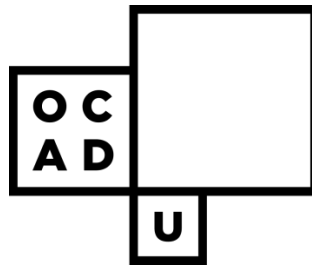


**TOUCHING OBJECTS:
Objects as Force-feedback Devices for Environmental
Storytelling**

by
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A thesis and presentation submitted to
OCAD University
in partial fulfillment to the requirements for the degree of
Master of Design in Digital Futures

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 Ruzette Tanyag 2014

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ABSTRACT

Thesis Title: Touching Objects : Objects as Force-Feedback Devices for Environmental Storytelling
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This study proposes the use of actuated physical objects to investigate force-feedback sensations to explore a 3D environment. In this study, touch triggers and feedback methods, such as haptic icons, were incorporated to the physical objects to engage the person's attention and interest towards the virtual objects. Rhythmical patterns were produced to indicate that the user is in proximity to the virtual objects. Afterwards, these virtual objects inside the 3D environment were modeled and analyzed based from the story, The Necklace by Guy de Maupassant. The Necklace, as a story, encloses visual details about the story's environment. Also, the necklace, as a physical object, is a representation of the main character's mishaps. Observations from the study indicate that users perceive the sensations as unique to that specific virtual object. Further observations reveal that it takes time to build mental associations between the actuated object and the 3D environment.

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1 INTRODUCTION

Objects have three intrinsic characteristics. According to Merriam-Webster (Object), objects are inanimate things which are visual, tangible and hold narrative information. Usually, the objects' visual attributes directs the user's attention and interest. The objects' tangibility then provides a richer user experience since they can be physically manipulated or explored. The user, upon exploration and manipulation of these objects, learns to understand the objects' importance to society.

In virtual game environments, objects are visible and contain narrative information. Burch indicates that objects convey narrative information as a supplementary aid to achieve the overall narrative context in the environment (Burch, 2012). He mentioned that game designers represent objects as forms of visual narratives, otherwise termed as environmental storytelling or environmental narratives. And environmental storytelling is "...the act of 'staging player-space' with environmental properties that can be interpreted as a meaningful whole, furthering the narrative of the game" (Worch & Smith, 2010).

However, the tangible aspects of these virtual objects are constrained to game controllers. In virtual game environments, the closest tangible experience we can perceive from virtual objects comes through the game controllers' force-feedback capabilities. Usually, a feedback or a notification from the game controller indicates that objects were touched and have been touched. And the feedback or the notification is represented by either one short-timed vibration, or a longer-timed vibration. However, these notifications do not indicate which specific virtual object was touched.

1.1 STATEMENT OF THE PROBLEM

This study suggests that exploring different force-feedback rhythms and patterns, called as haptic icons, as a way of distinguishing different virtual objects in a virtual game environment. By exploring different haptic icons, it may help enhance the lacking sensations perceived from the virtual environment. It may also enhance the experience of the narrative embedded in the virtual environment.

Furthermore, since virtual objects are essential in uncovering the narratives inside the 3D environment, this study suggests that physical objects related to the story should be investigated to understand if the interaction has been enhanced. This study also proposes to investigate physical objects as a medium for exploring 3D game environments with narrative inclinations and forced feedbacks.

1.2 BACKGROUND OF THE STUDY

We touch objects on a daily basis. When we write letters, we hold pens or pencils with our hands. We feel that pen's hardness as we grip it firmly between our fingers. The roughness of the paper sometimes lingers as our hands glide along the lines of our writing. And almost instantly, we feel that sharp pangs of pain as we experience paper cuts from flipping and dog-earing through pages of those letters.

The act of touching is significant in performing task-related actions (MacLean, 2000). Touching helps in probing for its tangible attributes,

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communicating a message, provoking a reaction, and validating the completion of an action. In the recreational and experience-rousing instances, touching helps us to appreciate aesthetic pleasures or comfort from passive and active touches; to “fidget to relieve tension;” or to create a physical and emotional bond with another conscious being.

Objects, on the other hand, are inanimate things that can be perceived through the senses of sight and touch (Object). While an object is mostly researched for its visual component, the importance of touch in objects is vital. Objects hold intrinsic characteristics that only the sense of touch can provide, such as size, shape, weight, texture and temperature. These qualities trigger an active exploration from the user (Heller, 2009; MacLean, 2000). Through manipulation, these objects create tactile sensations which are unique to every individual.

