Gali's Prize:

A Treasure Hunt Game for the Textile Museum of Canada

Pei Zhou

Gali's Prize: A Treasure Hunt Game for the Textile Museum of Canada

By

Pei Zhou

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Abstract

Gali's Prize is an experimental treasure-hunting game that integrates tangible and multi-screen interactions. The game has been designed for the Textile Museum of Canada (TMC) to replace the old quiz-style scavenger hunt with paper and pen. Its goal is to provide an entertaining, educational experience for children on school trips. The learning journey begins with an initial engagement at the starting spot and continues by approaching and connecting with a couple of specific artifacts in the exhibition space. The whole experience blends self-directed curation with an augmented reality (AR) treasure-hunting experience. During their participation, children will learn the stories behind the artifacts they encounter and gain lasting memories of their visit.

The investigation stands at the intersection of museum business, children's learning experience, and digital technology, and explores the opportunities and challenges involved in using mixed technologies in museums and galleries during the near future. At the same time, this examination studies the engagements and interactions of visitors on site. These explorations can potentially create benefits for both museums and visitors. The prototype of Gali's Prize was inspired by theoretical conclusions in existing literature, personal experiences in museums and galleries, and some studies of particular cases. It helps a specialized museum, the TMC, to experiment with a new solution that may solve their current issues.

This paper explains the relevant critical thinking, documents the development process of Gali's Prize, and provides discussion and reflection about the work.

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Finally, thanks for everything in my life.

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Where Do I Start?

Figure 1: Creed, M. (2001), Work No. 264, Two Protrusions from a Wall; Baseman, J. (1995), Call Me Mister

The idea of designing an entertaining educational experience using digital technology in a specific museum comes from my previous theoretical and on-site studies in this field.

When I was in the program of Art Museum and Gallery Studies at the University of Leicester, I wrote a master's-level thesis titled *Does the mobile phone enhance or distract the visit experience,* which includes all my research from 2010 to 2012. In that paper, I tried to analyze the current role of the mobile phone in museums, describe its double-sided impact on the experience of the visit, and explore the possible methods to minimize the distractions of the mobile phone. What I learned from this research is that, not only the mobile phone, but any type of digital technology inevitably provides an impetus for innovation in museums. Digital technologies can indeed help to enhance a visitor's experience by providing informative, lively personal guidance for visitors. As I will argue in this paper, these enhancements will never happen if the practice of using labels and docents for interpretation is continued. In addition, the presence of digital technologies in museums has shifted the core part of a visit to a museum from pure appreciation of the valuable collections to an experience of a new reality. From a micro-level point of view, this shift can be considered as evidence that digital technology distracts people from attention to the collections. If the situation is understood from a macro-level perspective, it may indicate a turning point for museums. The museum is no longer a place that simply provides materials; it provides experiences.

In 2011, I had a valuable offer to do an internship in The New Art Gallery Walsall in the United Kingdom. The internship provided me a great opportunity to participate and observe at a close distance the ways children engaged and interacted with the gallery's collections. During that period, I discovered that most of children

were fond of the sculpture *Two Protrusions from a Wall* by Martin Creed and a contemporary artwork, *Call Me Mister,* by Jordan Baseman (See Figure 1), because both of them are so special that children can imagine them as something else on their own, without interpretation by museum staff or parents. For instance, *Two Protrusions from a Wall* can be imagined as a part of a woman's body, while *Call Me Mister* can be seen as a man wearing a long beard. Through their imaginations, children may deepen their thinking about the relationship between objects in the world and gender. However, the way the children showed their love for these exhibits was different from the adults' way. My observation was they would not just stay in front of the objects and admire them for a longer time. They would also try their best to get a chance to touch and feel the objects, with the expectation of physical and even spiritual reactions, as they played with the interactive collections. Unfortunately, touching is generally banned by traditional art and artifact museums and galleries. When the children were stopped by a member of the security staff, they looked disappointed and then ran back to the ground floor because there was an engagement facility there where they could actually be involved in interaction. This experience made me realize that many fine art exhibitions and artifacts are losing people's attention, especially children's attention, only because they cannot provide interactive experiences for audiences. This loss of attention is a pity for the collection and also for its audience. In cases like this, initiatives are needed to design an engaging experience that motivates visitors, including children, to approach to the exhibits and investigate their meaning physically and spiritually. This kind of design is even more important than the attraction of visitors from outside to visit the museum. It is necessary to consider the demands of the visitors; for instance, children

may need help in their discovery of the interesting and exciting aspects of collections. They are expecting exhibits that include interaction.

Since I was concerned about these points, I made decisions about my next investigation. With the help of digital technology, I would love to design an entertaining learning journey for children. Within this kind of design, two vital tasks that need to be completed are: engaging children physically and moving them closer to some specific exhibits, and transforming non-interactive collections into interactive experiences. An expected result of accomplishing these the two tasks is that children will want to learn in a museum setting because of their self-motivation.

External Connection

LEFT: A photo for “Ancestry and Artistry: Maya textiles from Guatemala” Exhibition for TMC

RIGHT: A photo for the gift shop in TMC

Figure 2 (a), (b): Two views in the Textile Museum of Canada, Photos: Pei Zhou

Figure 3: Collar for a ceremonial huipil, gola San Critobal Totonicapan, Kiche Maya, c. 1930s-1940s, cotton, silk, commercial cotton.

Luckily, Gali's Prize has already found its most suitable museum — the Textile Museum of Canada (TMC), which is a small, specialized museum with approximately 12,000 collections from more than 200 countries and regions. Their collections include traditional fabrics, garments, carpets, and related artifacts such as beadwork and basketry. The uniqueness of the TMC is that it is situated between the realms of art and craft, and because its collections, can be considered as products of human sophistication and creative processes. The collections record the progress of human civilization during the course of history and celebrate cultural diversity around the world. At the same time, the artifacts themselves can also be seen as visual arts that have visual impacts through the sharp contrasts of various materials, colours, patterns, sewing skills, and so on. The uniqueness of the museum has engaged many people who have a particular interest in visiting the TMC's themed shows, which are based on the museum's permanent collection, and contemporary exhibitions of the work of Canadian and international artists.

However, the museum's uniqueness also creates a challenge. The museum's staff encounter difficulties in attracting children and in delivering the knowledge behind the artifacts or artworks. Compared with other typical collections that are enthusiastically welcomed by most children, such as dinosaur collections, collections relevant to textiles, for example, the collar shown in Figure 3, seem to be less exciting for children. For visitors, enjoyment of this type of work requires more patience and a bit more acquired knowledge of history and culture. Only through the exercise of some patience and the acquisition of some knowledge can they discover the deep excitement that may be found in such work, but neither of these activities are usually favoured by normal children. Besides, if children cannot interact with exhibits, they will very often be easily bored

and disappointed, just the way I experienced children's visits in The New Art Gallery Walsall. Although the TMC has a tradition of organizing scavenger hunt games for students on school trips and tries to lead children to acquire knowledge through a gaming event, the paper-pen mode quiz definitely limits the level of fun in the game. The result is that the scavenger hunt in the TMC would not be seen as a popular and successful event. Because of these limitations, the TMC has experienced demands to enhance children's learning experiences on visits to the museum. This situation has provided a wonderful opportunity to continuously develop my project, Gali's Prize.

Moreover, the managers of the textile museum care about and are implementing the use of digital technology in their work. So far, they have digitized all their permanent collections and stored the data in an online database. They have also developed several digital projects in collaboration with local artists. In addition, the TMC has prepared an experimental room for trials of new projects for the future. These initiatives indicate that the TMC has foreseen the future and is open to creative, innovative projects that utilize various digital technologies.

Accordingly, the matching goals of my investigation and of TMC initiatives are facilitating further cooperation. I am glad to meet the challenges involved in dealing with their difficulties too.

Hypothesis, Research Questions, and the Scope of Investigation

Figure 4: An illustration for thinking and research (Cited by Rodriguez, December 07th, 2012)

The hypotheses of Gali's Prize build on my previous studies: Firstly, **(H1) the movement to obtain various kinds of digital technology is one of the important trends in museums, at a time when digital technology has a role in an increasing number of fields. Digital technology brings innovation to museums. An obvious innovation is that museums have shifted from being material resources to becoming attractions that provide new experiences and information to the general public.**

Secondly, the managers of most museums believe that education is their key social responsibility. However, at a time when museums have shifted from being material-centred and government-controlled to being customer-centred and business-driven, a focus on didacticism has become obsolete. Today, **(H2) a wider concept of learning is advocated for more museums, that is, that learning should be a self-motivated experience. Museums should inspire their visitors to build a bridge between their existing knowledge and new insights by highlighting the exciting aspects of their collections, rather than using their expert power to supply visitors with official viewpoints. In this context, ludic learning experience, in other words, learning through play becomes more important.**

Based on these hypotheses, the main research question for my thesis project takes shape: **(Q) "How might we use mixed digital technologies, including personal mobile devices, stationary computers, sensors, and other popular technologies in museums to create a playful learning experience, such as a treasure-hunting game, for children in the Textile Museum of Canada?"**

The main research question leads to two important sub-questions that also need to be studied: One is **(Q1) "What could be a more effective kind of engagement for**

children?" The current types of engagement attract visitors to enter the museum and boost the entertainment level on site. However, I assume that a more effective kind of engagement facility could persuade visitors to approach the exhibits and naturally stop at more exhibits in a museum. Another is **(Q2) "How might we use and optimize the power of digital technology to create a primarily focused viewing experience that would provide a cool encounter, highlight exciting aspects, and encourage self-motivated learning in museums?"**

(S1) This project includes a plan to explore the use of **existing digital technologies** and to test the feasibility of utilizing them in museums in the near future. **(S2)** Although the design is specifically for the TMC, potentially, **it could also work in other art and artifact museums** that contain mainly non-interactive exhibits. **(S3) The target visitors are children from seven to eleven years of age, who occasionally visit museums on school trips.** Still, individuals who are member of the general public will not be excluded from experiencing Gali's Prize. **(S4) The investigation has focused more on the design of User Experience (UX), Natural User Interface (NUI), and trans-media storytelling.** The prototype is utilized as part of a design research that aims to mine more value from the use of digital technologies in museums, and also to develop more effectively executed on-site learning experience. In relative terms, my project may not have a perfect graphic design and optimized programming solutions because these are not the primary tasks of the study.

Methodology and Methods

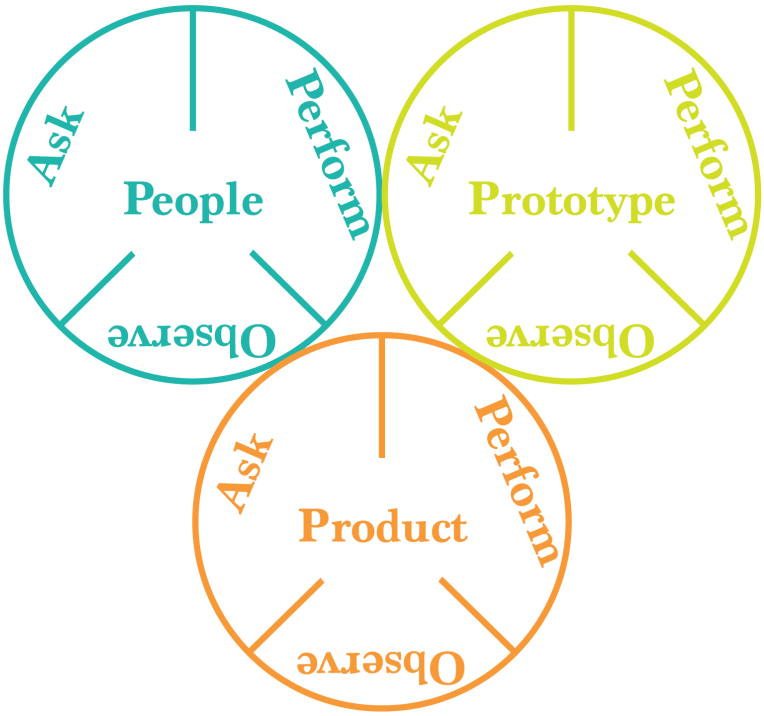

Figure 5: Ask, Observe, Perform Framework (Laurel, 2003)

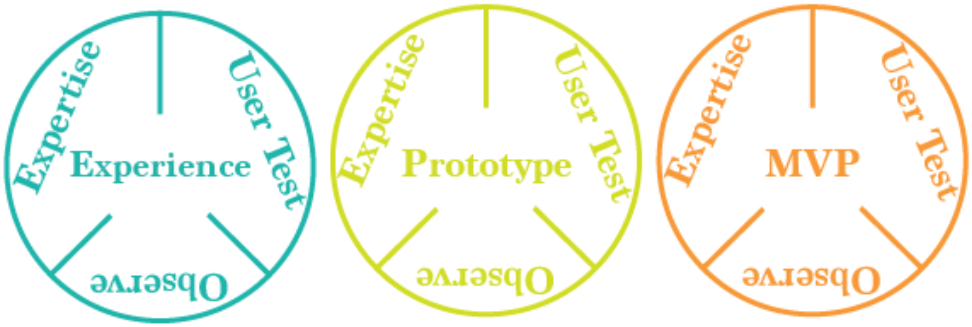

Figure 6: The Framework for Gali's Prize

The design concept of Gali's Prize emerges from the perspective of constructivism. Generally, constructivism is based on experimental learning that occurs through real-life experience and that both constructs knowledge and makes it conditional. From this perspective, the outcome of the research is problem-based adaptive learning, which challenges faulty schemata, integrates new knowledge with existing knowledge, and allows for the creation of original work or innovative procedures. In my specific project, I am using my existing knowledge system to design an entertaining learning experience for the TMC that may resolve some of its current issues. I assume that, during the process of this development, I will gain new understanding and experiences that will arise from the experiment. It is possible that this new understanding will reshape my knowledge system.

Modern constructivism can be basically characterized as including two types of thinking: radical constructivism and social constructivism. The former type contains two basic principles: (A) "Knowledge is actively constructed by the learner, not passively received from the environment" (Von Glasersfeld, 1990). (B) "Coming to know is a process of dynamic adaptation towards viable interpretations of experience. The knower does not necessarily construct knowledge of a 'real' world" (Von Glasersfeld, 1990). Radical constructivism emphasizes the importance of subjective consciousness and the uniqueness of an individual's thinking. The latter type of constructivism also includes one further principle: (C) "Reality is constructed intersubjectively; it is socially negotiated between significant others who are able to share meanings and social perspectives of a common lifeworld" (Taylor and Campbell-Williams, 1993). Social constructivism takes into account both the individual's subjective knowledge and society's objective knowledge. For my thesis project, I need to be a social constructivist

who explores a research hypothesis that is valuable, not only for me, but that can also influence a wide range of people and be accepted by them.

Therefore, during the process of research and design, I have learned from the Ask, Observe, Perform Framework (See Figure 5) that was introduced in *Design Research* (Laurel, 2003). This framework includes two key points: Firstly, the design research should be carried on within iterative loops. Thus, any great idea can be implemented in a prototype and get examined quickly. There will be more chances to improve, correct, and polish the design. Secondly, the Ask, Observe, Perform Framework presents a user-centred design process. Connecting with users and getting feedback from them frequently will be helpful in the effort to match products with users' real needs. Inspired by this model, I made a new framework especially for Gali's Prize (See Figure 6).

Seen from the digram, three stages planned in my investigation are: "Experience", focusing on understanding the current issues in museums, the demands from the children and building up a workable concept (An outcome in this stage is an user experience demo); In "Prototype" stage, some fragmented prototypes and code were produced, achieving the featured functionality of the project; "MVP[1]", is a stage that using an integrated minimum viable product[2] (MVP) to gather the data from on-site experience and exhibit in Graduation Show. Within each iteration, I changed "Ask" and "Perform" into "Expertise" and "User test." The original terms are set with the

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[1] When the term "Minimum Viable Product" or "MVP" refers to the viability in the new model, the definition has been extended as it is a strategy used for fast and quantitative market testing of a product or its features.

[2] When the term "Minimum Viable Product" refers to an outcome, I am using the original Eric Ries's (2011) definition: A Minimum Viable Product is that version of a new product which allows a team to collect the maximum amount of validated learning about customers with the least effort.

purpose of knowing better what users need and how they will use the product. "Expertise" and "User test" are used with the same intention. However, I preferred to use the specific terms to indicate the target people in the different steps. For the expert testing, I would heed the advice of professionals in various expertise areas, especially experts at the TMC and OCAD University (See a full list of experts in the Appendices). At the same time, for the user test, I would like to invite general users to test my design, since it is necessary to have information about the usage, interactions, and reactions from the interactions. That knowledge is the core part of my investigation. However, because of the limitations of time and conditions, not every expert and user test section is conducted officially. In the first two iterations, both expert and user test should be casual and should not include the involvement of children, whereas, in the last iteration, the sections are planned to be official, organized, and on-site. Moreover, the expert and user test at each stage should focus on a specific aspect. The user experience demonstration is conducted in order to examine the overall concept of Gali's Prize. The fragmented prototypes can help to maintain the functionality of both hardware and software; the expert and user test with a minimum viable product (MVP) will be focused on the final user experience.

Literature Review and Critical Thinking

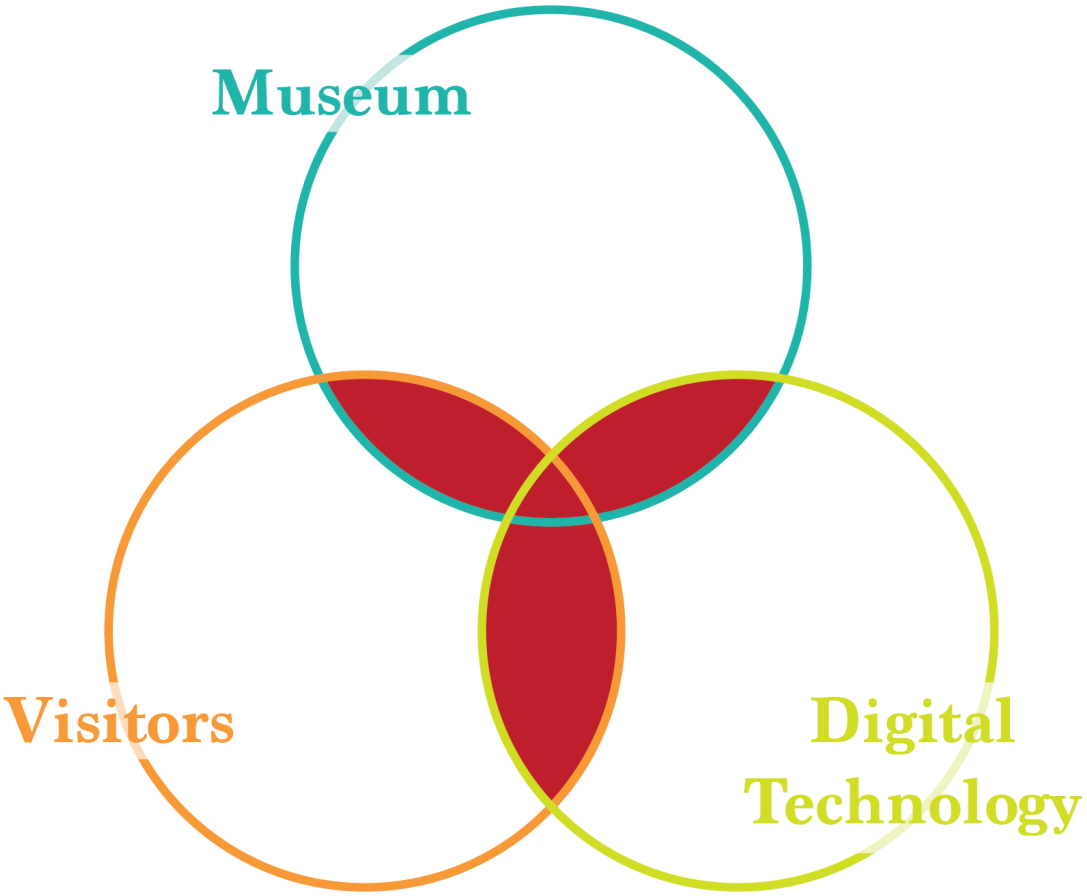


Figure 7: Research Field of Gali's Prize

Background Knowledge

A broad definition of "museum" includes "historical homes and sites; science and technology and nature centres; aquaria, zoos, and botanical gardens; as well as the traditional art, history museums" (Falk and Dierking, 2011; Gammon and Burch, 2008), and the word can refer to diverse facilities in society. From the nineteenth century to the present, museums have undergone dramatic changes. During this period, the museum has shifted from a particular space isolated from society to an important institution in society, from essentially material-centred or collection-based to visitor-centred or business-driven, and from homogenized to globalized (Knell, Macleod, and Watson, 2007).

