replicas were then hand painted to match the details and color variations of the originals as well. For the modern belongings, we used the actual items coated in resin or sealer. We were striving for high fidelity replicas to offer visitors an experience as close as possible to handling the actual belongings. Using the belongings as system inputs required the use of fiducial markers on each belonging, so we modified them to be small enough that they would not distract from the belonging or hinder the use of the belongings on the table. Lastly, in this dedication to accurately representing the belongings, the replicas were displayed on a museum cart. In museum storage, artifacts are kept in small plastic zip lock bags, so we placed the belongings on top of zip lock bags containing a slip of paper with an image of the replica and its name in hańq̓əmîn̓xw.

The two wooden and acrylic rings sit on the table. The rings are painted to match the specific monitors. There are four hańq̓əmîn̓xw terms etched around the rings, which serve as activators for the belongings. The hańq̓əmîn̓xw was included here, and as frequently as possible, to reiterate the importance of traditional language as included in our goals, DG2 and DG5.

Instructions are positioned on two sides of the table which include an illustration showing how to put a belonging in the ring along with text that briefly explaining the four hańq̓əmîn̓xw categories on the ring. These categories are stem to ? (What is this?), tsał̓ən (Understanding it), swxwał (Teachings since childhood), and cyx̓wax (Having stories). When a belonging is placed in a ring on the table, a digital ring with the English translations of the hańq̓əmîn̓xw etchings appears on the table around the physical ring.

Visitors must complete different interactions, akin to small matching puzzles, to access the information in each category. The categories reveal different layers of information about the belongings as a way to convey the complexity of the stories that these belongings can embody [DG4]. The activities required for each category take time and thought, and the correct answers are not always obvious or apparent. This was intended as a way for visitors to earn cultural knowledge and spend time engaging with Musquean heritage. Once a visitor completes all three of the interactions and matching puzzles, they can unlock a video of a Musquean community member sharing their own stories and lived experiences, offering layers of information and addressing issues around lack of depth as noted by Hornecker [18]. These activities and the stories at the end were designed in such a way that visitors could experience values by earning cultural knowledge [DG5].

User Scenario
We will now walk through each of these categories to further explain the interactions and activities involved, and we will use examples of specific belongings and the information connected to them to offer a better sense of the cultural knowledge that is being shared.

What is this?
To activate a belonging and to access basic information about a belonging’s function, a user must first place a belonging in one of the activator rings on the tabletop. This initial activation of the belonging will bring up What is this? information cards that appear on the table next to the ring, explaining what the belonging is and what it was used for. This simple initial interaction is used to bring people into the activity [DG1]. We also wanted to communicate information about the physicality of the belonging [DG3].

Handling the belonging in this way and accessing the basic information about its everyday use then meets this goal of understanding the use and place of the belongings in everyday life. In the case of the stone belonging with a hole in it, visitors will feel the weight and texture of the rock and learn that it is a net weight that was used to place fishing nets in the river.

Now that the visitor has basic knowledge of the belonging, they can explore Understanding it or Teachings. Each involve a small matching game to access more information about the belongings and Musquean culture which appears on the table in the form of quotes from Musquean community members, images, text, and historic documents that explain why the particular belonging is important in Musquean life. Both the Understanding it and Teachings categories serve to add different layers and facets to the information and stories told about the belongings [DG4].
Understanding it
For Understanding it a visitor can then find the area of the fish-cutting image that corresponds to the particular belonging. When visitors touch that section of the digital ring, dotted lines appear around the hotspots on the table to hint at the connections to be made. The visitor must move the belonging and ring over the correct spot on the image to access information about a belonging’s importance and place in Musqueam life.

Some connections are more obvious than others. For example, the slate blade and the modern knife are both used for cutting, and the stone net weight connects to the modern day fishing net in the fish-cutting image. But some connections are more abstract and do not relate directly to the belonging’s use, like the Indian status card that pairs with the totem of fish because of the fishing regulations imposed on First Nations by the Indian Act. The information cards in this case explain the traditional ways of the Musqueam people and the laws that have been imposed upon them.

Teachings
Visitors can learn more about the belongings in the Teachings category by matching an ancient belonging to its contemporary counterpart. Rather than connecting a belonging to the underlying image, here visitors are asked to make connections between the ancient and modern physical belongings. Through this activity visitors learn about continuity of Musqueam culture.