Objects also elicit an emotion when a viewer’s attention or interest is piqued (Object). It implies that any man-made or natural object, when touched, transmits functional signals to the user that evoke emotions through mental associations or related narrative events (MacLean, 2000). The slew of emotions is dependent upon the user’s interpretations of what the object offers (Pearce, Objects as meaning; or narrating the past, 1994). Pearce highlights that objects are transformed into ‘a more “correct,” richer, and more perceptive experience’, if the user physically interacts with the object (i.e. wearing the same coat he had seen 10 years ago) compared to visually engaging with it.

All objects are tailored with specific tasks that the creator or the owner can perform (MacLean, 2000). These actions, in turn, etch unique information that

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identifies the creators' natures in society (Burch, 2012; Pearce, Thinking About Things, 1994). It can be deduced that these information from the creators' characters are forms of narratives embedded in an object (Burch, 2012).

Burch, on the other hand, indicates that objects imply a creator (Burch, 2012). It suggests that an object is an embodiment of the creator's nature in society. Its creator imposes unique information, which determines its significance by asking the *hows*, *whats*, *whys*, *whens* and *wheres* questions. Identifying the creator also reveals certain narrative elements that convey the object's environment and the history associated with it. The nature of the environment exposes the object's rudimentary functionalities, while the history supports fundamental narrative that the creator has imposed on it (Pearce, Thinking About Things, 1994).

In game design and movies, these objects populate the game's or film's environment to create a backstory that will help with the story being told (Burch, 2012). And while the objects help the players understand the story behind the environment, the environment also aids in deducing elements to show the underlying narrative behind the object (Negroni, 2014; Burch, 2012). However, Burch further notes that these objects have limited functionalities. Game designers limit the full potential of each object as a means of guiding the players' movements to help them finish the intended gameplay. Objects are only viewed in a certain way, such as frontal view, and Unfortunately, the narrative information of these virtual objects is neglected due to the interactive nature of the games.

Researchers in the haptics try to simulate the perceptions of touch in virtual space. They have been developing force-feedback as a means of communicating that an action has been made. They developed haptic gloves and air haptics, to validate an action transmitted from virtual space. Others refined these tactile sensations to indicate pressure and spatiality-detection (Fрати & Prattichizzo, 2011).

These examples of haptics represent objects but not explore the objects itself for that experience. Usually, the touch that enhances these mediums is separated from the mediums themselves (Heibeck, Hope, & Legault, 2013).

1.3 PURPOSE OF THE STUDY

The purpose of the study is to investigate different ways of augmenting the experience of virtual objects and the 3D game environment through different force-feedback methods from physical objects. By stimulating the sense of touch produced from physical objects, the functionalities and interpretations of the virtual objects and their associations towards the 3D game environments may be enhanced. It also provides an engaging research in the field of haptics, and multimedia or cinematic art.

Another purpose of this study is to investigate how users interpret the force-feedback devices while exploring the 3D game environment. This is to determine how the physical objects positively or negatively affects the exploration of these environments.

1.4 RESEARCH QUESTIONS

1. How can we play with our sense of touch to explore the underlying narratives behind virtual objects in 3D game environments?
2. How do users interpret the sensations caused the by the objects, both physical and virtual, to tell the story in 3D game environments?

1.5 THEORETICAL FRAMEWORK

This study explores theoretical and applied case studies of objects, in relation to the sense of touch, material culture, narratives and environmental storytelling found on Chapter 2 Theoretical Framework. This study initially discusses the sense of touch and the exploration in the field of haptics. These theories are essential to assert the undervalued importance of the sense of touch, and how objects play a role in the experience of touching. Objects are then examined in the material culture to understand how they play a role in the environmental and cultural context. The material culture studies offer an engaging insight to how artifacts (or objects) have meaning, in man's context and how they are valuable to society. The studies in the material culture also tie up to understanding the context that game designers apply in environmental storytelling.

1.6 DESIGN AS REFLECTIVE PROCESS

This study used the short story, *The Necklace*, by Guy de Maupassant. The purpose of using this short story was that it was written with visual descriptions of

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the environmental properties and its environments. The short story was then deconstructed and analyzed to retrieve the essential related objects and its environment. The analysis incorporated Pearce's meaning-identification towards objects in the field of Material Culture (Pearce, Objects as meaning; or narrating the past, 1994). Afterwards, environmental narrative elements were modeled and textured in Autodesk Maya 2014 and imported into Unity3D to create a more interactive virtual object exploration.



FIGURE 1. GIBBS' MODEL OF REFLECTION

The integration of the force-feedback sensations were developed through reflection of tangible prototypes as a design process. The unique affordance of the physical objects was investigated to determine if users would explore it as a separate object. Touch triggers and feedback methods through different rhythms and patters were developed to engage the person's attention and interest towards both the physical and virtual objects. Using the reflective design process

helped in understanding how the physical objects may enhance the narrative of the environment and how these objects stimulate the sense of touch upon interacting with the virtual object.