One of the significant effects of the revolutions that have occurred in museums is that *education* has been listed at the top of museums' institutional priorities and has been a concern at least as great as research and collections (Falk and Dierking, 2011). One of the reasons is that financial support for museums has already shifted from mainly private funding and a modicum of public financial support to support from the public sector (Falk and Deiking, 2011; Watson, 2007). The public money comes with significant conditions attached, many of which require achievement of public educational goals. Therefore, the success of a museum or gallery is directly linked to its impact on the education of its visitors. An example of success is The Gardiner Museum of Ceramic Art, which is famous for its collections of ancient American artifacts, European pottery and porcelain, and contemporary ceramic art. Since its expansion from 2004 to 2006, the museum has had a large space for its educational clay classes and programs for different types of people, and these programs have been one of its steady revenue sources.

At the same time, digital technologies have been utilized in museums as tools. The first handheld device for use in a museum, which was invented in 1952, used a closed-circuit short wave radio broadcasting system (Tallon and Walker, 2008). Since that time, a wide variety of digital interpretative tools have appeared in the museum, such as audio tour handhelds, fixed kiosk-based computers, multi-media setups, mobile devices, and interactive toy devices. The use of digital technology in museum spaces arises from the demand for the provision of personal, customized service for individuals from various communities. This responsiveness is caused by museums' political characteristics — they have possessed "essentially caring and socially responsible ideologies" (Knell, Macleod, and Watson, 2007; Cameron, 2007; Golding, 2007) that prompt them to contribute to the creation of an equal society. The appearance of various digital technologies has brought more kinds of engagement and new interactions to museums, and, at the same time, created distractions from the physical materials in museums. One might suggest that the core purpose of visiting a museum has shifted from admiration of the aesthetics of veritable rare precious treasures to participation in new experiences and experiencing their emotional effects during the experience of the visit (Black, 2005; Roald, 2007; Tallon and Walker, 2008).

Museum as a "Context Provider"[3]

The book *Context Providers: Conditions of Meaning in Media Arts* provides inspiration that leads to an understanding of the museum in the digital era. In the book, *Lovejoy*, Paul and Vesna (2011) propose the idea that an artist should be considered as a context

[3] "Contexts Provider" must with Capital C and Capital P, for be differentiated from "context provider", a term to describe the artists

provider, rather than a content provider. This concept indicates two key points. First, it leads to the realization that, after the birth of new media art, the responsibility of an artist has shifted from the creation of a purely aesthetic object, namely, the content of an artwork, to the production of multiple contexts. It allows individuals to develop different understandings of a specific artwork, because it is consistent with the idea that the meaning-making process happens in a person's personal, social, and physical contexts (Falk and Deirking 2011). This notion is discussed further in this same chapter. Secondly, it suggests that the completion of an artwork depends not only on the artist. The audience has also been empowered to contribute to the artwork through interaction and experience with the contexts that artists have created previously.

In relative terms, the concept drives visitors to consider the museum a "Context Provider," a designation that also contains a double significance. One significance of the term is that it points to the new chaotic aura in museums during the digital age. Museums may contain multiple contexts from different times and spaces, including many past contexts from their collections, the current social and physical context on site, and also the virtual context produced by digital technological tools (Parry, 2007). Another interpretation emphasizes that museums should simply provide opportunities for interactions and proper guidance that may inspire further thinking within those contexts; this way of operating is preferable to showing authority and forcing people to accept expert opinions (Falk and Deirking, 2011).

These points suggest that the design of the experience in a museum should give attention to two considerations. First, the digital technological tools may create different requirements for the contexts on site. The choice of necessary contexts and elimination of the inappropriate ones for the exhibition is important to the enhancement of

experiences. The following examples demonstrate this point. "*David Bowie is…*" is an interesting exhibition staged at the Art Gallery of Ontario (AGO) in 2013. The experience was designed to be very artistic and immersive. In the exhibition, each visitor was equipped with a location-sensitive audio handheld device and wore headphones. The sensor on the handheld operated so that, when one walked closer to an exhibit, the interpretive audio automatically played. It should have been a great experience for visitors. Still, most people do not visit a museum as individuals. In this situation, communication with a person accompanying a visitor required removal of the headphones. When their talking was finished, they had to wear the headphones and listen to the audio guide again. In view of these interruptions there is a risk that the experience loses coherence. In contrast, in 2007, *Chanel Mobile Art Gallery* in Hong Kong allowed visitors to enter the space only one-by-one with a mp3 player, which controlled the social context (cutting off the communication among people) in the gallery space, so that the experience of immersion was successfully protected.

Secondly, when an experience for museums is designed, it is necessary to develop a proper method that allows visitors to generate a new understanding in an open context. For instance, "David Cronenberg: Transformation," an outstanding exhibition at the Museum of Contemporary Canadian Art (MOCCA) in 2013, chose to use multi-perspectives to inspire emotional sympathy and new understanding of a specific theme, and also to use Cronenberg's film as a medium in the middle that helps the development of deeper thinking. The artworks themselves are the intense emotional products that are constructed in the middle of Cronenberg's films and the artists' understanding of the themes. People understand these artworks through their personal understanding of Cronenberg's films, which helps them to feel the artists' concepts.

Because of these perspectives, visitors at the exhibition would feel that they are part of the exhibition and bring abstract feelings and understandings to the theme instead of knowing exactly what the content is.

The New Learning Experience Design for Children

Falk (2009) and Falk and Dierking (2011) proposed a broader concept of learning many years ago, which has been utilized in numerous museums. They believe that learning is actually an experience that links new information to existing concepts and principles in a learner's knowledge structure and generates long-lasting memories. Learning can be influenced by one's personal, social, and physical context in a museum (Falk, 2009; Falk and Dierking, 2011). On the basis of this concept, when a learning experience is designed for children, it is necessary to consider it from their three basic contexts, and to provide inspiration, bridges, and wonderful memories at the end.

Essentially, for a children's agenda, a visit to a museum should be a leisure time, which contrasts with formal education in a classroom, even when the children come to the museum on a school trip. Children prefer more entertaining and engaging events on site. Still, as a group of typical occasional visitors, they obviously need guidance and interpretation provided by the museum, because they usually do not prepare a detailed plan before their visit. Their lack of pre-knowledge about art and artifacts is different from the state of most adult regular visitors, and aimless experience sometimes easily makes them bored, especially when the exhibits are non-interactive or too abstract to be understood. The process of providing learning experiences for children is more difficult than offering learning to others. It is necessary to consider both entertainment and illumination.

Besides, children in different age brackets behave diversely in their visits. In one observation by Falk and Dierking (2011): children from six to twelve years old usually are more obedient to the guidance that is provided in the museums, and would love to be accompanied by their parents and teachers during the whole experience, which is opposite to teenagers who feel more comfortable with their friends, or being alone walking ahead of their guardians. Theoretically, it is because children at different ages progress through different stages of cognitive development (Piaget, 1983). Jean Piaget, in one of the most influential theories of cognitive development, has indicated that there are four distinct stages in children's progress: (I) From birth to age two is the sensorimotor stage, in which infants and toddlers acquire knowledge through sensory experiences and manipulating objects; (II) From age two to about age seven is the pre-operational stage. At this stage, children learn through pretend play, but still struggle with logic and taking the point of view of other people; (III) The concrete operational stage is from age seven to age eleven, which is significant for shifting from studying the concretes to understanding abstract and hypothetical concepts; (IV) The formal operational stage starts after age eleven, which involves an increase in logic, the ability to use deductive reasoning, and an understanding of abstract ideas (Piaget, 1983). Consequently, designers of learning experiences in museums should give consideration to children's specific cognitive development. For instance, providing concrete stimulations for children helping with understanding an abstract concept is proper for children from seven to eleven years old, but might be too intricate for younger children.

In addition, children's learning experiences have to be considered as occurring within their social groups, such as their family or their school companions, because no child will visit a museum alone. Different social contexts will require the design of

different scenarios. For example, on a family trip, children would have a chance to use their parents' smart phones as tools for their visit experience. Hence, a mobile app with a personal account would work for them. The agenda for a family would be to have a happy time playing together, so that the learning experience could potentially be child-centred, but go beyond that to include adult education. In contrast, on a school trip, the equipment provided by the museum would be more accessible; besides, the participation of many children in the experience together produces a better collaborative context for sharing the material recourses and exchanging information and knowledge.

Children's learning experience would also be directly influenced by the collections. An interactive exhibit may have a particular way of engaging children's eyes and easily attracting them to become immersed in it. Compared to this engagement, most traditional non-interactive arts and artifacts usually require a special technique, directed looking, to achieve learning through observation. Theoretically, the observation of arts and artifacts can be divided according to five different levels: physical properties, subject matter, illusory properties, formal elements, and viewer's perspectives, which represent the five steps in the process of meaning making — observe the appearance of an object, then experience a direct understanding of what this object is about, imagine something more than this object, evaluate the object on the level of art and craft, and develop a subjective idea at the end (Golding, 2007). The technique of directed looking is intended to initiate the shallow level of observation of an object, and then intimate the clues for a deeper level of observation, which inspires personal discovery and understanding of the object.

There are many examples of the use of directed looking as a core method in museums. For instance, many museums print out various paper graphics that are the

shape of some specific exhibits and encourage children to fill in the colours with colourful crayons as they stand in front of the real objects. Another similar example is a children's puzzle game, in which the patterns from specific exhibits are generated. One purpose of these activities is to encourage children to create something new. More importantly, it is assumed that, when children do the colouring or complete the puzzle, they will observe the original work first. By playing with the original idea of an exhibit, children may engage a deeper thinking by themselves. Moreover, the self-directed events that happen on school trips to the Museum of London have also used directed looking. These examples illustrate the traditional designs for children's learning experience. It seems that these are designated for children of different ages. Drawing experiences and puzzle games are for younger children, whereas knowledge-pursuing school trips are more suitable for teenagers. Children have the freedom to choose what they are interested in during this learning process, a way of operating that might be welcomed by the children. However, the old designs of directed looking have a limitation: the method engages only with vision. There is a lack of the feeling of involvement, and it is hard to become attracted to one object for a longer time. To break through this limitation, museums have anchored their hopes in digital technology. It is expected that the involvement of diverse digital technologies will be helpful in creating innovative and better directed looking experiences. Furthermore, since formal classes at schools are increasingly open and more stimulating than they were in the past, increasing the fun level by using digital approach may be necessary there too.

A great example is "Time Tremors" in the Art Gallery of Ontario (AGO). The exhibit was a mobile, online, real-world treasure hunt that combined game play with a transmedia approach to storytelling. In the game, children could get animated

notifications on their mobile phone through an Augmented Reality (AR) technique at special spots around and inside AGO. They were guided towards a series of target exhibits in order to complete tasks by answering a dozen questions in a certain amount of time. It was assumed that, at the end, children would obtain treasure and impart knowledge at the same time. This project brought a new story that was suitable and entertaining for children into the gallery, and created a new role for each child in the gaming event. The entertainment level and the feeling of participation in the experience were enhanced. The AR also successfully rendered many non-interactive materials in the museum into interactive materials and allowed children to engage more senses, such as touch and hearing, in the experience.

Technologies in Practices

It is inevitable that the use of digital technology in museums still needs to be further developed. On the one hand, it is used to pursue novel sensory stimulations for visitors. On the other hand, it is possible to develop scholars' current level of theoretical knowledge to another level through more practical research.

The most popular tool in museums for nearly a decade has been the smart phone because of its five significant advantages. Firstly, use of a visitor's personal mobile device can circumvent the museum's limited budget for equipment (Tallon and Walker, 2008). The traditional handhelds and other similar equipment have to be provided by museums, which spend a large amount of money on the devices. To charge visitors or not is a matter that is always a subject of argument. Use of a visitor's own device can solve this problem directly. Secondly, the smart phone can provide customized service for various visitors, a way of operating that is consistent with the

original goal of museums: to create the equal access for everyone in the society (Gammon and Burch, 2008). Thirdly, use of a mobile phone allows visitors to "talk back" to museums and share their thoughts with others quickly (Samis, 2008). This feedback from the public can help with the development of self-criticism and a better understanding about visitors. In addition, word-of-mouth promotion is one of the most efficient ways to expand an institution's popularity. Fourthly, through the provision of location-sensitive services on smart phones, a virtual space can be associated with locations in reality, a link that also creates new possibilities for interaction and engagement in museums. Fifth, the use of mobile phones for museum visits potentially extends the experience from on-site only to off-site too, an extension that may enrich both the pre-visit and post-visit for visitors. An increasing number of museums now have their own mobile applications. In the meanwhile, many digital media companies are expected to connect with museums in order to secure the authority to build their own applications.

However, many scholars have concerns that the use of mobile phones hinders visitors' interactions (Smith and Tinio, 2008) through reduction of communications and interactions among people, and also takes visitors' attention away from the exhibits. For this reason, scholars have indicated that guides for visitors in the cultural heritage domain may not be prepared through a single digital technology in advance; guides need a combination of mobile, stationary, virtual or augmented reality, and Internet technology (Gottlieb, 2008).

Recently, a popular technology that has appeared in museums is AR (augmented reality) technology, which is a cutting-edge technology that allows for a digitally enhanced view of the real world. AR can connect users with more meaningful content

in the physical world. In addition, with the camera and sensors on a smartphone or tablet, AR can easily add layers of multi-media information, such as videos, photos, and sounds, directly on top of specific items. The basic use of AR is similar to the use of QR code. When a special marker is seen by the camera on a smart device, multi-media information will pop-up on the screen as a new layer or object, as two- or three-dimensional augmentations — data that fits into the existing scene. Unlike QR code, AR does not need a special type of code as a marker; instead, it allows the generation of any graphics as AR markers.

A relevant example was "Time Tremors" at the AGO, which was mentioned previously. In this project, AR technology helped to indicate where visitors are standing and what painting they are looking at during the gaming event. To accomplish the tasks, players needed to interact with the pop-up multi-media information on the screen. Another example was the new dinosaur exhibition "The Ultimate Dinosaurs: Giants From Gondwana" at Royal Ontario Museum (ROM) in 2013. In this exhibition, three AR stations in the space allowed visitors to experience lively 3D dinosaurs, including the virtual fleshing out of a dinosaur skeleton. Additionally, through the use of body-scanning technology, two giant digital walls show dinosaurs from the northern and southern hemispheres that react to visitors' movements as they approach. Through the observation of users and experience of the AR application, one realizes that this technology is super-efficient at prolonging the time of the directed looking, and also at stimulating interest in discovering more about the collections. At the same time, it raises a question: does it reduce distractions from mobile phones or not? One may argue that the pop-up multi-media information on screen may increase distractions from mobile phones. Another person might have the opposite view: that AR technology helps

to suggest where to look, a type of direction that reduces distractions from other materials. This question needs to be further tested through practice in museums.

The growing market of NFC (Near Field Communication) phones has prompted museums to start testing this emerging technology on site. In 2011, the Museum of London did a test for its new system with a NFC phone. In cooperation with the Museum of London Dockland, the former museum installed a total of approximately 90 tags that are located in highly visible areas where users can access more information or special services. On site, all the tags are mounted on the walls. When individuals request further information, they need just to put a NFC phone close to or touching the specific tag. Thus, the relevant information would be downloaded to the NFC phone directly. This project is a prospective experiment even today. Many believe that there will be a future trend to the use of NFC phones in museums. However, at present, the market share of the NFC phone is still not significant, and the application of NFC has been happening only for a couple of years. The result is that, so far, widespread use of the phone is still impossible in museums.

Nevertheless, a similar technology, RFID (refers to radio frequency identification), has been in widespread use all over the world. It is a simple, relatively inexpensive, and reliable method of making connections between visitors and installations or exhibits. One of the projects using a RFID card is "Mobium" in Onyang Museum in South Korea. The Mobium system was designed to be a trans-media story-telling machine that transfers personal stories in the past to a collaborative story line and that can guide others' visits to the museum (Laurel, 2007). During the trans-media experience, the RFID ticket is used as a tool to track the location of visitors and to trigger interactions with the information panel. At the end, the ticket could be a

souvenir of the museum experience. The most significant feature of the use of RFID technology is that the interactions with the RFID card are simple, natural, user-friendly, and private. These qualities can contribute to the Natural User Interface (NUI), especially within a trans-media or multi-platform experience.

Design Process

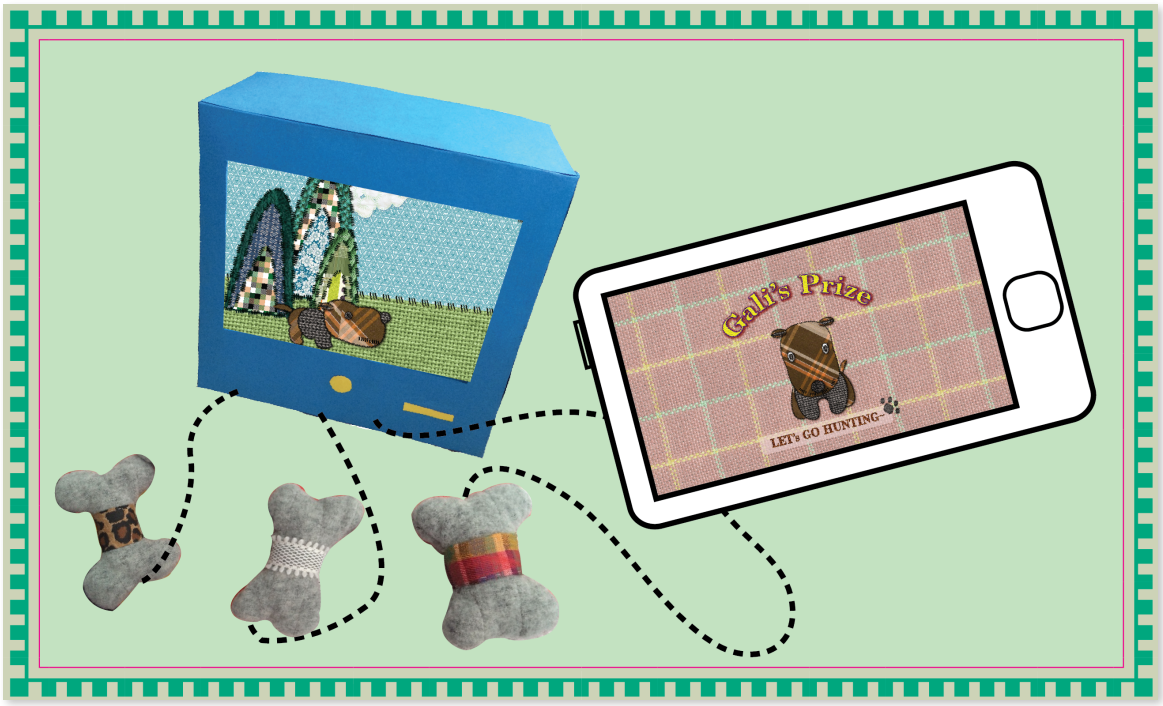


Figure 8: An illustration for Gali's Prize, made by Pei Zhou

Concept Overview

The mission of Gali's Prize is to help the textile museum to deal with its difficulties in drawing children's attention to their elegant but not exciting collections and in delivering informal knowledge to children. The treasure hunt game is an effort to provide new engagement through different types of interactions with digital technologies and to provide indexes to the excitement that are relevant to the artifacts. The result is a better entertainment and learning experience for children. Moreover, Gali's Prize can satisfy children's desires to engage in new experiences, participate in more physical interactions, become self-directed in the space, and also obtain small souvenirs from the gift shop. The belief is that they will gain a lasting memory of their visit.