When a visitor touches the category on the digital ring, a black circle appears and comes to a rest just outside the ring. Visitors place the matching belonging in the circle. When the correct match is made, again, the table displays a variety of documents, photographs, quotes, and text to offer visitors a better understanding of Musqueam’s cultural history and how their traditional ways have remained or evolved.

For example, the Coke can matches to the celt. The two belongings are seemingly unrelated, and visitors might see the Coke can as merely a soft drink or piece of litter and the celt as an ancient tool that evolved into the modern day axe. Yet in this connection, visitors learn that the two also represent extensive trade networks. The Coke can actually represents the global market economy, and the celt tells the story of Musqueam’s history of trade. Ancient Musqueam people, too, had far reaching trade routes that enabled them to acquire resources—like the nephrite from which this celt was crafted—that were unavailable in the region.

Having Stories
When a visitor touches Having Stories, a progress bar appears to show how much more of the belonging they need to explore before they can unlock the video. Once a visitor successfully completes the interactions for the first three categories, the progress bar becomes a button that allows them to play a video clip featuring a Musqueam community member sharing his or her own personal narrative relating how they learned certain aspects of Musqueam culture and knowledge.

USER STUDY
We conducted a field study of pelamíl̓k̓ — Belongings in the gallery space at the Museum of Anthropology to address our research question. The study consisted of observations and open interviews with 24 visitors. Two researchers conducted this study in the gallery space over the course of two weeks. Signs notifying visitors of the study were posted at the front desk of the museum and again near the table. We collected data for 11 men and 13 women ranging in age from 18 to over 50 year old.

Researchers observed visitors interacting with the table. When a visitor had spent at least 2 minutes with the table and successfully put a belonging in a ring to access What is this?, a researcher would approach the visitor and ask them
to participate. We settled on this time and interaction milestone method of visitor selection as the one with the least bias. We drew from Block et al.’s study [7] on fluid grouping at tabletop exhibits, excluding those who the researchers characterized as Shoppers and Joiners. If the visitor agreed to participate, the researcher would step aside as they continued their exploration of the table. Visitors would occasionally decline to participate, citing lack of either time to visit other areas of the museum or of English language abilities. When visitors had finished using the tabletop, they filled out a brief questionnaire with demographic information and complete a structured interview lasting 10-20 minutes.

Data Collection
We designed our interview questions to explore visitor experience related to our design goals. This enables us to provide a preliminary answer to our research question about effective design strategies that enable visitors to directly experience cultural values. We asked about visitor experiences in order of the goals (enter/engage – basic learning – deeper learning and experience values).

Our observational notes provide evidence that addresses how visitors entered the space and began interaction [DG1].

We began the interview with questions around what things visitors learned about Musqueam culture and how they learned this (e.g. What was something that surprised you about Musqueam culture that you didn’t know before?) [DG2].

To gauge visitors’ understanding of the belongings and their stories [DG3&4], we asked questions about what they thought the objects represented, why they thought we called them belongings, and if they saw any relationships between the four categories on information for each belonging (e.g. While using the table, you placed different objects in the ring. What do you think those objects represent?).

We asked visitors questions about what they learned of the values of Musqueam people [DG5], and also how they learned this, whether is was something they saw, read, heard, or interested with (e.g. Can you describe what you learned about Musqueam values that you didn’t know before? How did you learn this?). We followed up by explicitly telling them that one Musqueam value is that culture knowledge should be treated with respect and then asked visitors to describe if/how they might have experience with that the tabletop. We also asked visitors if there were any other values that they might thought might have been reflected in what they were doing with the belongings on the table. We followed up by explicitly mentioning each value and then asked visitors to describe if/how they might have experience that with the tabletop (e.g. A central Musqueam value is that cultural knowledge should be treated with respect. Can you describe any ways you might have experienced this value in the exhibit by what you did?). After piloting our interview questions with 2 participants, we continued interviewing a total of 24 museum visitors.

Analysis
Interviews were audio-recorded and transcribed. In our analysis we looked at data from each interview question separately. In order to address the interdependent nature of our design goals we also looked across data sources to explore how our inter-related strategies impacted visitor experience. Three researchers individually analyzed the transcriptions using open coding to identity emergent themes. The researchers individually went through two passes of the interview transcripts alongside observational notes. In the first pass, we each identified themes, in particular looking for themes that related design features with visitor responses or behaviors. We looked for themes that were common, interesting, unexpected or indicated problems with the design. In the second pass we each fine-tuned our description of the themes and looked for interrelationships between them. Then the three researchers worked as a group and compared themes. We had inter-rater agreement on all themes except one, for which we discovered we had used different terms to describe the same elements. While this level of coherence was unexpected, it gave us confidence in the reliability of our coding.