The Gibb's Model of Reflection (Gibbs, 1988), as seen in Figure 1. Gibbs' model of reflection, was used as the basis for the reflective design process in this study. Reflecting on the observations from the prototypes will help in the learning process about haptics and advancement of my skills as a practitioner.

1.7 LIMITATIONS OF THE STUDY

Several limitations are necessary for this study. First, the study only developed one virtual environment from the short story, *The Necklace* by Guy de Maupassant. Focusing on one virtual environment may aid in further exploring the narrative context of the virtual objects and its environment. Secondly, the physical objects as prototypes in this study may not accurately resemble the original object as described in the short story. The study prioritized the manipulation of the sensations in the virtual environment over the visual accuracy of the prototypes to the story. And lastly, the study was conducted with small participant size to easily determine and troubleshoot recurring problems.

1.8 OUTLINE OF THE STUDY

The study presents six chapters after the 1 Introduction chapter – 2 Theoretical Framework, 3 Narrative Analysis, 4 Tangible Prototypes, 5 Results and Discussion, 6 The Exhibition, and 7 Conclusion.

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The second chapter, 2 Theoretical Framework, examines the case studies on objects in different fields in material culture, haptics, and environmental storytelling. It aims to explore these concepts to strengthen the rationale of the study.

The third chapter, 3 Narrative Analysis, examines different narratives to be embedded in objects. It aims to present a story, to deconstruct it into characters, environmental items, and events, and incorporate visual and aural cues to help the users understand the haptic icons associated with the narratives.

The fourth chapter, 4 Tangible Prototypes, explores different ideas and technologies that could best interact with the visual and aural cues of the story. It aims to explore and reflect on how it is made and how it can be used by users. It uses the Gibbs Reflective Cycle (Gibbs, 1988) to identify areas which needs to be addressed.

The fifth chapter, 5 The User Study, aims to analyze and collate user-collected suggestions and reflections from the conducted study. It aims to understand various user-feedbacks to understand how users perceive the proposed tactile sensations.

The sixth chapter, 6 The Vanity Table, combines the physical prototype into a physical environment which relates to the story, The Necklace.

And lastly the seventh chapter, 7 Conclusion, summarizes and reflects upon the learning experience of the study. It discusses possible future directions that this study may explore, and it aims to present possible useful applications which could be investigated by other researchers.

2 THEORETICAL FRAMEWORK

2.1 THE SENSE OF TOUCH AND HAPTICS

The sense of touch is a multi-sensory channeled system that deals with perceiving external information through being in contact with our main receptor, the skin (Heller, 2009; MacLean, 2000). The perceived information that our sense of touch gathers is mostly collected from objects that we touch. Tactile researchers cite that is the primary sense that deals with interaction of objects (Bau & Poupyrev, 2012; Gibson, 1962). And as technologies advance, the tactile information from the objects is being lost due to the movement of space into the virtual realm. In turn, tactile researchers have investigated approaches on how to enhance the immersion of the users to *tactile-less* environments.

Haptics is originally derived from the Greek word, *haptikos*, which means to able to grasp or to perceive (Haptics is Quite Literally The Science of Touch). This term is mostly popular in the field of haptics as it combines the psychological, physiological, and technological aspects related to the sense of touch. The terms, “sense of touch” and “haptics”, are almost used interchangeably due to the action that sense of touch performs – to grasp or to perceive. It also denotes that to grasp or to perceive means engaging in a physical entity that allows exploration and manipulation. Also, it focuses more of the experience happening during the active exploration and manipulation of something, rather than the description of the object itself.

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Researchers investigate haptics because of the information presented and its affective consequences (Heller, 2009). McGee points out that the technological advancements in haptics are essential and useful to conveying and understanding the information about objects (McGee & Wall; MacLean, 2000). In virtual spaces, haptics is useful to enhance the realism of an object and the person's presence or immersion. It also encompasses the user navigation over, through, or to an object. On the other hand, Maclean (MacLean, 2000) supplemented the purpose as a form of the validation of performed task. Continuous construction of mental models which results to affective interpretation.

In virtual spaces, objects also live virtually. They lose the ability enjoy the activeness and the passivity of touches. Consequently, haptics researchers try to emulate the information conveyed by touch through the passivity. Haptic through forced feedback are encouraged to simulate shapes – large mechanical devices are used to incorporate pressure (Halabi & Kawasaki, 2010),

2.2 OBJECTS IN MATERIAL CULTURE

The analysis through the research found on the sense of touch or haptics reveals that objects contain unique information aside from the tangible characteristics it provides. In the material culture, objects are valuable in understanding the context of man's nature in society.