The design of Gali's Prize has accepted the positive effects of digital technology, has integrated mixed technologies, and has prepared tangible interactions, multi-platform experiences, and innovative AR storytelling for children. The importance of using Natural User Interface (NUI) for experience design has also been noted. It maintains the mystique about the workings of digital technology and also enhances the fluency of the user's experience. In addition, Gali's Prize has accepted the concept of learning as experience. It provides help that bridges children's pre-knowledge to the new things instead of educating them by rote memorization.

To achieve the best design, I have created a model that arranges the priorities among the multi-users, namely, the children, their teacher, and also museum staff members (See Figure 10). The pink rectangle in the model stands for the position of this project and how it may be proportioned to satisfy each user. Since Gali's Prize is a child-centred game experience, I would consider children's needs the highest priority

and then the teacher's expectations. The museum stands in a special position in this project. The expectation of museum represents the depth of the project, since a contribution to development and innovation at the museum is essential to Gali's Prize.

The experience of museums and theme parks has been compared (See Figure 11). From the comparison, one can learn that the uniqueness of a museum is that it possesses plenty of aesthetic values, whereas the theme parks have more entertainment values. The common feature of both kinds of institutions is social, cultural, and leisure entertainment. Recently, museums have learned from the theme parks that they need to organize on-site more entertaining events that have political and social implications. The goal is to influence an emerging middle-class population and to inculcate it with civilizing values and the rules of social decorum (Bennett, 1995; Bourdieu, 1984). However, the long life cycle of museums differentiates them from theme parks; more aesthetic values are needed in museums for children. So those who are developing Gali's Prize would consider moving gaming events for children a little bit towards aesthetic values as a goal.

The scenario for the experience is similar to this one: one day, a group of students goes on a school trip to the TMC. Upon their arrival, they are first gathered in the Learning Centre. There, each student is given a ticket and a mobile device[4]. Then a museum staff member or a teacher announces that they are going to participate in a treasure hunt game today and that the "Gali's Prize" application will provide them with information about the game. After the children look through the instructions in the

[4] As mentioned previously, for school trip, iPads provided by the museum are more accessible for children. And TMC has announced that they have bought twenty new iPads for future school trip events. However, due to the technical restriction, I will start from developing a mobile application for the latest iPhone first. Potentially, the next version of the application could be compatible for both iPhone and iPad.

app, they will know there is a secret hidden in their tickets, that is, a clue to the discovery of gold in the TMC. To obtain the clue, each child needs to find a dog, Gali, who has been trained as a professional gold hunter and is the only one who can read the secret. Children can find Gali on a touch screen somewhere in the Learning Centre. Through their interaction with the dog, the dog will provide highlights of two artifacts in the exhibition room. Children can download the treasure-hunting tasks on their mobile devices. Then they can go to the exhibition space and start their treasure hunt experience. To obtain the gold, the children need first to find the artifacts that Gali highlighted for them. Then they will listen to a relevant story and interact with the artifact through an AR experience that is a task. After the children accomplish the task, they get virtual gold as a reward. Their gold will be recorded by the app automatically. During the experience, the children may realize that the different tickets indicate different tasks. They are encouraged to exchange tickets with each other in order to learn more. During the learning experience, their teacher and museum staff members could help them when necessary, but not guide them all the time. At the end of the journey, children can exchange their virtual gold for a coupon, which is provided exclusively for use in the TMC's gift shop. The hope is that children will be excited about obtaining a reward in the real world. Even more important is the fact that the special lucky tickets can also be souvenirs for the children.

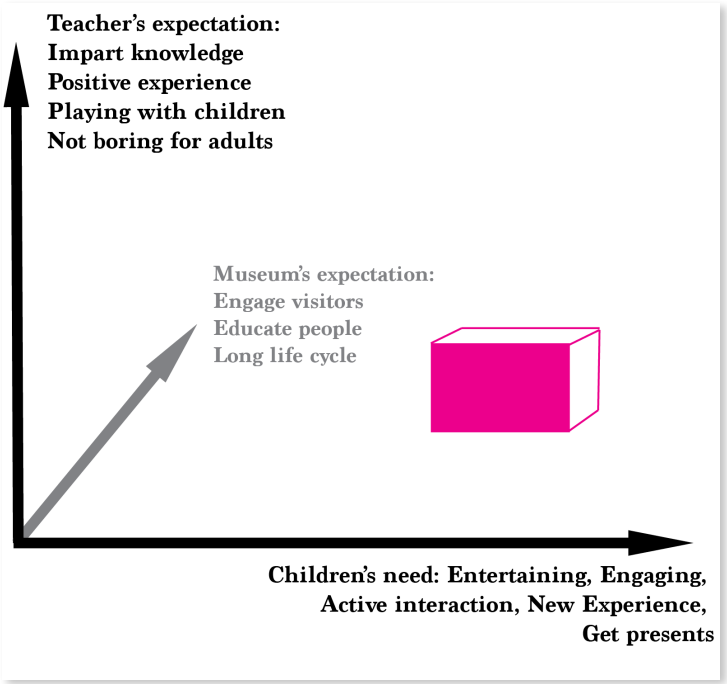


Figure 9: The priority model for multi-users

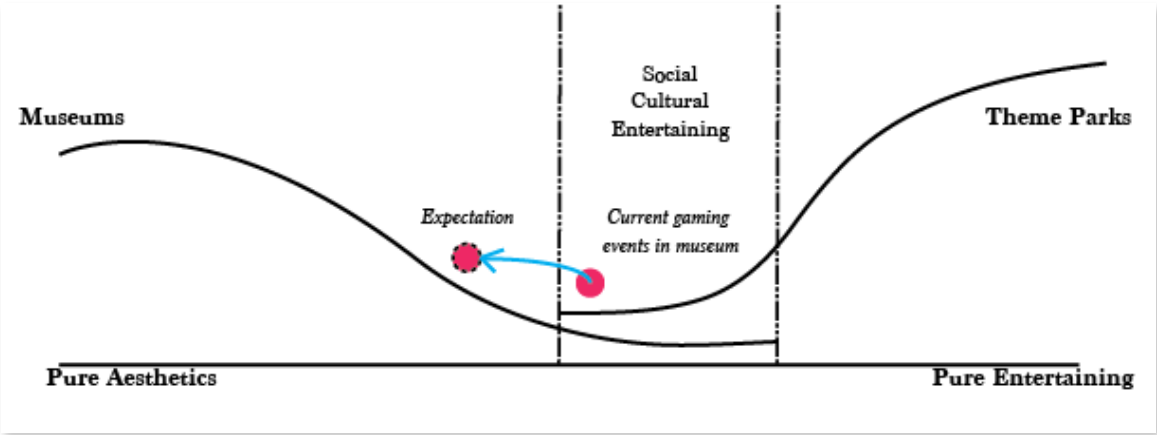


Figure 10: A comparison between museums and other theme parks

Museums has learnt from theme parks for several years. They have continued to develop more social, cultural and entertaining values for the on-site events, especially for games. However, the uniqueness of museums is that they possess many precious aesthetic values. So Gali's Prize wants to shift the on-site gaming events towards the pure aesthetics.

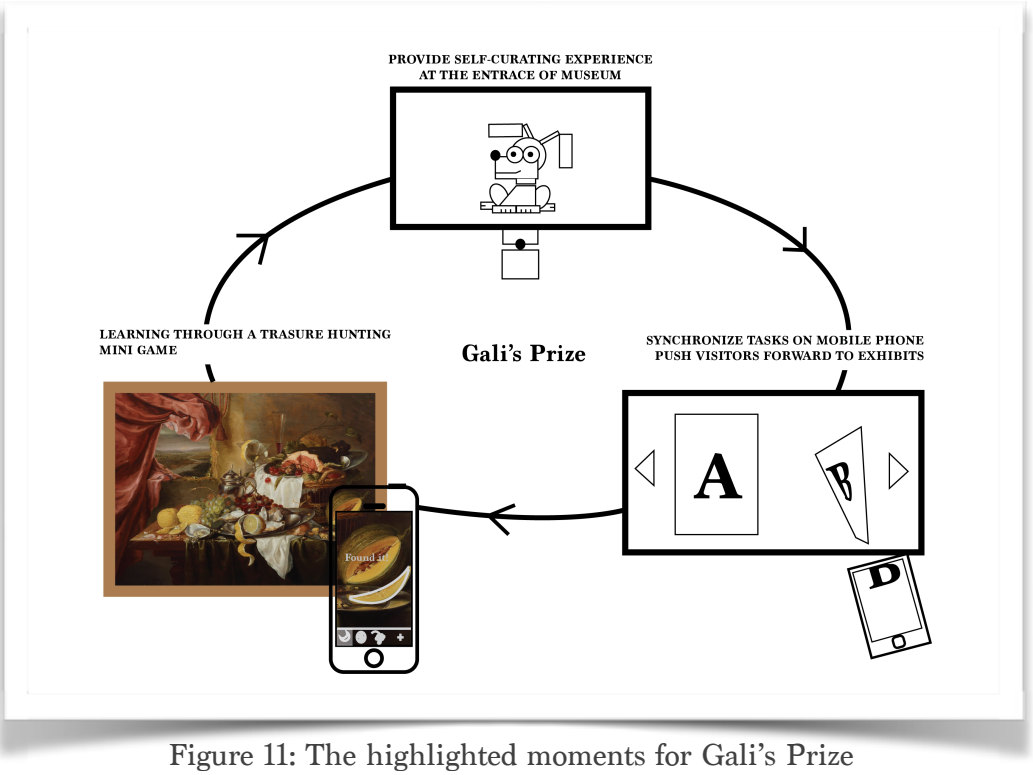


Figure 11: The highlighted moments for Gali's Prize

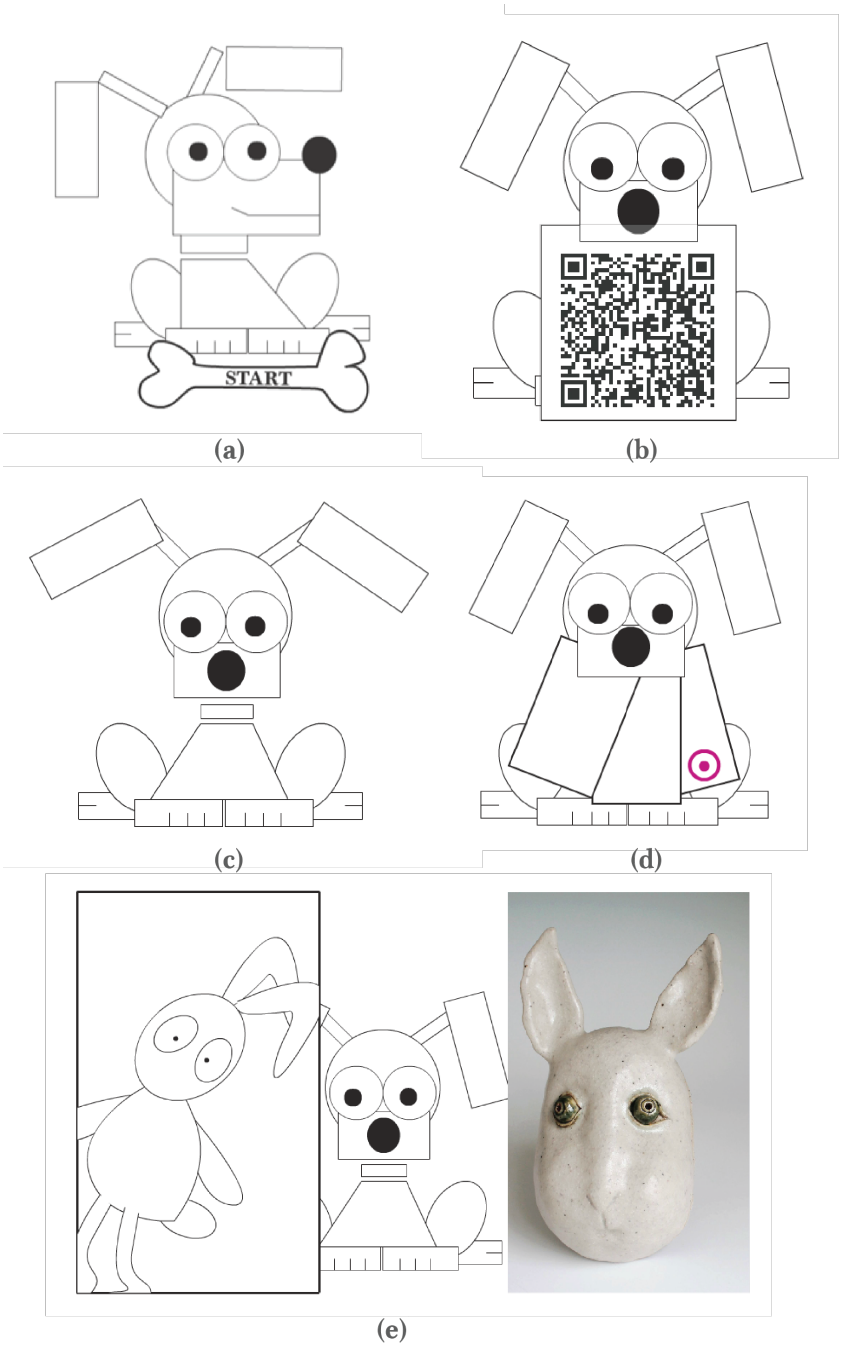
Figure 12: An interaction flow chart

User Experience Demo

The challenge of the first iteration is to explore the development of a conceptual blueprint of the ways users would interact on site, and the way software and hardware should be operated (See Figures 11-12). The purpose of the user experience demo is to illustrate all the possible happenings in the gaming event, and to present the game to experts and potential users in order to examine the feasibility of the design.

The user experience demo illustrates the first design of Gali's Prize, which allows children to bring their small, personal interesting devices to the museum and to use the devices to browse similar items that are shown in the collections. After that experience, they can hunt for gold and listen to stories from the collections that they choose. This design was partly inspired by two experimental projects in Cincinatti Museum Centre (TED.com, Dec 2012). The projects utilized the idea of using facial expressions and drawings to browse collections in a museum's database. Besides, in the old design, the directed looking in an augmented reality (AR) experience allows the children to contribute to other users' experiences by adding new elements that they are interested in to the database.

The demo includes an interactive animation that has a built-in flash and a mobile phone prototype that uses an easy prototyping software, Justinmind. The design of the characters and the interface are kept in a prototype style, with simple lines, texts, and colour. The screen shots from the user experience demo are shown below (See Figures 13-16).



(a) loading page

(b) generating QR code and waiting for scan

(c) recognize you

(d) get the searching result

(e) showing the result

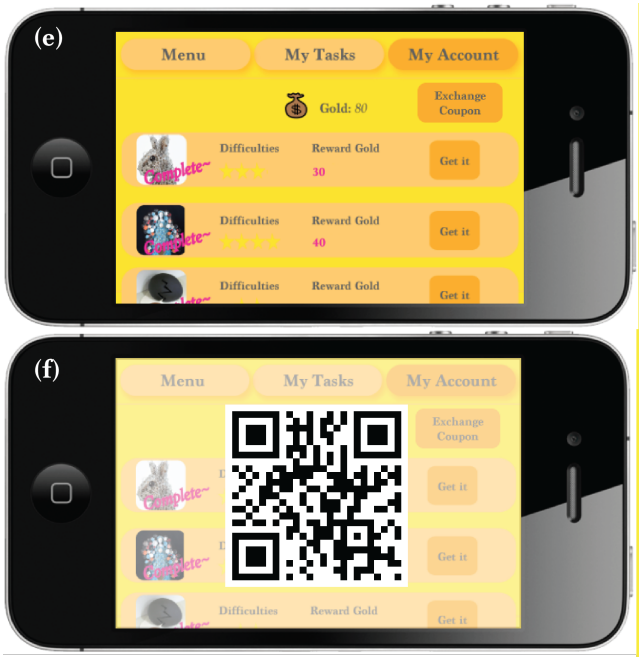
Figure 13: A screenshot from interactive animation

(a) menu page

(b) (c) "My Tasks" page

(d) illus-trate for AR interaction with an artwork

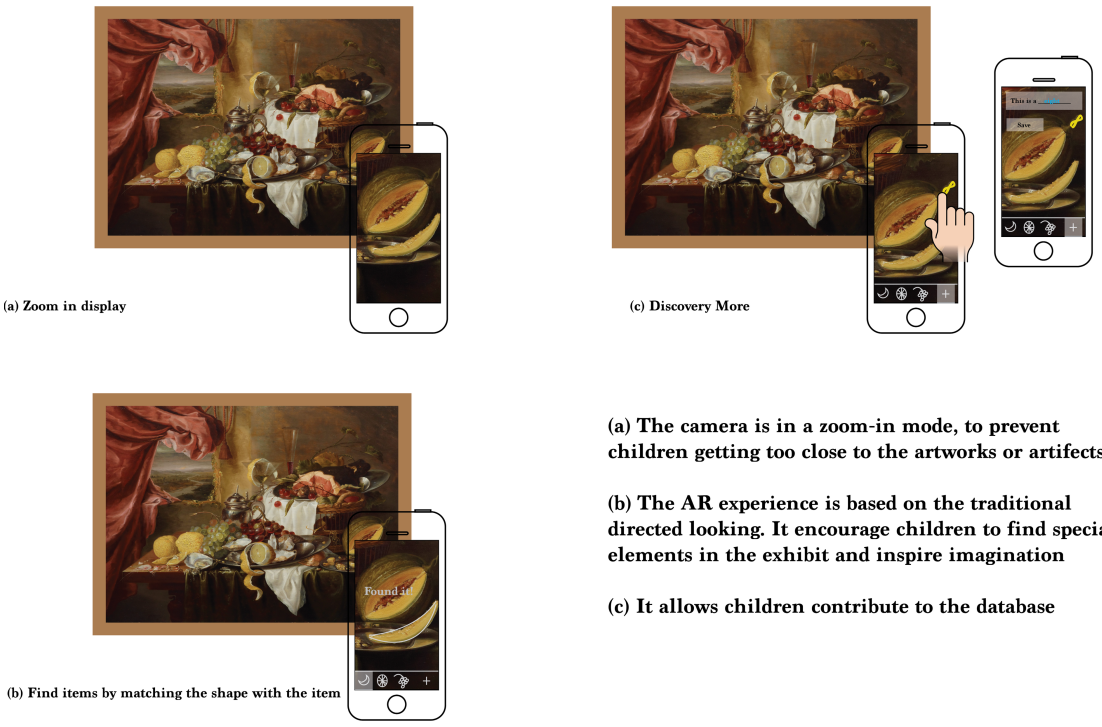
Figure 14: A screenshot from app mock up (A)



(e) "My Account" - records the gold and completed tasks

(f) exchange coupon - can use it in the gift shop

Figure 15: A screenshot from app mock up (B)



(a) The camera is in a zoom-in mode, to prevent children getting too close to the artworks or artifects

(b) The AR experience is based on the traditional directed looking. It encourage children to find special elements in the exhibit and inspire imagination

(c) It allows children contribute to the database

Figure 16: An illustration for AR experience

When I completed my user experience demo, I consulted with the professors at OCAD University whose areas of expertise are digital technology and design, and also met individually with professionals at the AGO and the TMC. The focus of the consultation was the design concept. Their critiques and suggestions, which incorporated various perspectives, motivated me to rethink many aspects in the design.

Professionals at OCAD University offered the following feedback:

- First, they expressed concerns about whether Gali's Prize provides a self-curating experience or is part of the museum's curatorial work.
- They also suggested that I should think about how to make the AR experience more meaningful. Their comments indicated that some of them were very concerned about the distractions that arise from screens. I therefore had to think again about whether it is a good idea to let children look back and forth at physical exhibits and then digital images on screens.
- Use of the technology of graphic recognition and matching for my thesis project would be very time consuming. The use of samples of artworks or artifacts to test it would be an urgent requirement.