RESULTS
Our overarching research question was: What are effective design strategies that enable visitors to directly experience cultural values while they interact with indigenous knowledge using a tangible tabletop system? Based on the work of others and ourselves, we proposed a set of design goals and inter-related strategies to meet those goals. Our analysis provides evidence for validation of our approach, and areas we need further refinement or exploration.

We were successful in creating an engaging tangible tabletop exhibit. While acknowledging that our consent protocol influenced the time spent with the table, our participants interacted with the table for at least 4 minutes, with an average of 8.8 minutes. One participant spent 40 minutes using the table. Participants overall enjoyed the experience and took away some new information from it.

Engaging and Learning about Musqueam Culture
Our first two goals were that people would enter the space, interact with the table, and learn something new about the Musqueam culture. We found that three design features contributed to achieving these goals. The visually interesting and unusual salmon cutting slide show on the wall mounted monitor and the modern fish cutting image on the tabletop (Figure 6) were successful in attracting people into the space and conveying basic information about Musqueam life. The cart of physical artifacts, which were not behind glass, also drew people in and immediately informed them about the culture by the nature of the ancient and modern belongings. In particular, all participants understood that the Musqueam people a fishing society in
the past, and that they still live in Vancouver today and carry on the fishing tradition of their ancestors.

“I learned that obviously fish is a big part of it, or else that whole graphic wouldn't be there, and they're using nets... They have to pay attention to the tides when they're fishing.” – P22

The combination of the monitors along with the instructions, the rings, and the belongings—specifically the Coke can—all worked towards enticing people to interact. People picked up the belongings and rings from the cart and placed them on the table with little more than an illustration. The Coke can was a particularly interesting belonging that caught the eye of many participants. It motivated them to interact with the other belongings. Thirteen participants commented on this explicitly.

“I put the Coke bottle in there I just laughed at the description of it. It seems like just lacking of culture subject to all of our modern marketing and immediacy of our consumerism and all of that.” – P16

Similarly, the combination of the belongings, the ring tool, and the What is this? information cards worked as an entry point to interacting with the table. Although What is this? was only an entry into the complex information available, this activity was valuable to participants.

“I spent most of the time exploring What is it? rather than stories.” – P17

People learned many new things about Musqueam’s fishing culture and the tools they used. Seventeen of 24 participants were able to explicitly describe a new piece of information about Musqueam culture that they accurately learned. They did this through their interactions with the ring, which enabled them to access information cards, as well as through directly handling belongings as physical forms. One participant described seeing a harpoon in a display case elsewhere, but actually learning more about it from interacting with it on the table top.

“I've seen those, it's the harpoon? I've seen those in a couple display cases on my way here, and never knew what it was and what it would be used for, so it was kind of interesting to see what that was about.” – P03

Another participant immediately noticed the language of the Musqueam people.

“I had no idea about the language. It was just completely being introduced as something foreign.” – P23

Richness and Stories about Belongings

Our second two design goals were about visitors reaching deeper understandings: the richness of information represented by belongings (beyond the identity and simple function) and the complex stories related to belongings. We found that these design features were particularly successful here. These features were the selection of both ancient and modern belongings, the fidelity of the replicas, and the complexity of the four inter-related activities.

Ancient and modern belongings

Thirteen of the 24 participants expressed that they understood the continuity of Musqueam culture in their interview responses. The design feature of using ancient belongings with contemporary items worked well to get people thinking about cultural continuity.

“They're a changing culture. It's sort of something I gleaned just by looking at the objects on the table in the first place. When you approach it and you see a harpoon and a Coke can together, you almost don't need the table.” – P22

“This goes back again to the idea of the old object and the new object co-existing, in the sense that there's hardly ever a distinct line between "Oh, this is the culture before, there's the culture now."” – P18

The belongings, although they were physical objects, also represented intangible elements such as the complexity of their stories. As one participant expressed it,

“Obviously Coca-Cola is not just Coca cola.” – P11

Three participants overlooked the modern items, choosing to focus on the unfamiliar belongings. Their curiosity was satisfied by discovering what the ancient belongings were and what they were used for simply by accessing What is this? However, they missed some of the rich stories about the modern objects, and because they did not pair ancient and modern belongings, they missed learning about how traditions had evolved or remained the same (Teachings).

“I didn't end up putting anything like the Coke can or the keys in there, I put all the little things that I didn't know what they were for on the table.” – P03

Belonging Physical Fidelity

The fidelity of the belongings, our careful considerations of how realistic they should look and feel, and the choice of displaying everyday belongings were important in having visitors immediately understand that they were of utility and value.

Eight participants described the importance of the ability to handle the belongings and how it allowed for a better understanding of them.

“It was just nice to have something in your hand. It gives you a little bit better perspective in maybe how it was used and how in relation to the other objects and giving you a little more perspective in that way.” – P16

“I was using a knife... I kind of felt like the modern day knife, what we're used to now, is very different than what they had, but that's what they had. It's what they were using, and it's easy to understand how these tools were used and how these tools were created.” – P04
The fidelity of the belongings also affected other aspects of interaction and impressions about values. We will address this further in our findings for Q3 and Q4 and our discussion.

Activity Complexity
The belongings and physical-digital ring were designed to enable visitors to trigger four different activities, each with a different kind of information about the belongings. Participants clearly understood that there was more information available about the objects, even if they couldn’t understand how to interact with all four categories of activities. For example, our design decision to place duolanguage labels of the four categories of information on the ring tool enabled visitors to realize there was more information available. As one participant explained,

“It seemed almost like an intricate web. On the onset, it seems like they’re four separate things that you kind of click on, and then after while you play around with it a little bit, and you start realizing that no, they’re all connected. In order to fully understand it, you have to spend a considerable amount of time and mental effort to actually go through each of these little links and each of these little webs to actually get to that full understanding of how they’re connected.” – P18

The Understanding it task of matching belongings to the underlying image was effective in getting people to think about the continuity of culture as well as context. Visitors found that the ancient tools such as the slate blade and celt had more obvious connections to their modern day versions: the knife and the axe. By using some recognizable ancient tools and pairing them with modern counterparts, we enabled many visitors to understand the continuous and long history of Musqueam culture.

“Because the background was the modern objects, so to connect what is the possession of the belonging and how does it connect to a modern object that is still used today.” – P20

Our decision to have belongings used on a tabletop display of a fish-cutting table provided context for the belongings. This decision enabled visitors to quickly understand how the belongings and their stories related to one another, how belongings were embedded in complex stories [DGH] and how the belongings showed how the Musqueam live today. For example, one visitor said,

“It’s to give the object a place in the context so it isn’t just an object in isolation. It’s an object that connects to other objects, like the people, other functions. It has a functional reason for being there. It doesn’t exist in isolation. It exists in context so it’s trying to give context.” – P06

“It’s good to know what something does, but there’s so much more to it than just what it does and what’s involved in actually using it... how long it takes to do things and there’re other pieces involved in using it and the engineering that goes behind it. There’s so much more involved than just what it is. It adds another dimension to the object.” – P16

The Teachings category, even though fewer people successfully accomplished that activity, still aided in achieving DG4 by showing the richness and complexity of information.

“(Matching ancient belongings to ancient belongings) would be important to understand how they’re still used the same way and how those uses have changed. That would be important. How perhaps we’ve left behind some of the ancient uses or we rely on newer ways of learning in... new contemporary ways of fishing.” – P19

The four categories together on the ring, along with the status bar aided visitors’ understanding that there was more to the story. When asked the relationship among the four categories, participants responded,

“Sort of different levels of depth to the conversation right so one was just a description of the object or belonging and then an application of it, how it was used and then how it connected to something else.” – P17

“It seems like something can be a tool, but there’s something deeper behind it. It gives a little bit more layers to the piece and it makes it less of just an object. It gives you a little bit more insight into the culture and pieces together.” – P16

Values
The Musqueam values we focused on were: treating cultural knowledge with respect, the importance of the hän̓q̓ən̓miʔátł̓, the notion that belongings still belonged to the ancestors and that cultural knowledge should be earned. Visitors often mentioned these values in their responses to previous questions, however we explicitly asked about them in the latter part of the interview.