The experts based in museums offered different comments about my project:

- All of them had an overall positive attitude to Gali's Prize. They thought it could be an interesting project and a useful resource for museums.
- One concern expressed was that development of this project on site might require collaboration among different departments, such as the curatorial department, the learning and visitor department, the digital media department, and

so on. Such collaboration is hard to arrange in large-scale museums such as the AGO and ROM, but would be more feasible and beneficial in a smaller museum.

- The staff in museums hesitate to allow children to use anything they like for browsing, because then the experience would be too open to exercise control over it. They suggested that I start with a simple plan that would use physical icons that are first chosen by the museum. The advantage of using selected physical icons as searching objects is that the museum can control the content that they will provide to visitors and can effectively reduce errors during the computer's search process. The use of several objects still provides options for children to choose something they like.

After this consultation process, I invited four potential users who are members of the general public to offer feedback about the design concept. Because the process of locating children for the first user test could be time consuming, I chose a mother (mature adult), an English teacher (mature adult), and two younger adults (18 to 20 years of age) from China or Canada to participate in the user test. The mature adults represented the attitude of parents and teachers, and the younger adults expressed opinions that were closer to children's thinking. All the conversations happened via Skype and included a screen sharing my user experience demo. Their feedback can be summarized as follows:

- All of them agreed that Gali's Prize would be a great game for children, but they were concerned that, if children did not know about this gaming event in advance, they would not bring any object special and suitable they wish as a starting point for visual browsing of collection objects in a self-directed experience. They

preferred the idea of using special physical icons that would be provided by the museums.

- The parent and the teacher expressed concern that there might be too many steps involved and that users would not understand how to operate the game. Later, they said that perhaps their doubt arose from the fact that they did not really experience the game, but instead looked through the mockups while I explained everything to them quickly.
- In contrast, the younger users understood the interactive flow very fast. They also mentioned that they were not fond of museums, because, to them, the experience of visiting museums was simply walking around in the space without any purpose. Normally, they would not go to a museum unless they had to, but they thought that Gali's Prize could make the visit experience more interesting, not only for children, but also for adults.
- They understood that my thesis project would end with a Minimum Viable Product (MVP) and that the interface design would not be the core part of the design. However, they felt the dog character would be attractive to children, so the character should have an appealing appearance. Maybe a simple design with more colours could work for them.

In light of the feedbacks from the expert and user tests, I re-considered several points in the project:

- Firstly, it is necessary to clarify that Gali's Prize is a self-directed learning experience. It would not influence the contents in the exhibition at all, but coordinate with the exist exhibits on-site, providing an additional journey for

children on their school trips. Functionally, it only could play the traditional role of teachers and docents, providing guidance and interpretations to the children using a treasure-hunting game.

- Secondly, as mentioned in previous chapter, with regard to the AR experience, I noted the double-sided effects of this experience. Still, my opinion is that, for a person who has engaged with a collection, a screen with AR effects might distract from the experience and be redundant, but, for a child who has a problem with relating positively to a specific collection, the positive effects of AR technology far outweigh any negative features. Therefore, I persist with experimentation with AR in my project.
- One point in the feedback from general users is that the graphic designs on both platforms should be improved (more design, more colour). This recommendation challenges my original idea, which was to produce the MVP. The concept of a Minimum Viable Product involves quickly prototyping the highlighted features of the product and testing it. This process assigns a higher priority to the functionality of a product and a lower priority to interface design. On the one hand, I think it is reasonable to adhere to the principle of the MVP, since the development of a testable prototype is urgent for my project. On the other hand, I have to agree that the interface design matters to the experience and will definitely be influenced by my expert and user test feedback in the third iteration. In order to achieve a balance between efficiency and quality, I have decided to make a more acceptable interface design and to use the patterns from textiles for my prototype. I will not pursue a perfect version of the interface.

- I would also like to advocate the idea of using a physical icon in Gali's Prize. I have designed three pieces of RFID ticket to be the physical icons in the gaming event.
- In addition, I have selected six pieces of artifacts from the TMC's permanent collections in preparation for a further test of the AR experience.

Prototype

The second iteration of Gali's Prize has the challenge of overcoming many technical issues in the process of developing a functional and testable prototype by the end of the iteration. The prototype contains a Java application on Mac, linked with a RFID reader and an Arduino UNO board, and also an iOS application for iPhone 5 and iPhone 5s. All of the code was co-programmed with Mr. Chi Zhang, a talented programmer who has great knowledge of digital technologies and is interested in developing cross-platform software.

Victory I: The animation of Gali was designed with an intention to use textiles as patterns, since the project is being done in cooperation with the TMC (See Figure 17). The animation was built in Processing, an open source software with numerous .png images first, and then transferred into NetBeans using Java language in preparation for further connections with other electronic elements and iOS application.

Victory II: A QR login system has been used in Gali's Prize in order to pair a specific mobile phone with the Java application on a touch screen. The advantage of its use is that it allows users to connect with a public screen without typing in any personal information such as a username and password. Because it is unnecessary to require children to create personal accounts, for Gali's Prize, each QR code contains only time information that has been compiled by a hash algorithm. When the mobile phone gets the hash number, it will automatically send the same number back to the server (the java application) to pair with the computer. The QR generator has been embedded in the Java application. It can generate new QR code at the backstage and save the new code as a .png file. The previous QR code image in the data folder is replaced. Thus, in the animation, the QR code is always the latest (See Figure 18).

Victory III: The mobile application is built in Xcode using Objective C language. The interface of the mobile application continues to use the idea of textiles with simple layouts (See Figure 19). The development of coding the application started from building up the three basic UI view controllers, which are the menu, my tasks, and my gourd[5]. After that, a loading page, instructions, a QR reader, and so on have been embedded in the application. The basic development flow is to build up the main storyboard first, then declare each object in the .h file, and initiate each object and code its methods in the .m file. To embed the QR reader in the application, a SDK, ZXing, has been used in the Xcode.

Victory IV: The physical icons have been designed as three special tickets with RFID tags. In order to develop a souvenir style for the tags, various types of RFID tags have been tested (See Figure 20). The design concept is the creation of something similar to the products in the TMC's gift shop. The RFID tickets are designed to appear as soft dog bone toys with different ribbons (See Figure 21). Each of them indicates a different task list for treasure hunting (Animal, Geometry, and Textile). The size of the tickets is perfect for children's hands. This design requires a smaller but sensitive RFID tag. Through testing, I chose to use a capsule one in my project. To link to a RFID reader, the Java application needs to read through the serial port. Since the Java application is on Mac OS, the built-in device management directory, "/dev," has been called in the code. Thus, the Java application would be able to read the string in the RFID tags easily and directly.

[5] The meaning of "My gourd" is the same with "My bag." The idea of use a gourd represents a bag carrying props and money in game comes from the legends in Chinese Taoism. The Taoists use gourds to collect treasures and imprison the monsters.

Victory V: The communication between the Java application and the mobile application is more complex than reading strings from the serial port. To achieve this communication, the Socket Protocol has been used for both platforms. Through the Socket Protocol, the Java application should act as a server and take charge of listening to the socket access (port 1112), whereas the mobile application is a client. The IP address of the server is changeless so that it can be manually written into the code for the mobile application. When the mobile phone sends the first message to the server using Socket, the backstage of the mobile phone will generate a temporary IP address for itself, and the server can get the address through the initial message delivery. When both of them know each other's IP address, further communication can be achieved (See Figure 22). The relevant code can be found in the appendices.

Victory VI: To bridge two platforms in the prototype, it is necessary to trigger a tangible interaction using a specific sensor. When individuals want to download the treasure hunt tasks to their mobile phones, they can simply put their mobile phones in the sync area. The system will then know that the mobile phone is waiting for the data, and then, send the data. For this part of the project, I thought that either a force sensor or an infrared sensor could work. Through a test, I realized that an infrared sensor might detect nearby movements, thereby causing errors in the system and ruining the whole experience, an outcome that would be destructive to the project. The decision therefore was to use a force sensor to initiate the synchronization (See Figure 23).

Victory VII: The AR experience has been updated. During the game, children are allowed to use the mobile phone as a detector, exploring gold all over the artifacts in a certain distance. In this process, the additional information will be appeared too. Two examples of the AR effects has been shown in Figure 24. One is providing a few

information about polar bear; Another is trying to impart the knowledge about Tatting skills. This type of information will be pop-up one by one. Therefore, children would acquire the relevant knowledge as part of the discovery in the hunt experience. Also, a certain amount of gold are hidden in each animated video clip. Children can get them by finding it and tapping it on the screen. To code the augmented reality part, I searched for many open AR toolkits. As a result, I realized that most of the AR tool kits are outdated — too old to be compatible with iOS 7 and the latest version of Xcode. The one used in this project is Vuforia SDK. In the SDK, there are many .m files has been packaged as unreadable file, which causes more difficulties to make adjustments inside, and reduces the possibilities in the experience. In order to achieve the AR experience, numerous of open source examples has been analyzed. The current AR experience combines many examples of them with more new codes. A restriction of current AR experience is from the limited techniques of iOS programming and CG animation for now, however, it potentially illustrates what could be augmented on a textile artifact.

Figure 17: A screenshot for Gali

Figure 18: A screenshot for QR login

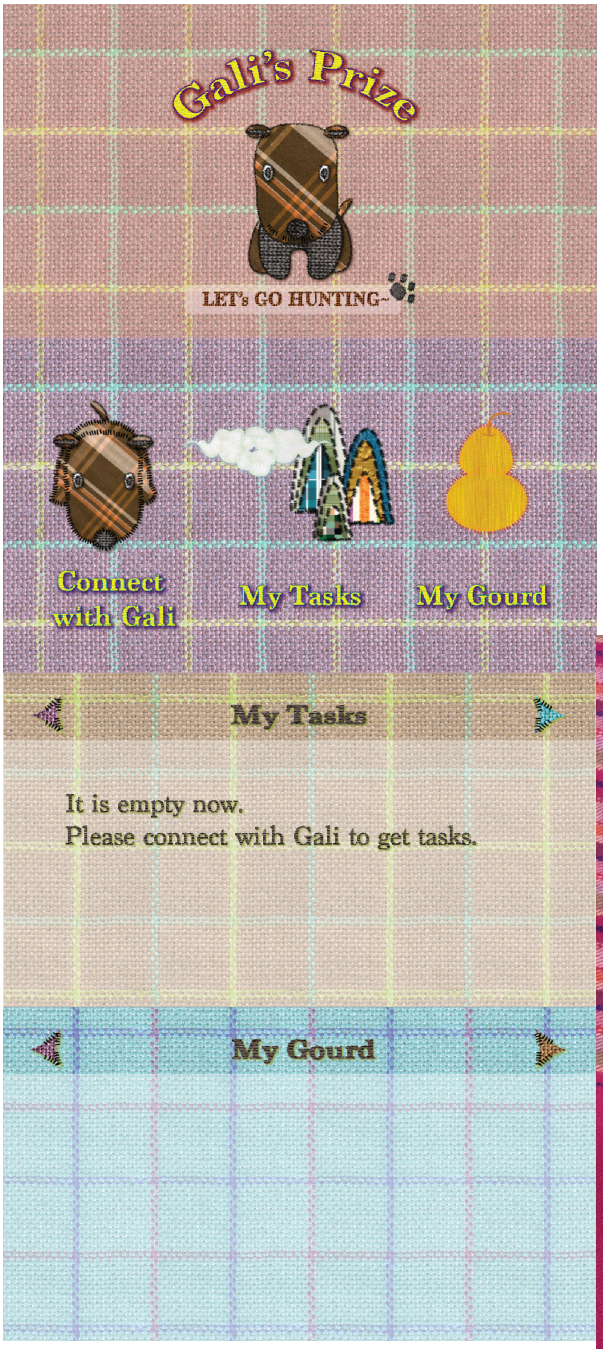


Figure 19: Screenshots from mobile application

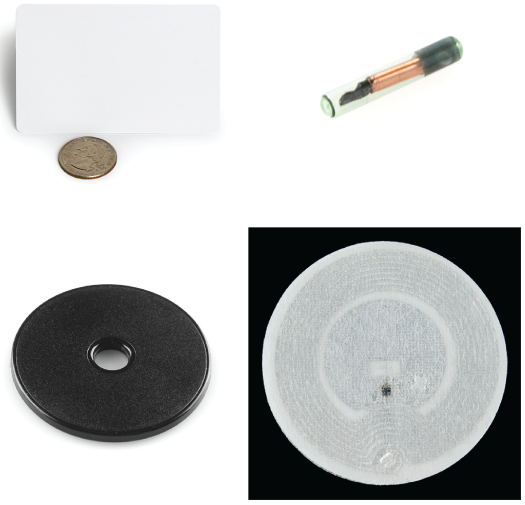


Figure 20: RFID cards

Figure 21: RFID tickets

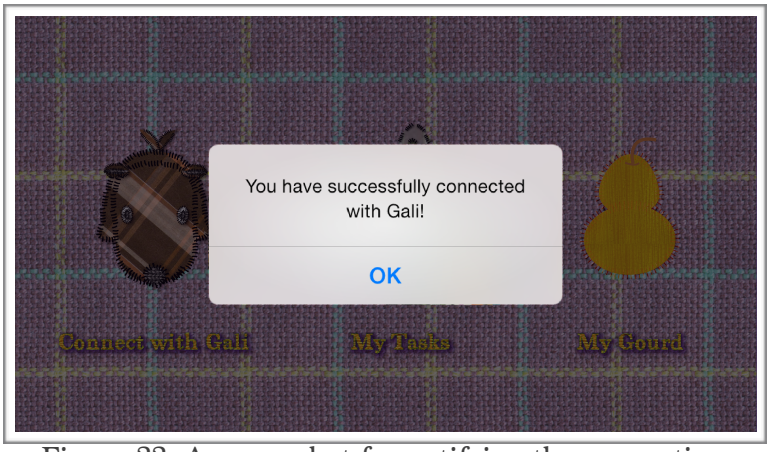


Figure 22: A screenshot for notifying the connection with Java application

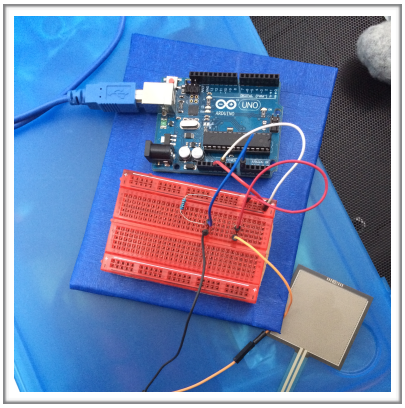


Figure 23: A photo of Arduino board with force sensor

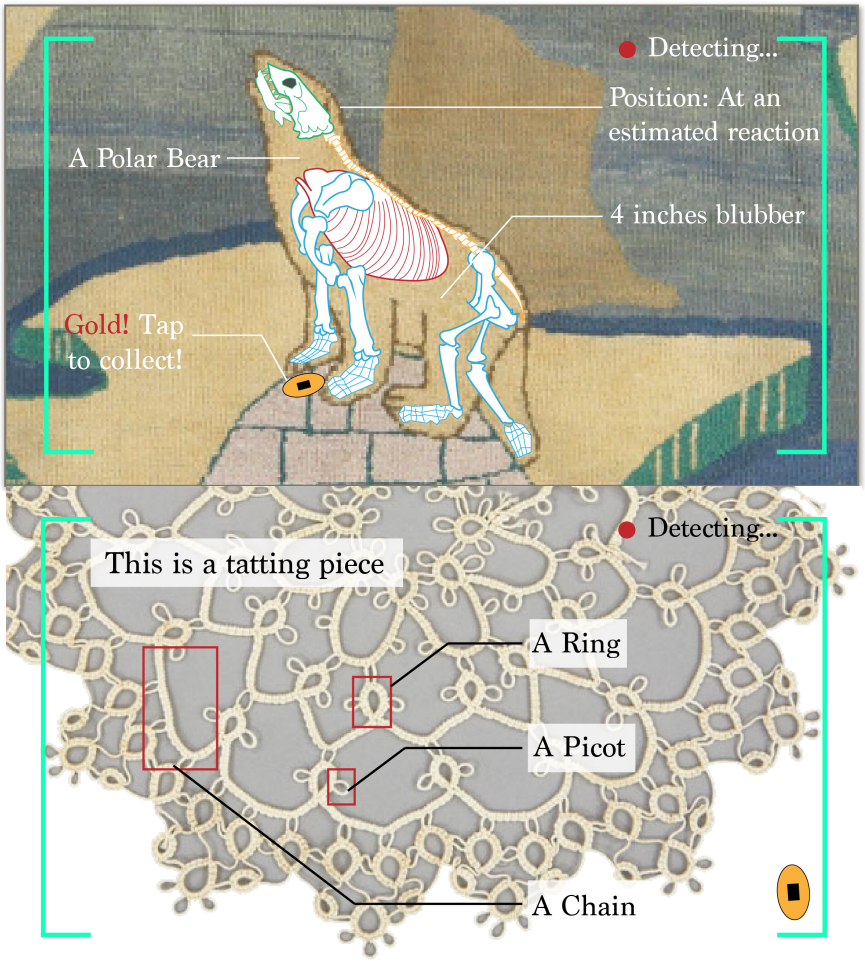


Figure 24: Two examples of AR effects - Upper: A task in "Animal" Category Lower: A task in "Textile" Category

The prototype has been shown to professionals at OCAD University and the textile museum many times, and their valuable critiques and advice have been sought. Overall, all of them judged that the development of prototype was a smooth and impressive process. They appreciated the progress of my work. Still, they made detailed comments about some of its aspects.

- Firstly, the specialists from the TMC suggested that the instructions in the mobile app should include more graphics and less text. They believed that children would read short phrases on screens, but not paragraphs. One reason is that children are impatient about reading. Another is that the appearance of more text on a page will mean that fonts are smaller, and their size will also cause difficulties in reading. To respond to this point, I changed the text instructions to comic graphic-style instructions (See Figures 25-26).
- Secondly, many experts thought that there should be some sound effects and even dialogue for the dog, Gali. One reason was that sound could be helpful in enhancing the experience. Another was that, with the dialogue guide, the design would be more inclusive for users. Regarding this point, my concern was that the use of sound effects in a museum might interrupt other general visitors' experiences. This interruption would be prohibited by the museum. I brought up this question about sound with the staff at the TMC. Their opinion was that less sound is better, but that sound effects that are not loud and annoying would be acceptable. Accordingly, basic sound effects and simple dialogues would be added to the game.
- Another issue that needs to be resolved is the exact plan for syncing the data to mobile phone. Since a force sensor has been used to detect a user's intent to download tasks to the mobile phone, an index is needed, without extra instructions,

to indicate where the sync area is, what action should be taken to initiate the downloading, and why it is necessary to have physical touching. To deal with this issue, a plan has been developed to build a re-designed pet bowl that allows users to put the phone into the bowl only vertically (the vertical position is better for the force sensor), like a stand. However, this arrangement is too concrete for NUI. Another plan is to build up a slot. When an individual wants to synchronize the data, he or she can just insert the phone into the slot, similar to the way a card is inserted into an ATM at a bank. This way of proceeding is easy to understand and makes sense to the experts, who consider it a better option. This design will be shown at the MVP stage.

Although the treasure hunt game has a clear scenario in the design process, it is still hard to predict the actual usage of the system by real users. Individuals could potentially have different ways of operating their equipment and software. In order to reduce unnecessary errors in the experience, I invited six friends to the place where I work in order to debug the system. All of them were first introduced to the basic story of the project. Then, without any guidance or instruction, they tried to play with the prototypes in any way that they wanted for an hour.

The result was that they found many errors in the prototype that had to be corrected. For instance, when tasks are downloaded from the server, if the user has stayed in the "My Tasks" page, the tasks will not be updated automatically. This issue requires a little correction in the code. Another issue is that the operation of the prototype has to depend on open, stable local Wifi. However, the Internet at school and in the museum is secured and does not allow communications among different devices.