Without meeting our first four goals, it seems unlikely we would have met this one. However, once visitors entered the space, interacted with different objects, and began to see the complexity of information available, they were cued to experience values. In addition, we found that these inter-related design strategies enabled visitors to experience values. We purposefully broke the tradition of having objects behind glass – placing replicas on a cart – which would normally only be accessible to museum staff. We also identified the physical-digital activity categories using both the hän̓q̓ən̓miʔátł̓ language and English, created depth of content through non-linear layers (rather than linear game levels), and showed progress each time a belonging was placed in a ring. People successfully recognized values in their interactions, specifically the care they took with the belongings and the time and effort spent with the table.

Seven participants noticed respect reflected in the way they carefully handled and returned the belongings to their
proper places on the cart. Even the contemporary belongings were treated with some reverence.

“I knew that I needed to put (the belongings) back where I found them in order to leave it for someone else to be able to follow me and do the table. In that way, that's teaching me to be respectful for the display itself.” – P05

“You're asked to do things in a certain way. You're asked to put them back on the table and that's sort of following rules in conventions.” – P11

“I treated them carefully. Actually the Coke can you treat it a bit like a cultural artifact, but I think that's because of the social rules.” – P06

Participants engaged with the table for an average of almost nine minutes, which illustrates the success of our choice to create complex interaction possibilities with inter-related activities and twelve different tangible belongings to use. Many visitors recognized that spending time to learn about this information was a way of respecting Musqueam culture.

**Figure 6: Belongings cart**

“By taking the time to look at it... I'll walk up and actually read more of what I'm looking on other than just looking at something. Definitely, taking the time to digest what I read and think about it from a different person's place.” – P08

"I think in that way it's giving your undivided attention as a way of showing respect.” – P15

“I think also just following the story and the instruction and doing something the way that it was explained to you, that was a value.” – P17

This is interesting. It's subtle, but the value is having the respect to stay with something no matter what the situation is. My respect would have gone longer if it was a human. My respect was shorter because it was technology. That reflects on culture. If it is a human passing down traditions, it is longer term than to go back and just put out a book and try to teach it from a book. That's a huge lesson that I surreptitiously got, but no one spelled it out for me.” – P21

The tabletop was a complex system, and people did not necessarily discover its full functionality. However, they did understand that making the effort was a sign of respect and earning knowledge.

**DISCUSSION**

Our contribution is that of identifying goals and describing and evaluating our design strategies that created opportunities for museum visitors to engage, learn new things and experience cultural values through their interactions with a tangible tabletop system. We generalize our findings so that other designers of tabletops for cultural heritage can design to support visitors to experience cultural values.

The unusual images of fish, the high fidelity of the physical belonging replicas, and the rings brought people into the space and enticed them to interact with the table, surrounding Homecker's concept of access points and entry points [20]. Obtaining the basic What is This? information was simple, offering the early feel of success [1, 9, 10], encouraging them to continue. The quality of the replicas (an issue of importance as noted by Horn [17]), the duo-language categories of information around the digital ring, and the progress bar allowed visitors to have a better understanding of the belonging by handling it and communicating the complexity of information surrounding the belongings. We found that, as suggested by Giacciardi and Palen [11], this multimodal interaction aided the exploration of tangible and intangible cultural heritage and allowed for new ways of engaging with specific cultural values. Indeed, visitors were able to identify Musqueam values and understand that cultural knowledge should be earned and treated with respect through interacting with detailed replicas.

We designed the activities to be intentionally difficult so visitors would actually have to spend time with and “earn” cultural knowledge, reflecting those values. The complexity of the system along with our decisions to give little instruction or feedback were intended to slow visitors down to take time with the information. This did work, yet we were hoping visitors would be able to access more content than they actually did. Twenty-four participants logged a total of 212 minutes with the tabletop, yet no one was able to access a video by exploring all four categories of information. While some visitors did uncover the multiple layers of information available from the different categories, which can enable richer interactive experiences [9, 10], most did not reach this level of understanding.

For Understanding it, many participants understood from the dotted line what they were supposed to do but were still unable to do so. This was due to a combination of technical issues (e.g., accidental touches changing the category on the digital ring) as well as interaction design issues leaving participants confused as to how they should complete the task. For Teachings, visitors were uncertain as to what they should do or assumed the table was malfunctioning. These activities need clear instructions on the table or salient feedback to help visitors actually access the information. In our post-study revisions to the system we improved usability of the Teachings and Understanding it activities, which may enable more visitors to reach the Having Stories content.
While we do see these issues of instruction and feedback as an area in which we can improve the design, it also speaks to the success of the interactions in helping visitors understand the complex stories and values we wanted to convey. 

**Belongings** — Belongings is rich with content that tells specific stories about the belongings of the Musqueam people and their continuing culture, but visitors were able to grasp information about Musqueam culture and identity, complex meanings behind the ancient and contemporary belongings, and even the specific value of earning and respecting knowledge without actually accessing much of the content.

**Design Recommendations**

Our design goals provide a rough trajectory for how visitors can interact with a cultural tabletop exhibit moving from basic engagement to deeper learning then to cultural experience. Here we summarize seven inter-related design strategies that may enable others to design to support visitors to experience intangible elements of cultural heritage directly through their interactions.

1. **Cultural Forms**. Use unusual or intriguing representations of cultural forms to draw people in (e.g., large fish cutting images and high-fidelity archeological replicas).

2. **Accessible Information**. Create opportunities for immediate interaction and access to basic information. Placing a belonging in a ring marked with ḥəḿ̓əḿ̓ and ḥəḿ̓əḿ̓ provides a very simple form of access allowing visitors to interact immediately, quickly learn basic information as well as provides entry to the value around language.

3. **Connect**. Connect the exhibit to visitors’ lives. The modern objects provide connections from the exhibition to visitors’ personal worlds. This provides a comparative foundation which may encourage visitors to connect cultural values to their own. The juxtaposition of ancient and modern belongings encouraged visitors to think about the combination of objects, mentally engaging with the belongings before even physically interacting with them.

4. **Contextualize**. Provide context through different modalities. The tabletop fish cutting carving image, the belongings and the ḥəḿ̓əḿ̓ language on the rings provide immediate context for visitors. Visual and physical elements of our design immediately convey that this is an exhibition about an indigenous group whose culture focuses on fishing. The pairing of modern and ancient belongings creates a contextual timeline, connecting past and present.

5. **Hands on values**. Design the physical properties of tangible objects to convey cultural values in such a way that visitors can immediately perceive those values as they view and handle the objects. Visitors viewed and handled life-like replicas of belongings, and then placed them back in their marked location on the cart. Through their form visitors directly experienced reverence and respect for these belongings, and by extension for the culture. There are many ways to reflect values in physical forms and resulting interactions. For example, the value of recycling could be communicated by low-fidelity, easily decomposable forms!

6. **Utilize social practices**. Use social practices to guide interaction and communicate tangible and intangible knowledge, like values. Interaction design can mimic, mirror or reverse such practices. We played on tradition museum storage practices and in doing so both utilized and broke social practices around (not) handling artifacts in ways that enabled visitors to experience respect for the objects.

7. **Non-linear explorations**. We used four non-linear but inter-related activities that enabled visitors to engage with belongings in a variety of different ways; all of which conveyed complexity of information and reflected values without forcing visitors to explore all content. In other tabletop designs, tangible objects often trigger only simple pieces of information (e.g., [18]) or have single-use functions (e.g., magnifying glass). We suggest that a single belonging can enable a series of interrelated but non-linear activities, providing a rich interactional experience and helping to convey complex information. While visitors could explore as much or little of the content they liked, the number of belongings and the ring’s belonging-specific status bar hinted at the depth of information available and conveyed values around taking time, care, and effort to understand Musqueam cultures. The specifics of activity designs will necessarily change based on the cultures, values, and exhibitions -- providing rich opportunities for new research.

**CONCLUSION**

In this paper we illustrate how cultural values can be made tangible through a unique design approach to an interactive tabletop museum exhibit. We offer seven inter-related design recommendations that may benefit designers of other culturally-specific tangible tabletop applications. In the approach we describe how cultural values are conveyed by embodying them in tangible objects, playing on social practices, embedding them in activities that together with digital content create opportunities for visitors to experience values throughout their interactions with an exhibit. Overall, we see our work as a significant contribution in understanding how to design to support visitor interactions with tangible elements of culture such as values. We found that tangible and embodied forms of interactions can be effectively used to support a greater understanding of cultural values. Indigenous heritage, and continuity of culture in a museum setting.

**REFERENCES**

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