To solve this problem, a hotspot Wifi from a mobile phone has been tested too. It is open but unstable in some special situations. For example, a user turned off his phone after connecting with Gali, and, when he turned on his phone again, he could not download the tasks, because the hotspot Wifi was cut off when he turned off the phone. The process of communication between the computer and the mobile phone was thus interrupted. Further research about this issue is needed.

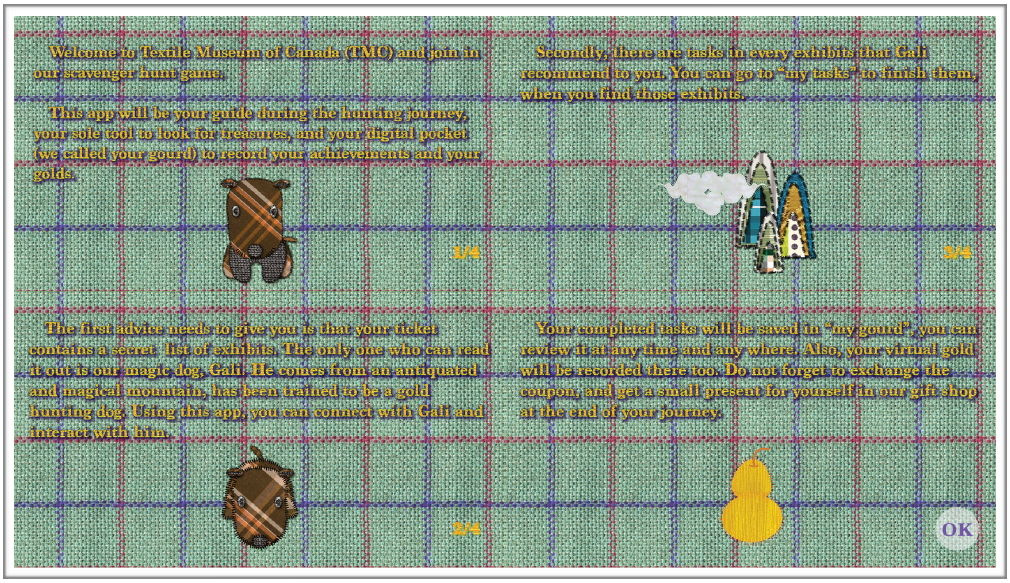


Figure 25: The old version of instructions

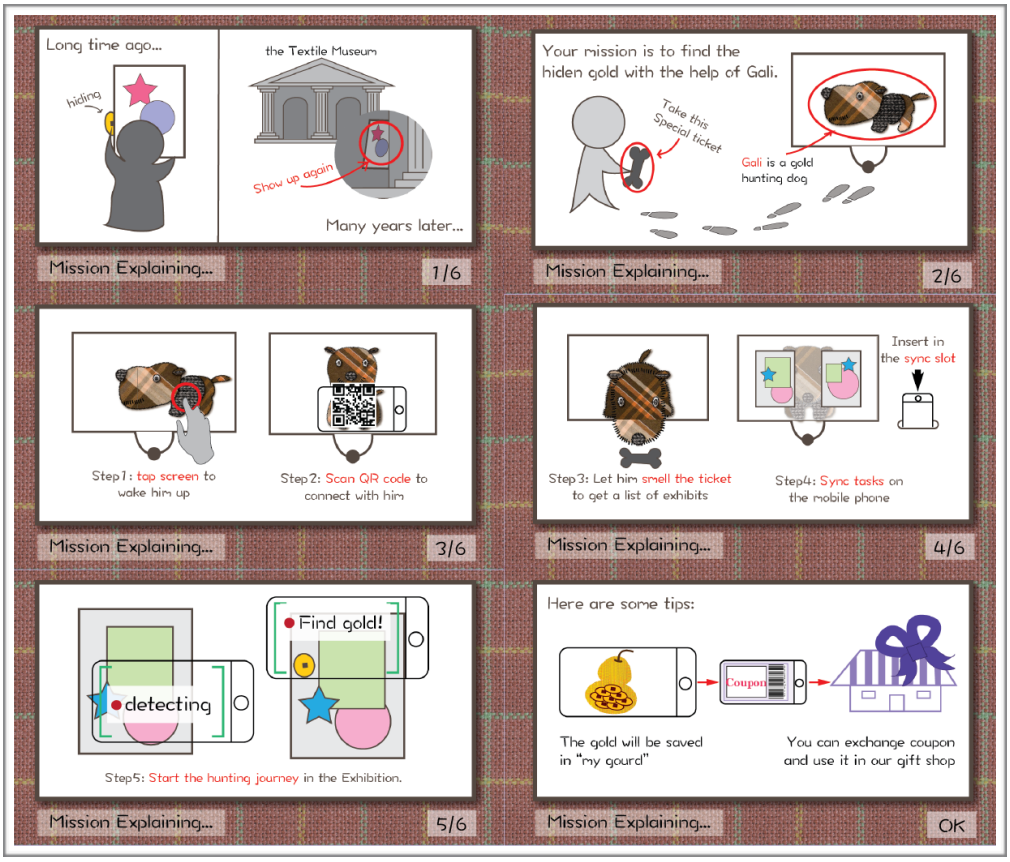


Figure 26: The new version of instructions

Minimum Viable Product (MVP)

The challenge for the third iteration is to combine all the elements into one product (MVP), which is ready for being tested with children on a school trip in the textile museum and displayed at the Student Graduation Show.

Firstly, to display the interactive animation in Java application, I did research about touch-based products in the current market. There are basically four types of products that can be options for my project: mounted touch screens, multi-touch monitors, multi-touch all-in-one computers, and touch-based laptops. The criteria for selecting the suitable product are based on the product's compatibility with Mac OS X, the screen size, its price, and the display resolution. The order is presented according to the importance of each criterion. It is now rare to see touch-based screen products especially for Mac OS in the market, and so the search for open source drivers becomes very important. I found a website, touch-based.com, where many free and for-sale drivers for most of the mounted touch screens and monitors of any kind of operating system are provided. Using this list, I ordered two products for comparison, namely, the HP Pavilion 23TM and the Acer T232HL. Both of them are 23 inches, and the display resolution under the Windows system is HD 1080p. The exported image under Mac OS and the usage of touch gestures with the open source driver needed to be compared. As a result, I selected Acer's monitor for my project because of its better display and performance.

Secondly, the Internet issue discovered in the second iteration needed to be solved. I have tried to build up the laptop as a router and to set up a portable router that provides local Wifi. However, all of them failed in the end because of the restrictions of the computer and the network. Luckily, I found a new product from

China, called Mi-Wifi, which is a portable USB device that can provide Wifi from a computer to other electronic devices, such as a mobile phone, a tablet, and even another laptop with simple setup steps for system preferences (See Figure 27).

After these steps, the separate parts were assembled together, using a Mac mini with the required software linked to an external monitor, a RFID reader, and an Arduino with a force sensor.

The on-site set-up to conduct expert and user testing of the overall experience of Gali's Prize was developed for professional staff members at the TMC and for children from a school trip. The initial plan for TMC testing called for an installation with the touch screen monitor in a corner of the Learning Centre, with six selected artifacts mounted on the walls of an experimental room next to the Learning Centre (See Figures 28-29). However, due to scheduling challenges in the museum and curatorial concern for conservation of precious artifacts, it was decided to arrange a compact, self-contained experience for on-site expert and user testing by putting all the artifacts on a large table, with all the electronic elements and devices contained in a shelf unit on another table (See Figure 30).

The on-site expert testing in the TMC was held on March 26th and 27th after completing a simple set-up with the help of the curators. Three museum staff members with interest in testing the Gali's Prize prototype participated. In order to model the needs and responses of children, these experts were provided at first with only the basic, necessary instructions prior to their experience. When they met with difficulty in continuing the game independently, additional instructions were provided. During this test cycle, I observed the experts' behaviours, interactions, and emotional expressions.

After their experiences, I also invited them to talk about their personal feelings, suggestions and critiques about my thesis project.

On March 28th, based on these expert suggestions, I made many small changes in the prototype before the user test with children, such as adding a Help button on the Main Menu and directional indicators for interaction in both the screen design and the physical set-up. Whereas the experts interacted with six artifacts, in contrast, we decided to reduce these to two for the school children, to offer a more convenient and exciting experience. On the day of the user testing with children, TMC selected two boys, one eight and the other ten in age. We observed their whole gaming experience and afterward, interviewed them to gather feedback. These valuable results are reported below.

During these three days of on-site testing everything went smoothly, except for several interruptions caused by 3G network instability due to signal strength. In the two test cycles, I received much praise about Gali's Prize. First, nearly everyone was impressed by the complexity of the project, and was interested in the "magical" power of digital technology, such as seamless, invisible syncing of the mobile device. Experts and children alike enjoyed the intuitive metaphor in which a cute dog character uses keen sense of smell to help the user undertake a special treasure hunt (by detecting a unique RFID in the dog bone). Most of the experts predicted that a child would be surprised upon seeing the pop-up animation in the AR experience, and they were correct. During the user testing, both children repeatedly showed surprise and delight, in particular during the pairing of mobile device with touch screen; getting tasks from Gali; and viewing AR effects. In fact they asked if they could view the AR experience with additional artifacts! Experts and children alike appreciated the many detailed designs in

the prototype. For instance, everyone loved the use of textile patterns in the interface. Both experts and children were fond of the graphic "nose" (for bone sniffing) near the touch screen, as it helped to connect the virtual world to reality. In addition to the scheduled tests, two women (retired seniors volunteering for a TMC event) also approached the test installation to inquire about Gali's Prize. Although they did not test the experience, they praised the project for offering learning opportunities for younger generations.

These tests of Gali's Prize indicate that AR offers a promising and helpful path to support directed looking for specific museum exhibits, enabling younger visitors to get closer to deeper insights. The evidence for this is that everyone who tried Gali's Prize was readily able to recall one or more meaningful features in the artifacts, without reporting any feeling of distraction arising from the AR experience.

At the same time, the on-site tests also revealed a number of oversights and misconceptions in the prototype. A primary oversight was the selection of certain textile artifacts which were too large to be taken in by the mobile device's camera when placed on the table. A significant misconception was the assumption that users would read lengthy instructions before undertaking a series of tasks (connecting with Gali, receiving a special quest, searching for gold), or that they would use a Help function. In fact, as one expert suggested, it would be much easier if the mobile application mixed the instructions and actions together, to support "learning by doing." Future development of Gali's Prize will need to make adjustments focusing on these concerns.

Through these expert and user tests, I have had opportunity to reflect on this thesis project.

Firstly, regarding the use of digital technology, I have realized that compared with adults, children are better at handling multi-platform screen experiences. I observed that children had no problem with following the instructions. When children reviewed the illustrated instructions screens in the mobile device they paid more attention to the graphics. Children seemed to reveal a "graphics first, multi-screen" aptitude that supported an unhesitating shift of attention between the small and large screens. In contrast, adults paid more attention to the text, and expected to receive clear textual directions about when to look between the screens — yet such directions were not part of the design.

The implications of these generational preferences offer some insight for future museum experience design. In my effort to create a "natural user interface," I developed instructions paralleling normal interactions with a real pet. Yet, for a century or more, museums visitors have learned by reading wall text and label text, leading to text-centred biases. What's more, because past uses of digital technology have been based around a single platform, adults are used to doing their next interaction on the same platform. But these assumptions have not yet been formed by young children. To this point, multiscreen experience designers need to consider carefully how and where to provide instructions to their users, with awareness of generational preferences. It is important to investigate how can we might manage helpful "pattern making" and "pattern breaking" through the new designs.

Secondly, experts reviewing this project have commented on its complexity, saying that it seems to have too many steps and tasks prior to the most important part, the AR experience in which children obtain treasures and knowledge. One might feel it slows the progress of a child entering the exhibition unnecessarily. From the

perspective of education, it seems reasonable to be concerned about delaying the encounter with the artifacts. However, considered from the perspective of a game, if a child could obtain treasure easily, she might cherish it less, whereas a hard-won treasure may well build up a lasting memory in child's heart. Taking these concerns together, the designer needs to find a balance between elaborating the process of treasure hunting and preserving time for artifact-centred education. In the case of the Gali's Prize prototype, the process of receiving tasks from Gali took two to five minutes, while completing two treasure hunts took about three minutes. While this may seem out of balance, once a full database of artifacts is built up, time spent on directed looking with more than two artifacts would increase, while receiving these tasks would stay constant. This would prolong the time for education and improve the balance.

Following the expert and user testing, the MVP was to prepared for the Student Graduation Show. To determine the best possible presentation plan, I designed three different options (See Figures 31-33). The key purpose of the first plan was to make all the digital technology invisible and provided the minimum of equipment for experiencing Gali's Prize. All the electronic hardware was supposed to be organized in a special box, along with a mobile phone and a monitor for showing the artifacts. One concern about this design was that decorating the hardware with a desktop look in fact makes the system into a concrete machine and emphasized the existence of the digital technology, which was the opposite of the project's original purpose. Therefore, other plans were to try to merge the system with the exhibition space: the second plan was to build a table that allows people to have the experience around it, and the third plan was use of the assembled furniture to build a fake wall. These designs were quite different

because the former one utilized the concept of centralizing people in a certain area and encouraging them to have the experience together. It could be helpful if there was a concern that only one iPhone could be provided for the show. In contrast, the intention of the latter plan was to increase the display area on three walls and to disperse the crowd on two sides, according to their preferences. This solution could potentially better show the relevance of the design to visitors. For instance, one side could present experiencing the prototype, and another side could show the demonstration video for on-site experience. Besides, when the prototype had any error, there was still something else that could be shown to visitors. A vote by users in final expert and user tests led to the selection of using the second plan with a projected demo video on the wall for the display in the Graduation Show (See Figure 34).

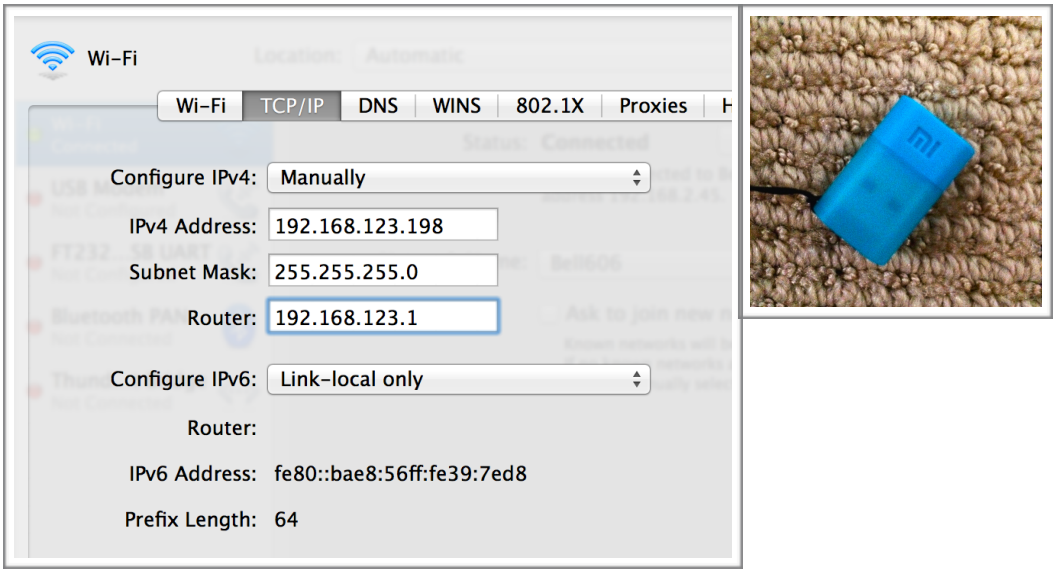


Figure 27: Mi-Wifi and its set up

Figure 28: A horizontal view of the experiment room

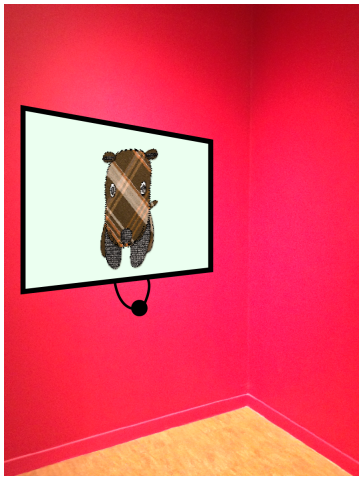


Figure 29: An illustration for installing the touch screen in the TMC

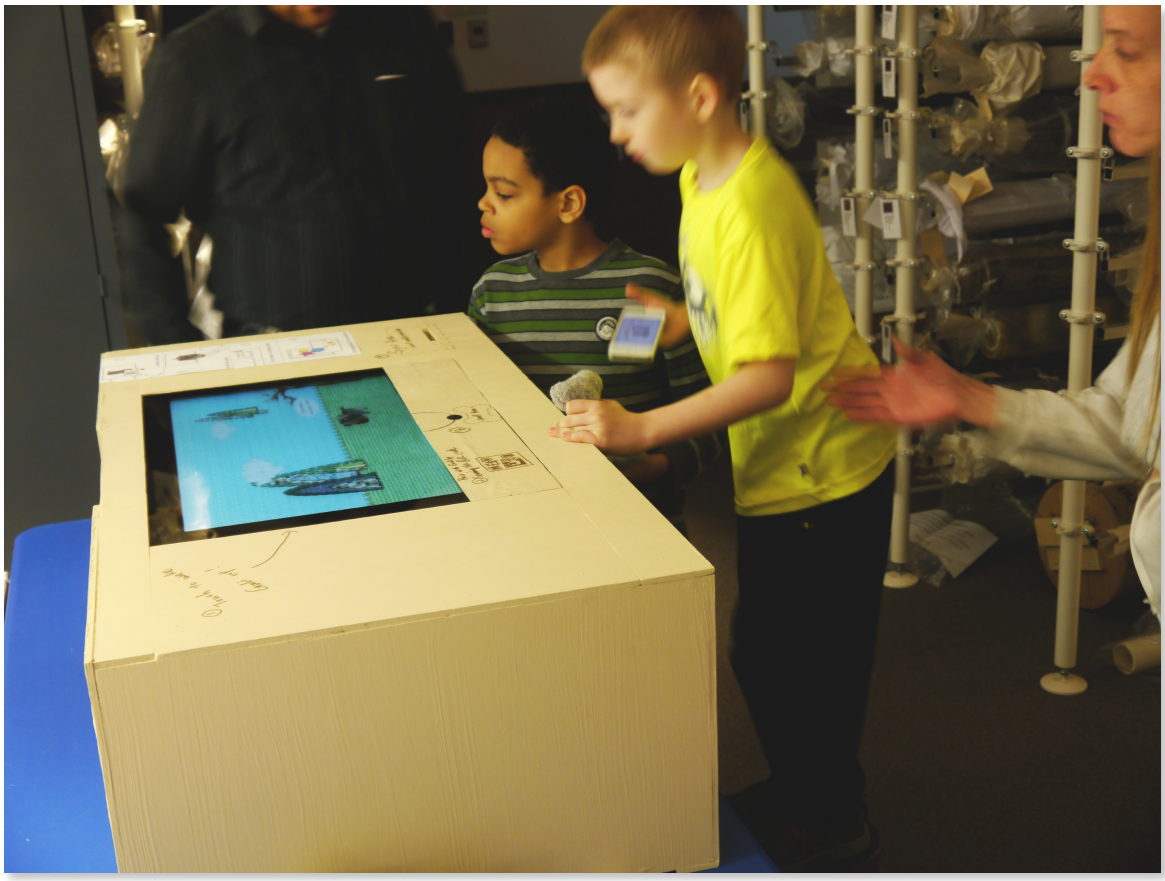


Figure 30: A photo of on-site user test with children on a school trip, photo: Pei Zhou

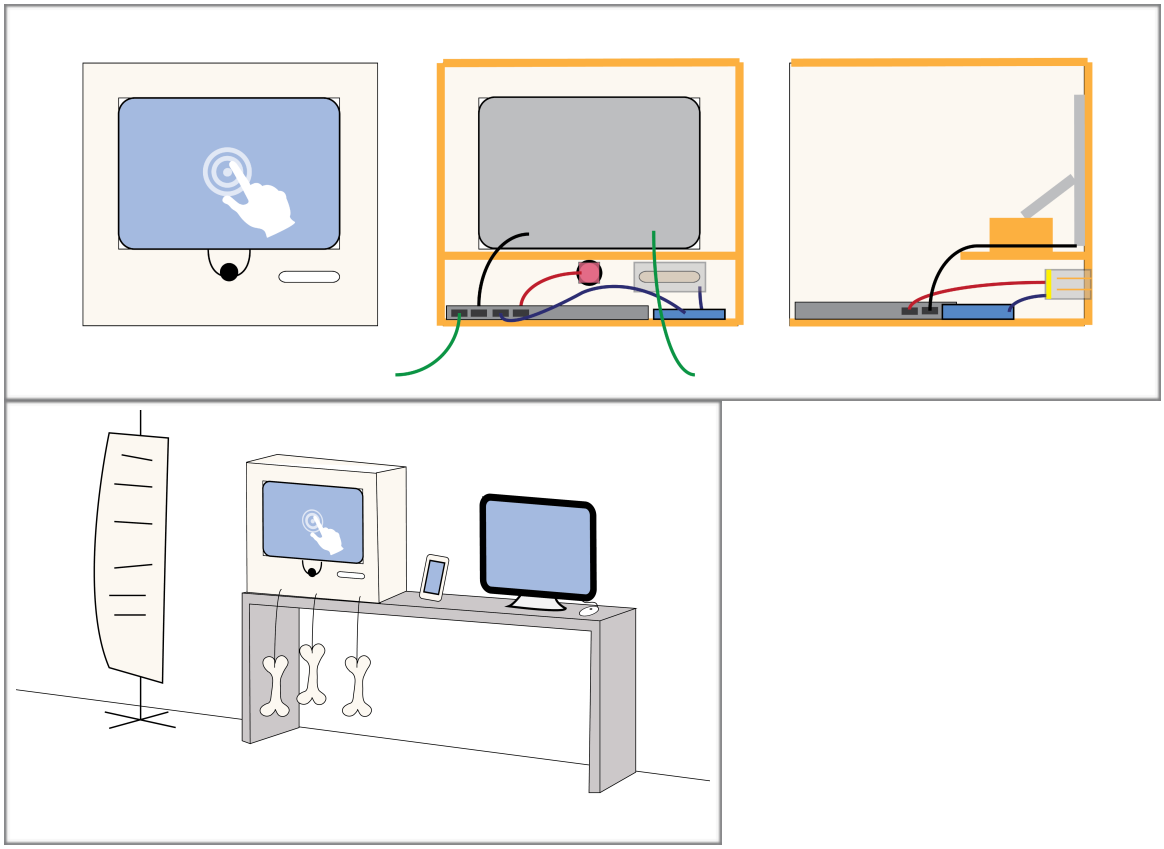


Figure 31: Display solution version I

Figure 33: Display solution version III

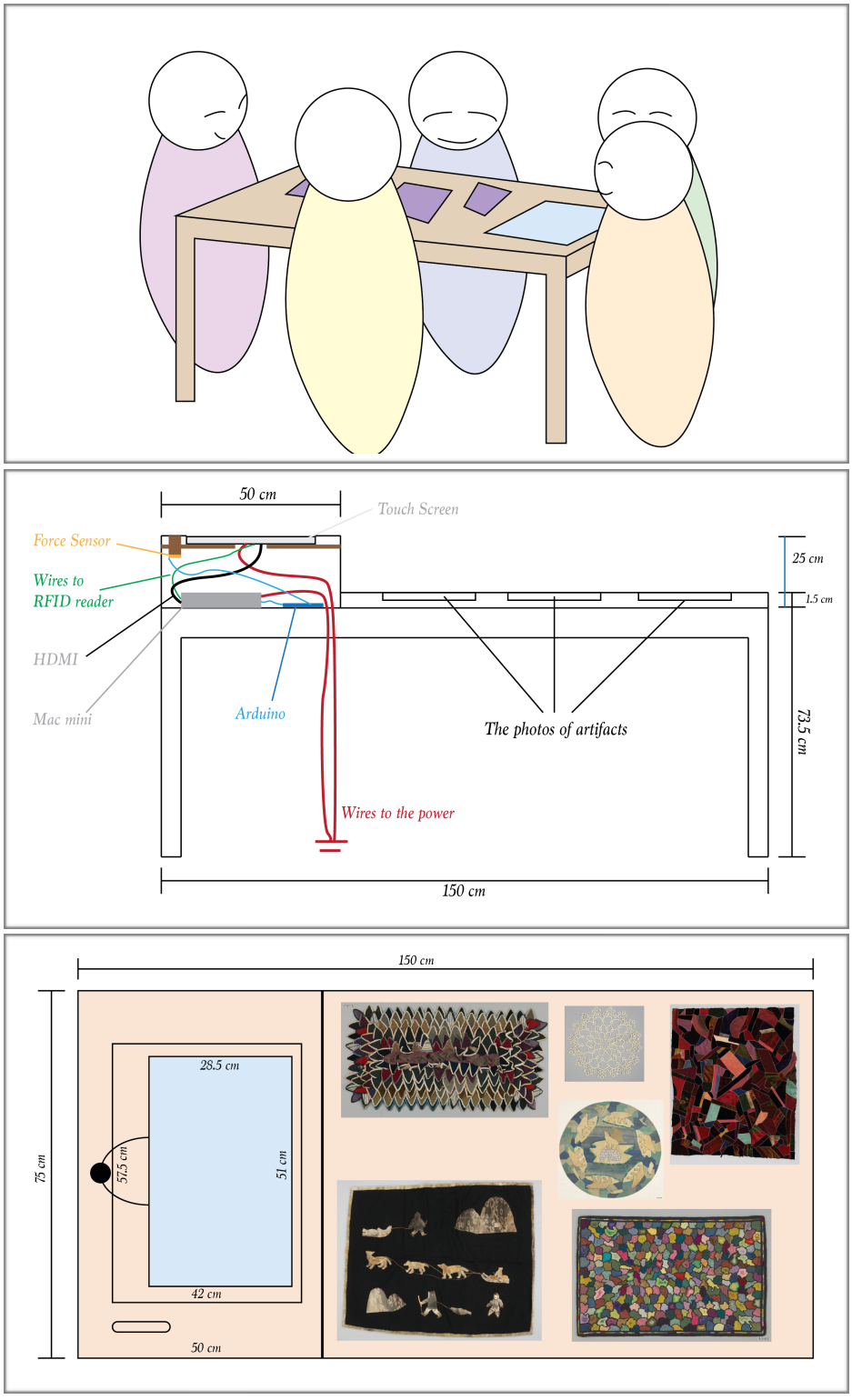


Figure 32: Display solution version II

Reflections

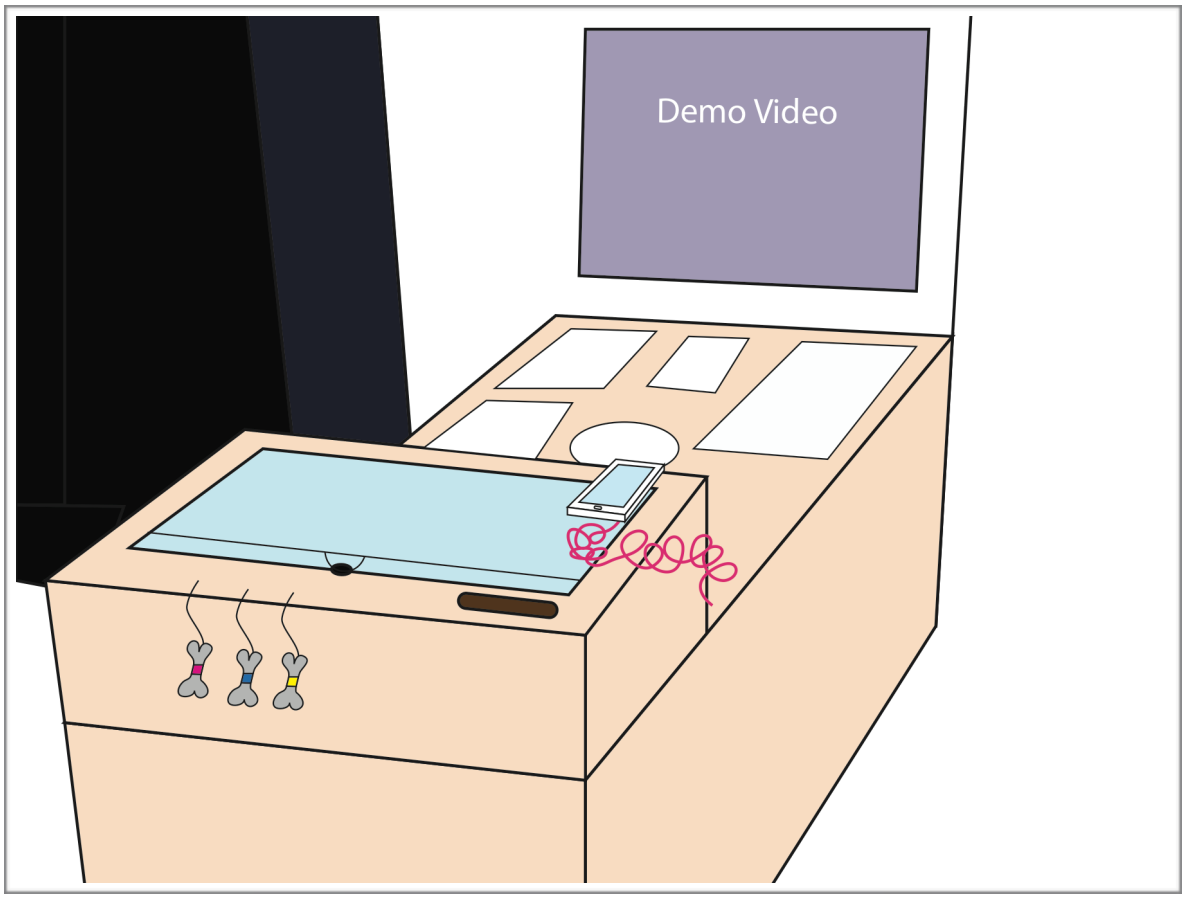


Figure 34: Gali's Prize in the Student Graduation Show

The Gali's Prize project, as an experimental treasure hunt game for the Textile Museum of Canada, has integrated and prototyped many popular existing digital technologies in order to enhance visitors' experiences in museums. The project successfully met the demands of its target users, namely, children from a school trip, and provided a self-motivated, entertaining learning experience for them. In the project, there has also been consideration of the whole visit experience, including a possible boost to business in the gift shop. The strength of the Gali's Prize project is the strength of the concept, which arises from both practical experience and theoretical studies of current issues in the context of a specific museum. Every step in the design process has clear challenges to meet and goals to achieve. During this process, outreach work has also been undertaken, so that the experience of using Gali's Prize could be tested on-site, and responses could be gathered from its multi-users.

However, the design of Gali's Prize also has some restrictions. Firstly, because of restrictions in programming skills, the work of prototyping started with the use of basic and achievable development tools. Then possible methods to overcome technical difficulties were explored. Therefore, the integrity and compatibility of the whole system has been reduced. If we had known at the outset that the prototype would serve as a game package, both the Java and iOS applications would have best been built with Unity, a popular game engine. In this case, the development of the AR experience could have been easier and better. Secondly, because of time limitations, Gali's Prize has been designed to be a Minimum Viable Product at this stage. This way of proceeding accounts for certain imperfections in the outcome, such as the animation and the graphic design. It possibly explains some the negative outcomes in relation to the goal of engaging children in the experience. This experience teaches me that the goal of

MVP is critical to the User Experience Design. Although producing a MVP can reduce the amount of time on prototyping, and be ready for testing earlier, MVP cannot provide the best results in the visual effects and interactions.

In the near future, Gali's Prize will be further polished in the museum and will achieve a smoother operation and more interesting stories within the AR experience. It is expected that it will be available for the public again in the textile museum in next year.

Conclusion

The conclusion may be drawn, when Gali's Prize is viewed from a social constructivist perspective, that the project has developed an experimental prototype for the textile museum, and that such a project could potentially also work for other art and artifact museums, specifically to enhance the entertainment and learning experience for children. The purpose of the project is not merely to have a special, designed experience for museums, but instead to build a deeper understanding of the potential for the use of digital technology in the context of museums and to collect useful data for further studies during the design process.

This investigation has studied the use of mixed digital technologies in museums from a future-oriented perspective. Today, the use of digital technology in museums still relies on mobile devices and their applications as primary opportunities because of their mobility and accessibility. This usage is also supported by other relevant technologies, such as augmented reality, QR code, the stationary computer, and RFID tags. The involvement of emerging technologies can create stimulating activities for children by providing new sensory experiences and tangible interactions when stories are told. This involvement can help to transform a passive exhibit into an interactive one and can draw children's attention to the knowledge behind the exhibit.

This consideration brings up a critical uncertainty about the future: the convergence of digital technology. On the one hand, in the provision of convenient, comprehensive service in museums, museums may need powerful all-in-one equipment that integrates all the necessary technologies. On the other hand, the restrictions and distractions of mobile phones and screens may need to be reduced in order to create a more immersive experience. For the latter reason, the tools in museums could also be

distributed into many smaller use of digital, interactive technology. This critical question could point to a direction for further studies.

In addition, through the use of the user-centred design as a research method, plenty of data from participants has been gathered from on-site expert and user testing. This data can in the future be utilized in further studies about the behaviours and the learning processes of younger generations.

Bibliography

Bardzell, S., Bardzell, J., Forlizzi, J., Zimmerman, J., Antanitis, J. (2012), Critical design and critical theory: the challenge of designing for provocation. In DIS '12: Proceedings of the Designing Interactive Systems Conference.
Bates, Joseph (1994) The role of emotion in believable agents in Communications of the ACM , Volume 37 Issue 7.

Barton, J. (Dec, 2012), The Museum of You, Retrieved from http://www.ted.com/talks/jake_barton_the_museum_of_you.html

Bennett, T. (1995), *The Birth of Museum: History, Theory, Politics.* London and New York: Routledge.

Bernward Joerges (1999), Do Politics Have Artefacts?. In *Social Studies of Science*, Vol. 29, No. 3 p.411-31.

Black, G. (2005), *The Engaging Museum: Developing Museums for Visitor Involvement*, Oxon: Routledge.

Bolter, J. D., and Grusin, R. (2000), *Remediation: Understanding New Media.* The MIT Press.

Bourdieu, P. (1984), *Distinction: A Social Critique of the Judgement of Taste.* London and New York: Routledge.

R. Buchanan and V. Margolin (Eds.) (1995) *Discovering Design*, Chicago and London: The University of Chicago Press.

Conway, J. and Hillegass, A. (2012) *iOS Programming: The Big Nerd Ranch Guide (3rd Edition)*, Indianapolis, USA: Pearson Technology Group.

Falk, J. H., (2009), *Identity and the Museum Visitor Experience*, Walnut Creek, Calif.: Left Coast Press.

Falk, J. H., and Dierking, L. D. (2011), *The Museum Experience*, Walnut Creek: LCoastPress.

Getting Started with the iOS Native SDK, Retrieved from *https://developer.vuforia.com/resources/dev-guide/getting-started-ios-native-sdk*

Heller, S. and Womack, D. (2008), *Becoming A Digital Designer: A Guide to Careers in Web/Video/Broadcast/Game + Animation Design*, Canada: John Wiley & Sons, Inc..

Holbrook, M.B., Chestnut, R.W., Oliva, T.A., and Greenleaf, E.A. (September, 1984), Play as a Consumption Experience: The Roles of Emotions, Performance, and Personality in the Enjoyment of Games. In *Journal of consumer Research*, Vol 11.

Johnson, B. D. (2010), *Screen Future: The Future of Entertainment, Computing, and the Devices We Love*, the United States of America: Richard Bowles.

Kochan, S. G. (2011), *Programming in Objective-C (4th edition)*, USA: Pearson Education.

S. J. Knell, S. MacLeod, S. E. R. Watson (Eds.) (2007), *Museum Revolutions: How Museums and Change and are Changed*, New York: Routledge.

B. Laurel (Eds) (2003), *Design Research: Methods and Perpectives*, Cambridge, Mass.: MIT Press.

M. Lovejoy, C. Paul, V. Vesna (Eds) (2011), *Context Providers: conditions of meaning in media arts*, The University of Chicago Press.

Norman, D. A. (1988), *The Psychology of Everyday Things*, New York: Basic Books.

(1998), *The Invisible Computer: Why good products can fail, the personal computer is so complex, and information appliances are the solution*, Cambridge, Mass.: MIT Press.

(2004), *Emotional Design: Why we love (or hate) everyday things*, New York: Basic Books

(2007), *The Design of Future Things*, New York: Basic Books.

(2011), *Living with complexity*, Cambridge, Mass.: MIT Press.

Parry, R. (2007), *Recording the Museum: digital heritage and the technologies of change*, London and New York: Routledge.

Piaget, J. (1983), Piaget's theory. In P. Mussen (ed), *Handbook of Child Psychology*, 4th edition, Vol. 1, New York: Wiley.

Ries, E. (September 13, 2011), *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*, Crown Business.

Rheingold, H. (2002), *Smart Mobs: The next social revolution; Transforming cultures and communities in the Age of Instant Access*, United States of America: Perseus.

Roald, Tone, (2007) Chapter 4: Experiences in Art. In *Consciousness, Literature and the Arts*, Volume 10: Cognition in Emotion: An Investigation Through Experiences with Art. Editions Rodopi. pp 60-81.

Rodriguez, K. (December 7th, 2012), *Adobe Marketing Cloud Takes Marketing Analytics to New Heights*, Retrieved from *http://blog.amadeusconsulting.com/adobe-marketing-cloud-takes-marketing-analytics-heights/*

R. Sandel (Eds.) (2002), *Museums, Society, Inequality*, Oxon: Routledge.

L. Tallon & K. Walker (Eds.) (2008), *Digital technologies and the museum experience: Handheld guides and other media*, Lanham, MD: AltaMira Press.

Taylor, P., and Campbell-Williams, M. (1993), Discourse towards balanced rationality in the high school mathematics classroom: ideas from Habermas's critical theory. In *Constructivist interpretations of teaching and learning mathematics: proceedings of Topic Group 10 at the Seventh International Congress on Mathematical Education (ICME-7), held in Quebec, Canada, August 1992, 1993.*

Ware, C. (2008), *Visual Thinking for Design*, Burlington, MA: Elsevier Inc..

S. Watson (Eds.) (2007), *Museums and their Communities*, Oxon: Routledge.

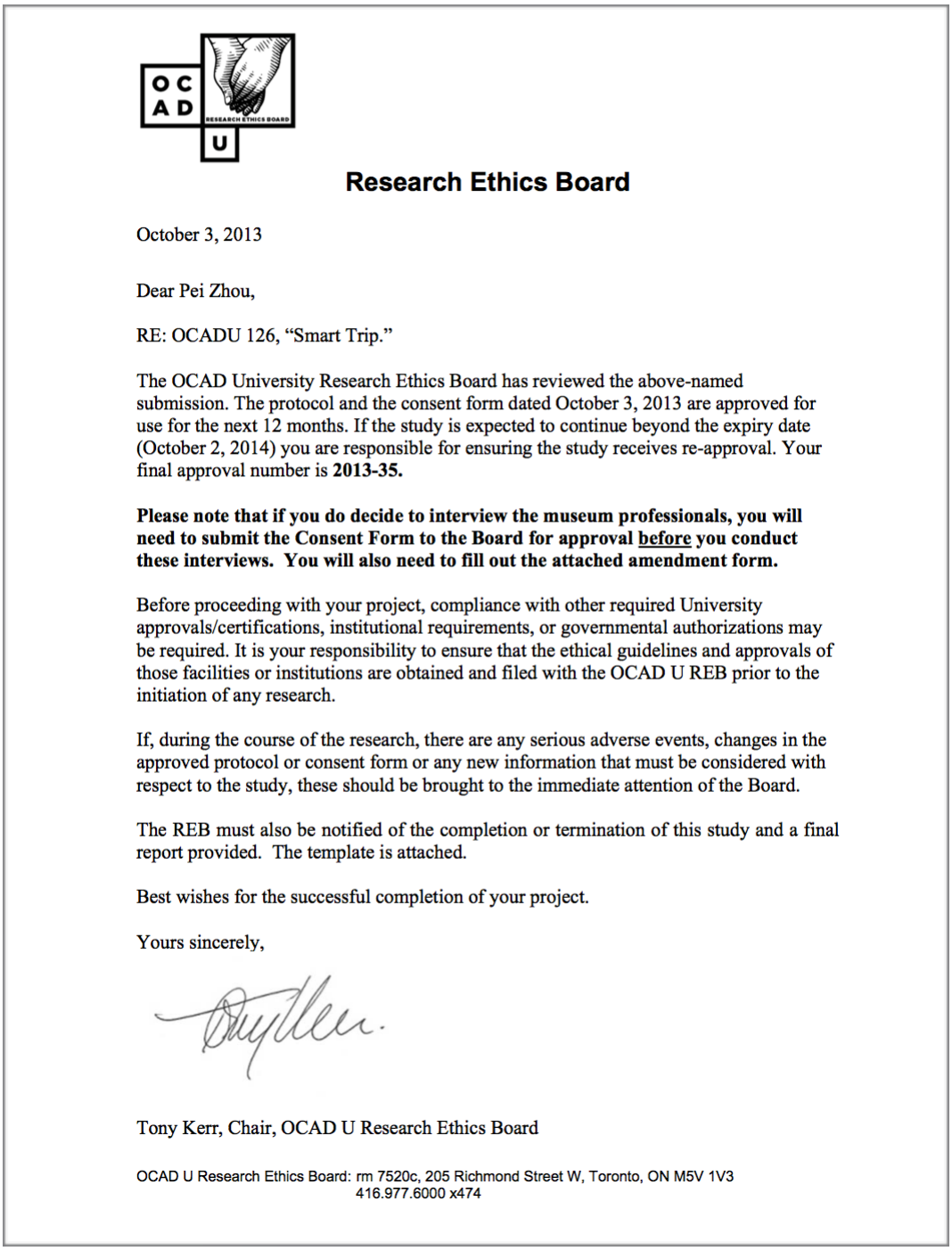
Von Glasersfeld, E. (1990), An exposition of constructivism: Why some like it radical. In R. B. Davis, C. A. Maher and N. Noddings (Eds.), *Constructivist views on the teaching and learning of mathematics*, Reston, Virginia: National Council of Teachers of Mathematics, pp 19-29.

Winner, L. (1980), Do Artifacts Have Politics? In *Daedalus*, Vol. 109, No. 1. Reprinted in MacKenzie, D. A., and Wajcman, J. (Eds), *The Social Shaping of Technology*, London: Open University Press, 1985; second edition 1999.

ZXing, Retrieved from *https://github.com/zxing/zxing*

Appendices

Appendix A: REB Approved



Research Ethics Board

October 3, 2013

Dear Pei Zhou,

RE: OCADU 126, "Smart Trip."

The OCAD University Research Ethics Board has reviewed the above-named submission. The protocol and the consent form dated October 3, 2013 are approved for use for the next 12 months. If the study is expected to continue beyond the expiry date (October 2, 2014) you are responsible for ensuring the study receives re-approval. Your final approval number is **2013-35.**

Please note that if you do decide to interview the museum professionals, you will need to submit the Consent Form to the Board for approval before you conduct these interviews. You will also need to fill out the attached amendment form.

Before proceeding with your project, compliance with other required University approvals/certifications, institutional requirements, or governmental authorizations may be required. It is your responsibility to ensure that the ethical guidelines and approvals of those facilities or institutions are obtained and filed with the OCAD U REB prior to the initiation of any research.

If, during the course of the research, there are any serious adverse events, changes in the approved protocol or consent form or any new information that must be considered with respect to the study, these should be brought to the immediate attention of the Board.

The REB must also be notified of the completion or termination of this study and a final report provided. The template is attached.

Best wishes for the successful completion of your project.

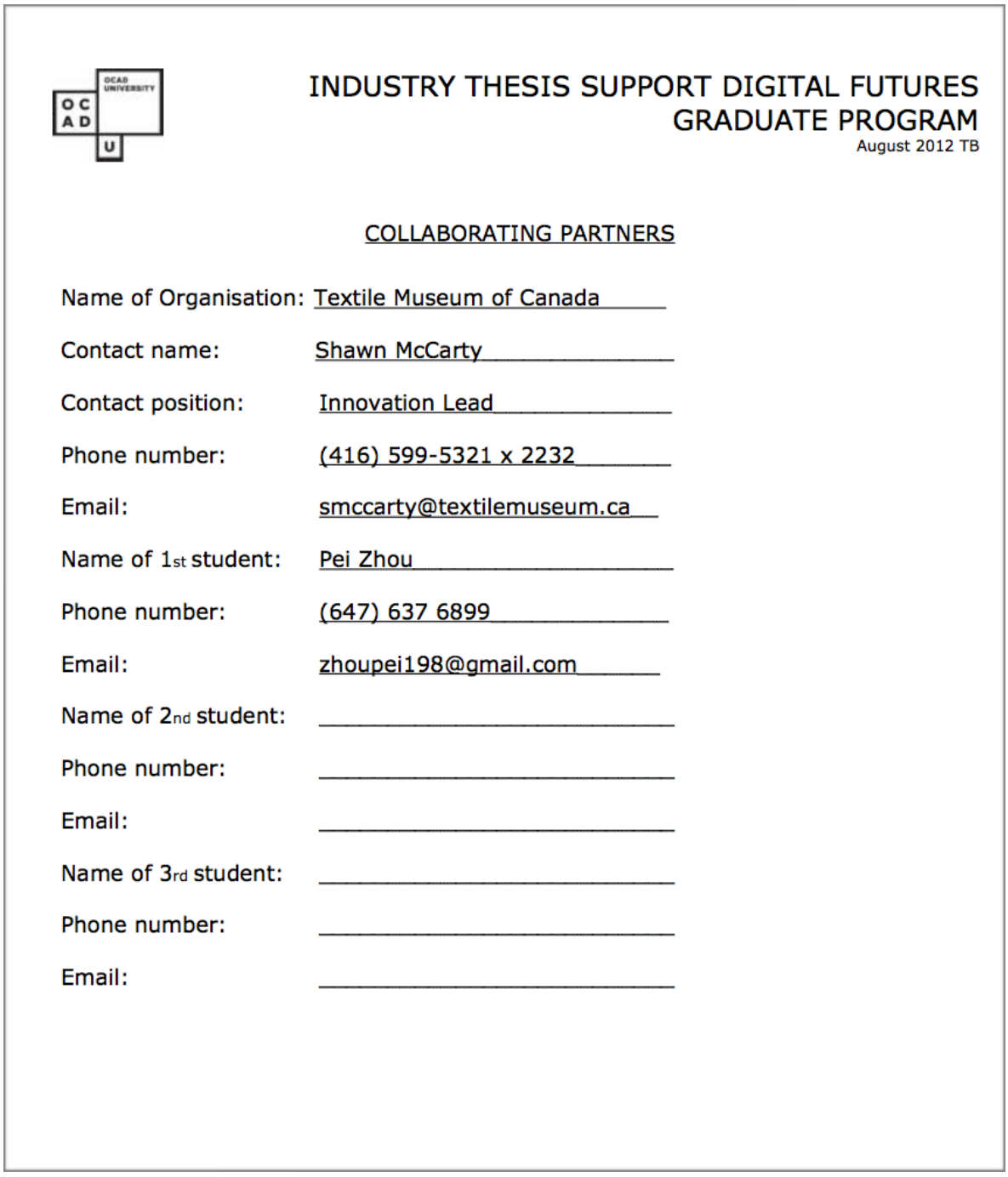
Yours sincerely,

Tony Kerr, Chair, OCAD U Research Ethics Board

OCAD U Research Ethics Board: rm 7520c, 205 Richmond Street W, Toronto, ON M5V 1V3
416.977.6000 x474

Appendix A - Approved REB

Appendix B: Collaborating Partners Form



INDUSTRY THESIS SUPPORT DIGITAL FUTURES GRADUATE PROGRAM
August 2012 TB

COLLABORATING PARTNERS

Name of Organisation: Textile Museum of Canada

Contact name: Shawn McCarty

Contact position: Innovation Lead

Phone number: (416) 599-5321 x 2232

Email: smccarty@textilemuseum.ca

Name of 1st student: Pei Zhou

Phone number: (647) 637 6899

Email: zhoupei198@gmail.com

Name of 2nd student: _____

Phone number: _____

Email: _____

Name of 3rd student: _____

Phone number: _____

Email: _____

Appendix B - Collaborating Partners Form - Page 1

COLLABORATIVE SUPPORT

A collaboration with a student may relate entirely to their thesis work, or it may be relevant to part of it. In some situations, the student may be gaining experience that is useful but not directly related, eg: working as an intern on a client project for an organisation.

The level of collaboration can vary greatly. A student undertakes a thesis over the course of a year starting in mid April. The thesis comprises three elements: an exhibited creative work, a presentation defence and a supporting document. Further details of the thesis procedures are attached in the appendix.

Because of the applied research emphasis on the program there is tremendous value in students having the support of a relevant organisation to provide expertise, in-kind, data, project or financial support. The work will also benefit supporting organisations creatively, technically or commercially. Students also have two supervisors drawn from OCAD University faculty.

INTELLECTUAL PROPERTY

Work by the student(s) will form part of a publicly available thesis and supporting organisations will be fully credited in their contribution to this work. The preference is for all work to be featured in the thesis and subject to the normal forms of copyright. However, if necessary commercially sensitive work may be excluded or partially excluded from the thesis.

Please indicate with a ✓ the intellectual property arrangements:

All work by the student(s) will be their intellectual property	
All unpaid work by the student(s) will be their intellectual property	
All work that you pay the student(s) to undertake will be kept confidential and will be your intellectual property or that of your client(s)	✓
Only commercially sensitive aspects of work that you pay the student(s) to undertake will be kept confidential and will be your intellectual property or that of your client(s)	
All work that has been jointly created will be publicly available under a joint creative commons licence arrangement http://creativecommons.org/about and the chosen licence will be by mutual agreement before the work commences	
All of the work will be credited appropriately and fully available in the public domain with no ownership	

Appendix B - Collaborating Partners Form - Page 2

MEETINGS AND WORKSPACE
Please indicate with a ✓ how you will meet and locate the student(s):

The student(s) will have regular use of workspace in our office	
The student(s) will have occasional use of workspace in our office	✓
Meetings will be held on a weekly basis to mentor the student	
Meetings will be held on a fortnightly basis to mentor the student	
Meetings will be held on a monthly basis to mentor the student	✓

MATERIAL SUPPORT Please indicate with a ✓ how you will support the student(s):
IN-KIND

Use of equipment	
Use of facilities, eg: computers, printing, workshops	✓
Access to expertise within our organisation	✓
Access to experts that we are working with	
Access to other organisations or individuals we know that may be useful for the work	
Access to client(s) that we are working for	
Access to relevant data, eg: technical, statistical, reports, drawings, creative	

FINANCIAL

Cash contribution for the student(s)	
Take student as a paid intern	
Donation of equipment or materials	

Appendix B - Collaborating Partners Form - Page 3

Appendix C: A List of Experts

- Tom Barker - Director, Graduate Program in Digital Futures, OCAD University
- Greg Van Alstyne - Director of Research, Strategic Innovation Lab; Associate Professor, OCAD University
- Caroline Langill - Associate Professor, Interim Dean, FoLAS/SIS
- Kurtis Leisick - Chair, The School of Craft + Emerging Media; Director, CE3C (Creative Environment for Emerging Electronic Culture) Alberta College of Art + Design
- Martha Ladly Professor of Design and Associate Dean, Graduate Studies, OCAD University
- Marie O'Mahony - Professor in Faculty of Design, OCAD University
- Nick Puckett - Faculty in OCAD University; Founding Director of AltN Research + Design
- Job Rutgers -Professor in OCAD University; Ambient Experience Lab

- Shauna McCabe - Executive Director in the Textile Museum of Canada
- Shawn McCarty - Innovation Lead in the Textile Museum of Canada
- Denise Roberts - Coordinator, Digital Interpretation, Art Gallery of Ontario (AGO)
- Virginia Vuleta - Director, Digital Services, Art Gallery of Ontario (AGO)
- Katherine Nip - Manager, Web Services, Digital Services, Art Gallery of Ontario (AGO)
- Alex Mayhew - Creative Director, Xenophile Media
- He Hao - Senior Lecturer, School of City Design, China Central Academy of Fine Arts

Appendix D: The Code Book (Main Parts in the Code)

iOS App

GaliViewController.m

```
#import "GaliViewController.h"
@interface GaliViewController ()
@property (weak, nonatomic) IBOutlet UIButton *taskButton;
@end
…
@implementation GaliViewController
@synthesize messages;
- (IBAction)unwindToMenu:(UIStoryboardSegue *)unwindSegue {…}
- (void)viewDidLoad {…}
- (void)initNetworkCommunication {…}
- (void)sendMessage:(NSString *)message {
  NSString *response  = [NSString stringWithFormat:@"%@\n", message];
     NSData *data = [[NSData alloc] initWithData:[response
dataUsingEncoding:NSASCIIStringEncoding]];
     [outputStream write:[data bytes] maxLength:[data length]];
}
- (void)stream:(NSStream *)theStream handleEvent:
(NSStreamEvent)streamEvent {
     switch (streamEvent) {
      case NSStreamEventOpenCompleted:
            NSLog(@"Stream opened"); break;
      case NSStreamEventHasBytesAvailable:
    if (theStream == inputStream) {
      uint8_t buffer[1024];
      int len;
      while ([inputStream hasBytesAvailable]) {
        len = [inputStream read:buffer maxLength:sizeof(buffer)];
        if (len > 0) {
        NSString *output = [[NSString alloc] initWithBytes:buffer
length:len encoding:NSASCIIStringEncoding];
        if (nil != output) {
          NSLog(@"server said: %@", output);
          if ([output isEqualToString:@"Logged in!\n"]) {
            AudioServicesPlaySystemSound(kSystemSoundID_Vibrate);
            UIAlertView *alert = [[UIAlertView alloc]
                  initWithTitle:@""
                  message:@"You have successfully connected with Gali!"
                  delegate:nil
                  cancelButtonTitle:@"OK"
                  otherButtonTitles:nil];
            [alert show];
          } else if ([output isEqualToString:@"task:geometry\n"]) {
            if (![[self getTopViewController] isKindOfClass:[self
class]]) {
            [[self getTopViewController]
dismissViewControllerAnimated:NO completion:nil];
```

```
            }
            [TasksViewController setTaskCategory:TASK_GEOMETRY];
            [self performSegueWithIdentifier:@"showTasks" sender:self];
          } else if ([output isEqualToString:@"task:animal\n"]) {
            if (![[self getTopViewController] isKindOfClass:[self
class]]) {
            [[self getTopViewController]
dismissViewControllerAnimated:NO completion:nil];
            }
            [TasksViewController setTaskCategory:TASK_ANIMAL];
            [self performSegueWithIdentifier:@"showTasks" sender:self];
          } else if ([output isEqualToString:@"task:textile\n"]) {
            if (![[self getTopViewController] isKindOfClass:[self
class]]) {
            [[self getTopViewController]
dismissViewControllerAnimated:NO completion:nil];
            }
            [TasksViewController setTaskCategory:TASK_TEXTILE];
            [self performSegueWithIdentifier:@"showTasks" sender:self];
          } else if ([output isEqualToString:@"connection:terminated
\n"]) {
            AudioServicesPlaySystemSound(kSystemSoundID_Vibrate);
            UIAlertView *alert = [[UIAlertView alloc]
                  initWithTitle:@""
                  message:@"It's time for you to go hunting now. You
have been disconnected with Gali."
                  delegate:self
                  cancelButtonTitle:nil
                  otherButtonTitles:@"OK", nil];
            [alert show];
            [self sendMessage:@"goodbye"];
          }
         }
        }
      }
    }
            break;
      case NSStreamEventErrorOccurred:
            NSLog(@"Can not connect to the host!");
            break;
      case NSStreamEventEndEncountered:
            break;
      default:
            NSLog(@"Unknown event");
     }
}
- (void)didReceiveMemoryWarning {…}
- (IBAction)connectGaliButtonPressed:(UIButton *)sender {
  [self initNetworkCommunication];
  NSLog(@"Scanning..");
```

```
  ZBarReaderViewController *codeReader = [[ZBarReaderViewController
alloc] init];
  codeReader.readerDelegate = self;
  codeReader.supportedOrientationsMask =
ZBarOrientationMask(UIInterfaceOrientationLandscapeLeft);
  ZBarImageScanner *scanner = codeReader.scanner;
  [scanner setSymbology:ZBAR_I25 config:ZBAR_CFG_ENABLE to:0];
  [self presentViewController:codeReader animated:YES completion:nil];
}
- (void) imagePickerController:(UIImagePickerController *)reader
didFinishPickingMediaWithInfo:(NSDictionary *)info {
  id<NSFastEnumeration> results = [info
objectForKey:ZBarReaderControllerResults];
  ZBarSymbol *symbol = nil;
  for (symbol in results) {
    break;
  }
  qrCodeString = symbol.data;
  NSLog(@"%@", qrCodeString);
  [reader dismissViewControllerAnimated:YES completion:nil];
  [self sendMessage:qrCodeString];
}
- (UIViewController*) getTopViewController {
  UIViewController *topViewController = [UIApplication
sharedApplication].keyWindow.rootViewController;
  while (topViewController.presentedViewController) {
    topViewController = topViewController.presentedViewController;
    [topViewController nibName];
  }
  return topViewController;
}
@end
```

TaskViewController.m

```
#import …
@interface TasksViewController ()
@property (strong, nonatomic) IBOutletCollection(UIButton) NSArray
*taskButtons;
@property NSString * taskCategoryName;
@end
static NSInteger taskCategory;
static NSString* taskDataSet;
@implementation TasksViewController
+ (void) setTaskCategory:(NSInteger) category {…}
+ (NSInteger) taskCategory {…}
+ (void)setTaskDataSet:(NSString *)dataSet {…}
+ (NSString*)getTaskDataSet {…}
- (void)viewDidLoad {
  [super viewDidLoad];
  if (self) {
    NSArray *tasks = [self randomTasks];
```

```
    if (tasks) {
    for (int i = 0; i < 2; i++) {
      UIButton * button = [self.taskButtons objectAtIndex:i];
      [button setImage:[UIImage imageNamed:[[tasks objectAtIndex:i]
imgName]] forState:UIControlStateNormal];
      [button setTitle:[NSString stringWithFormat:@"%d", i+1]
forState:UIControlStateNormal];
      button.titleLabel.hidden = YES;
    }
    } else {
    [self.isEmptyTextImageView setHidden:FALSE];
    for (int i = 0; i < 2; i++) {
      [[self.taskButtons objectAtIndex:i] setHidden:TRUE];
    }
    }
  }
}
- (void)didChangeValueForKey:(NSString *)taskCategory {…}
- (void)didReceiveMemoryWarning {…}
- (NSArray *) randomTasks {
  NSMutableArray * tasks = [[NSMutableArray alloc]init];
  switch (taskCategory) {
    case 0:
    return NULL;
    case 1:
    for (int i= 0; i < 2; i++) {
      Task * task = [[Task alloc] init];
      task.category = @"animal";
      self.taskCategoryName = @"Animal";
      task.imgName = [[@"animal" stringByAppendingString:[NSString
stringWithFormat:@"%d", i + 1]] stringByAppendingString:@"-27"];
      [tasks addObject:task];
    } break;
    case 2:
    for (int i= 0; i < 2; i++) {
      Task * task = [[Task alloc] init];
      task.category = @"geometry";
      self.taskCategoryName = @"Geometry";
      task.imgName = [[@"geometry" stringByAppendingString:[NSString
stringWithFormat:@"%d", i + 1]] stringByAppendingString:@"-27"];
      [tasks addObject:task];
    } break;
    case 3:
    for (int i= 0; i < 2; i++) {
      Task * task = [[Task alloc] init];
      task.category = @"textile";
      self.taskCategoryName = @"Textile";
      task.imgName = [[@"textile" stringByAppendingString:[NSString
stringWithFormat:@"%d", i + 1]] stringByAppendingString:@"-27"];
      [tasks addObject:task];
    } break;
```

```
  }
  return tasks;
}
- (IBAction)taskButtonPressed:(UIButton *)sender {
  NSLog(@"%@ Button Pressed", sender.titleLabel.text);
  taskDataSet = [NSString stringWithFormat:@"%@%@.xml",
self.taskCategoryName, sender.titleLabel.text];
  self.window = [[UIWindow alloc] initWithFrame:[[UIScreen mainScreen]
bounds]];
  Class vcClass = NSClassFromString(@"VideoPlaybackViewController");
  id vc = [[vcClass alloc] initWithNibName:nil bundle:nil];
  SampleAppSlidingMenuController *slidingMenuController =
[[SampleAppSlidingMenuController alloc] initWithRootViewController:vc];
  [slidingMenuController shouldIgnoreDoubleTap];
  [self presentViewController:vc animated:YES completion:nil];
  AudioServicesPlaySystemSound(kSystemSoundID_Vibrate);
  UIAlertView *alert = [[UIAlertView alloc]
          initWithTitle:@""
          message:@"Double-tap screen to get back."
          delegate:self
          cancelButtonTitle:nil
          otherButtonTitles:@"OK", nil];
  [alert show];
}
- (IBAction)backButton:(UIButton *)sender {
  [self dismissViewControllerAnimated:YES completion:nil];
}
@end
```

VideoPlaybackEAGLView.mm

```
…
namespace {
  const float kObjectScale = 3.0f;
  const char* textureFilenames[NUM_AUGMENTATION_TEXTURES] = {
    "icon_play.png",
    "icon_loading.png",
    "icon_error.png",
    "Animal1_1.png",
    "Animal1_2.png",
    "Animal2_1.png",
    "Animal2_2.png",
    "Geometry1_1.png",
    "Geometry1_2.png",
    "Geometry2_1.png",
    "Geometry2_2.png",
    "Textile1_1.png",
    "Textile1_2.png",
    "Textile2_1.png",
    "Textile2_2.png",
  };
  enum tagObjectIndex {…};
```

```
…
- (void) prepare {
…
    switch (i) {
    case 0:
      filename = @"animal1_1.mov"; break;
    case 1:
      filename = @"animal1_2.mov"; break;
    case 2:
      filename = @"animal2_1.mov"; break;
    case 3:
      filename = @"animal2_2.mov"; break;
    case 4:
      filename = @"geometry1_1.mov"; break;
    case 5:
      filename = @"geometry1_2.mov"; break;
    case 6:
      filename = @"geometry2_1.mov"; break;
    case 7:
      filename = @"geometry2_2.mov"; break;
    case 8:
      filename = @"textile1_1.mov"; break;
    case 9:
      filename = @"textile1_2.mov"; break;
    case 10:
      filename = @"textile2_1.mov"; break;
    case 11:
      filename = @"textile2_2.mov"; break;
    }
    if (NO == [player load:filename playImmediately:NO
fromPosition:videoPlaybackTime[i]]) {
    NSLog(@"Failed to load media");
    }
  }
}
…
- (void)renderFrameQCAR {
…
   int playerIndex = 0;  // animal1_1
    if (strcmp(imageTarget.getName(), "Animal1_2") == 0) {
    playerIndex = 1;
    } else if (strcmp(imageTarget.getName(), "Animal2_1") == 0) {
    playerIndex = 2;
    } else if (strcmp(imageTarget.getName(), "Animal2_2") == 0) {
    playerIndex = 3;
    } else if (strcmp(imageTarget.getName(), "Geometry1_1") == 0) {
    playerIndex = 4;
    } else if (strcmp(imageTarget.getName(), "Geometry1_2") == 0) {
    playerIndex = 5;
    } else if (strcmp(imageTarget.getName(), "Geometry2_1") == 0) {
    playerIndex = 6;
```

```
    } else if (strcmp(imageTarget.getName(), "Geometry2_2") == 0) {
    playerIndex = 7;
    } else if (strcmp(imageTarget.getName(), "Textile1_1") == 0) {
    playerIndex = 8;
    } else if (strcmp(imageTarget.getName(), "Textile1_2") == 0) {
    playerIndex = 9;
    } else if (strcmp(imageTarget.getName(), "Textile2_1") == 0) {
    playerIndex = 10;
    } else if (strcmp(imageTarget.getName(), "Textile2_2") == 0) {
    playerIndex = 11;
    }
…}
…
```

Java Server App:

Gali.java

```
package gali;
import processing.core.*;
public class Gali {
    public static void main(String[] args) {
        new Thread(new JavaReadIO()).start();
        new Thread(new Connection()).start();
        new Thread(new JavaReadArduinoSerial()).start();
        PApplet.main(new String[] {"--present",
"gali.GetScavengerTask"});    }
}
```

GetScavengerTask.java

```
package gali;
import …
public class GetScavengerTask extends PApplet {
    private Background background;
    private Canvas canvas;
    private Dog dog;
    private Tasks animalTasks, geometryTasks, textileTasks;
    static String process = "wait to start";
    static String QRL = "not activated";
    static String selection = "null";
    static String mobileSync = "not activated";
    static boolean overCircle = false;
    Tasks selectedTasks = null;
    PImage[] animalImages, geometryImages, textileImages;
    @Override
    public void setup() {
        process = "wait to start";
        QRL = "not activated";
        selection = "null";
        mobileSync = "not activated";
        overCircle = false;
        selectedTasks = null;
```

```
        PImage backgroundImage = loadImage("background.png");
        PImage mountain1Image = loadImage("mountain1.png");
        PImage mountain2Image = loadImage("mountain2.png");
        PImage treeImage = loadImage("tree.png");
        PImage cloudImage = loadImage("cloud.png");
        animalImages = new PImage[]{loadImage("animal1.png"),
loadImage("animal2.png")};
        animalTasks = new Tasks(this, "animal", animalImages);
        geometryImages = new PImage[]{loadImage("geometry1.png"),
loadImage("geometry2.png")};
        geometryTasks = new Tasks(this, "geometry", geometryImages);
        textileImages = new PImage[]{loadImage("textile1.png"),
loadImage("textile2.png")};
        textileTasks = new Tasks(this, "textile", textileImages);
        dog = new Dog(this);
        Mountain[] mountains = {new Mountain(this, mountain1Image,
displayWidth / 12, displayHeight / 4, displayWidth/4, displayHeight/2),
new Mountain(this, mountain2Image, displayWidth * 3 / 4, displayHeight /
12, displayWidth/10, displayHeight/3)};
        Tree[] trees = {new Tree(this, treeImage, displayWidth*4/5,
displayHeight*2/5, displayWidth/5, displayHeight/2)};
        Cloud[] clouds = {new Cloud(this, cloudImage, displayWidth * 4 /
7, displayHeight / 8, displayWidth/5, displayHeight*3/20, (float)0.3,
displayWidth * 4 / 7, displayWidth * 3 / 5), new Cloud(this, cloudImage,
displayWidth / 3, displayHeight / 5, displayWidth/4, (float)
(displayHeight*0.225), (float)-0.5, displayWidth / 5, displayWidth /
3)};
        background = new Background(this, backgroundImage, 0, -
displayHeight*3/20, displayWidth, displayWidth * 4 / 3);
        canvas = new Canvas(this, background, mountains, trees, clouds);
        size(displayWidth, displayHeight);
        smooth();
    }
    @Override
    public void draw() {
        canvas.displayCanvas();
        try {
            this.interact();
        } catch (WriterException | IOException |
NoSuchAlgorithmException ex) {

Logger.getLogger(GetScavengerTask.class.getName()).log(Level.SEVERE,
null, ex);
        }
    }
    public void interact() throws WriterException, IOException,
NoSuchAlgorithmException {
        if (process.equals("wait to start")) {
            dog.dogState();
            if (dog.dogState == false) {
                dog.textState1();
```

```
            dog.dogSleep();
        } else {
            dog.chooseDia();
            dog.dogRun();
        }
    }
    if (process.equals("wait to connect")) {
        if (canvas.isMovedUp()) {
            if (!canvas.getStatus().equals("lg")) {
            } else {
                dog.dogSmell();
            }
        }
    }
    if (process.equals("code is ready")) {
        dog.bringCode();
    }
    if (QRL.equals("activated")) {
        process = "connected";
    }
    if (process.equals("connected")) {
        dog.helloDia();
        selection = dog.connected();
    }
    if (process.equals("browsing")) {
        dog.dogSmell2();
    }
    if (process.equals("find results")) {
        dog.checkList();
        dog.find();
    }
    if (process.equals("show results")) {
        dog.dogSit();
        canvas.semiTrans();
        switch (selection) {
            case "animal":
                selectedTasks = animalTasks;
                break;
            case "geometry":
                selectedTasks = geometryTasks;
                break;
            case "textile":
                selectedTasks = textileTasks;
                break;
        }
        selectedTasks.displayTasks();
        if (selectedTasks.syncWithMobileTask()) {
            Connection.sendMessage("task:" + selection);
            mobileSync = "finish data sync";
            canvas.setUpSpd(-10);
            canvas.setStatus("down");
```

```
            }
        }
        if (mobileSync.equals("finish data sync")) {
            if(!Connection.requestToDisconnect){
                Connection.sendMessage("connection:terminated");
                Connection.requestToDisconnect = true;
            }
            process = "null";
            if (Connection.thisClient.isClosed() &&
canvas.isMovedDown()) {
                if (canvas.getStatus().equals("g")) {
                    process = "wait to start";
                    QRL = "not actived";
                    selection = "null";
                    mobileSync = "not actived";
                    canvas.restart();
                    dog.restart();
                    selectedTasks.restart();
                    Connection.requestToDisconnect = false;
                }
            }
        }
    }
}
```

Connection.java

```
package gali;
…
public class Connection implements Runnable {
    static ServerSocket serverSocket;
    static Socket thisClient = null;
    static boolean requestToDisconnect = false;
    @Override
    public void run() {
        try {
            serverSocket = new ServerSocket(5678, 0,
InetAddress.getLocalHost());
            System.out.println(serverSocket.getLocalSocketAddress());
        } catch (IOException e) {
        }
        while (true) {
            try {
                thisClient = serverSocket.accept();
                while (!thisClient.isClosed()) {
                    InputStream is = thisClient.getInputStream();
                    InputStreamReader clientInput = new
InputStreamReader(is);
                    BufferedReader br = new BufferedReader(clientInput);
                    System.out.println("当前socket客户端的IP地址:" +
thisClient.getInetAddress());
```

```
                    String clientStr = br.readLine();
                    System.out.println("客户端说:" + clientStr);
                    if (clientStr.equals(Dog.qrText)) {
                        GetScavengerTask.QRL = "activated";
                        Connection.sendMessage("Logged in!");
                    }
                    if (clientStr.equals("goodbye")) {
                        thisClient.close();
                    }
                }
            } catch (IOException e) {
            }
        }
    }
    public static void sendMessage(String message) throws
UnsupportedEncodingException, IOException {
        thisClient.getOutputStream().write((message +
"\n").getBytes("US-ASCII"));
    }
}
```

JavaReadIO.java

```
package gali;
…
public class JavaReadIO implements Runnable{
    @Override
    public void run()  {
        try {
            Robot robot = new Robot();
            String line;
            while (true) {
                BufferedReader reader = new BufferedReader(new
FileReader("/dev/cu.usbserial-A601LRUY"));
                line = reader.readLine();
                System.out.println(line);
                switch (line.trim()) {
                    case "004DB9761C9E":
                        robot.keyPress(KeyEvent.VK_A);
                        robot.keyRelease(KeyEvent.VK_A);
                        break;
                    case "004DB9779E1D":
                        robot.keyPress(KeyEvent.VK_G);
                        robot.keyRelease(KeyEvent.VK_G);
                        break;
                    default:
                        robot.keyPress(KeyEvent.VK_T);
                        robot.keyRelease(KeyEvent.VK_T);
                        break;
                }
            }
```

```
        }
      …
    }
}
```

QRGen.java

```
package gali;
…
public class QRGen {
    public static boolean generateQRCode(String text) throws
WriterException, IOException {
        String filePath = "data/QR.png";
        int size = 500;
        String fileType = "png";
        File qrFile = new File(filePath);
        createQRImage(qrFile, text, size, fileType);
        return true;
    }
    private static void createQRImage(File qrFile, String qrCodeText,
int size,
            String fileType) throws WriterException, IOException {
        Hashtable hintMap = new Hashtable();
        hintMap.put(EncodeHintType.ERROR_CORRECTION,
ErrorCorrectionLevel.L);
        hintMap.put(EncodeHintType.MARGIN, 2);
        QRCodeWriter qrCodeWriter = new QRCodeWriter();
        BitMatrix byteMatrix = qrCodeWriter.encode(qrCodeText,
                BarcodeFormat.QR_CODE, size, size, hintMap);
        int matrixWidth = byteMatrix.getWidth();
        BufferedImage image = new BufferedImage(matrixWidth,
matrixWidth,
                BufferedImage.TYPE_INT_RGB);
        image.createGraphics();
        Graphics2D graphics = (Graphics2D) image.getGraphics();
        graphics.setColor(Color.WHITE);
        graphics.fillRect(0, 0, matrixWidth, matrixWidth);
        graphics.setColor(Color.BLACK);
        for (int i = 0; i < matrixWidth; i++) {
            for (int j = 0; j < matrixWidth; j++) {
                if (byteMatrix.get(i, j)) {
                    graphics.fillRect(i, j, 1, 1);
                }
            }
        }
        ImageIO.write(image, fileType, qrFile);
    }
}
```

Dog.java

```
package gali;
…
```

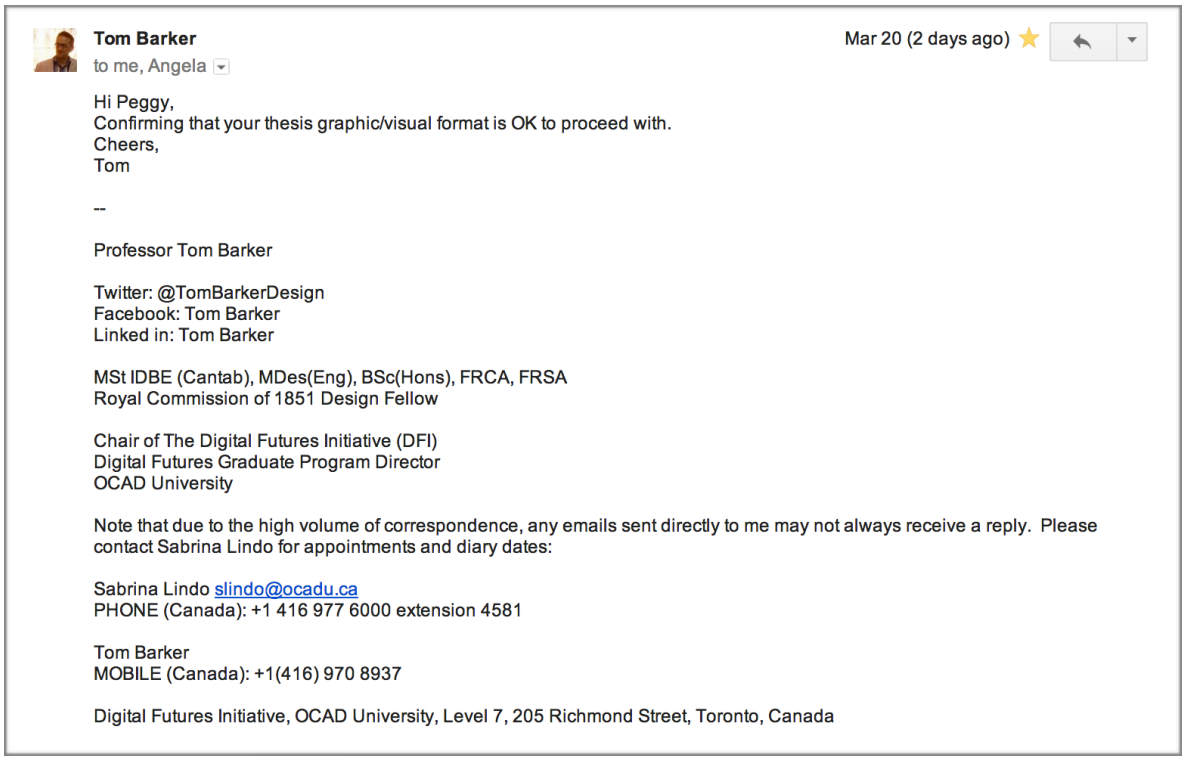
```
public class Dog {
     … //initiate and setup
    public Dog(PApplet pa) {…}
    void textState1() {…}
    void dogSleep() throws WriterException, IOException,
NoSuchAlgorithmException {…}
    void chooseDia() {…}
    void dogRun() throws NoSuchAlgorithmException, WriterException,
IOException {…}
    void dogState() {…}
    void dogSmell() throws WriterException, IOException {…}
    void bringCode() {…}
    void helloDia() {…}
    public String connected() {…}
    void dogSmell2() {…}
    void checkList() {…}
    public boolean find() {…}
    void dogSit() {…}
    void restart() {…}
}
```

Appendix E: The cost of prototypes

Model Number	Item Name	Unit Price (CAD)	Total Price (CAD)
SEN-09416	RFID Glass Capsule	4.95	14.85
SEN-09417	RFID Button	3.95	11.85
SEN-11319	RFID Tag	2.66	26.6
SEN-10126	RFID Module	29.95	29.95
SEN-08423	RFID Reader Breakout	0.95	1.9
RTL-11839	RFID Starter Kit	49.95	49.95
DEV-10406	RFID Evaluation Shield	19.95	19.95
RTL-11506	RFID Tag	9.95	9.95
CAB-11301	USB Mini-B Cable	3.95	3.95
N/A	Clothe, Needle and threads	- - -	59.95
Acer T232HL	Acer multi-touch monitor	326.59	326.59
000.585.19	Ikea Shelf Unit	39.99	39.99
727.242.28	200-piece wood screw set	5.99	5.99
102.422.73	Jigsaw	26.99	26.99
001.961.01	Screwdriver/drill, lithium-ion	24.99	24.99
N/A	Plywood Board, Fluid Acrylics and brush	- - -	189.93
N/A	Apple développer account	99	99
Before TAX	**942.38**	**Total**	**1064.89**

Appendix E - The cost of prototypes

Appendix F: The Agreement of the Bespoke Format



Tom Barker Mar 20 (2 days ago)

to me, Angela

Hi Peggy,
Confirming that your thesis graphic/visual format is OK to proceed with.
Cheers,
Tom

--

Professor Tom Barker

Twitter: @TomBarkerDesign
Facebook: Tom Barker
Linked in: Tom Barker

MSt IDBE (Cantab), MDes(Eng), BSc(Hons), FRCA, FRSA
Royal Commission of 1851 Design Fellow

Chair of The Digital Futures Initiative (DFI)
Digital Futures Graduate Program Director
OCAD University

Note that due to the high volume of correspondence, any emails sent directly to me may not always receive a reply. Please contact Sabrina Lindo for appointments and diary dates:

Sabrina Lindo slindo@ocadu.ca
PHONE (Canada): +1 416 977 6000 extension 4581

Tom Barker
MOBILE (Canada): +1(416) 970 8937

Digital Futures Initiative, OCAD University, Level 7, 205 Richmond Street, Toronto, Canada

Appendix F - The Agreement of the Bespoke Format