Prown discusses that material culture focuses on the cultural investigation and the use of objects as its primary data (Prown, 1982). According to Prown:

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“Material culture as a study is based upon the obvious fact that the existence of a man-made object is concrete evidence of the presence of a human intelligence operating at the time of fabrication. The underlying premise is that objects made or modified by man reflect, consciously or unconsciously, directly or indirectly, the beliefs of individuals who made, commissioned, purchased, or used them, and by extension the beliefs of the larger society to which they belonged.”

In that sense, it can be inferred that the study of the material culture encompasses physical objects modified by man, such as “a hammer, a plow, a microscope, a house, a painting, and a city.” However, natural objects which can be modified by nature are not culturally bound so they are disregarded.

It is important to investigate the cultural value of such objects because of the implicit cultural beliefs embedded upon them. It is said that “...A value that accrues from utility will inhere as long as an object continues to be useful and can return when an obsolete object again becomes useful (wood stoves in an oil shortage) (Prown, 1982)” Furthermore, most objects are widely accepted by society that deeper cultural investigations are overpowered by their basic cultural assumptions.

Extracting information about culture from mute objects are determined from the “...*description*, recording the internal evidence of the objects itself; to *deduction*, interpreting the interaction between the object and the perceiver; and to *speculation*, framing hypotheses and questions which lead out from the object to external evidence for testing and resolution. (Prown, 1982)”

Pearce understands Prown’s explanations and further affirmed that objects serve as a way of describing the past. She introduces Lieutenant Henry Anderson’s jacket, or *coatee*, that he wore during the battle of Waterloo (Pierce

S., 1994). If not for the inherent value, the personal story that took place in the battle of Waterloo and its importance to the wearer of the coatee, the worn-out jacket would have deemed invaluable and disposable to artifact-collectors. The value that it comprises allows it to be considered as pieces in museum collections as it adds further knowledge within the "...broad fields of social history, applied art, and ethnography. (Pearce, Objects as meaning; or narrating the past, 1994)"

2.3 OBJECTS IN ENVIRONMENTAL STORYTELLING

Worch and Smith (Worch & Smith, 2010) introduces the concept that game environments, or virtual reality games, contain narrative information and strengthens and molds character identity. These game environments communicate a fictional premise by showing you :

- the functional purpose of the place,
- the historical events that happened in that place,
- its inhabitants and living conditions,
- what might happen, and
- the mood it wants to convey

Through these spaces, the player assumes an identity that has to adhere to the social norms and behaviors in that context.

Jenkins (Jenkins, 2004) then discusses that while the relationship between games and stories provoke controversy in the realm of Games Studies, everyone might agree that games can often be abstract, experiential, and may contain

narrative context. Spatiality exploration, however, introduces the concept that games can also contain narrative architecture.

He initially points that Environmental Storytelling, or simply called Spatial Stories, are a form of sculpted spaces or worlds with narrative inclination. These designed spaces, often considered as game spaces, are embedded with narratives which provide some story pretext of how a game progresses or plays out in a particular game design. They, then, assist in creating narrative experiences.

Designing game spaces are invested with attached story elements from existing film or literary genres, which create a more immersive representation of the narrative it conveys. And not all game spaces reproduce exact replicas of the narratives of different literary genres - they often elicit preconceived user narratives from the atmosphere and feel that a space evokes.

Thus, Jenkins defines four preconditions which could create immersive environment stories. They can:

1. Evoke pre-existing narrative conditions,
 - “remediate a pre-existing story (Back to the Future) or draw upon a broadly shared genre tradition”
2. Enact stories,
 - “discuss games as stories, we are referring to games that either enable players to perform or witness narrative events”
3. Embed narrative information in a scene, and
 - “spectators test and reformulate their mental maps of the narrative action and the story space”

4. Provide emergent narrative resources.
 - “a kind of authoring environment within which players can define their own goals and write their own stories”



FIGURE 2. PIXAR'S TOY STORY 2. VIDEO STILL. IDENTIFYING WHO ANDY'S MOM IS. (LASSETER, TOY STORY 2, 1999)

While objects help the user identify what happened to an environment through spatial stories, environments and the story can also aid in identifying the narrative behind an object. Take for instance Negroni's theory on the movie series – Toy Story (Negroni, 2014; Lasseter, Toy Story , 1995; Lasseter, Toy Story 2, 1999; Unkrich, 2010). He argues that the key to Andy's mom's identity lies in uncovering the secrets behind the story and the environment itself is through the inspection of the objects. After a detailed explanation of the relationships between the environments, and the surrounding objects, he concluded Jessie's owner and the Andy's cowboy hat timelines ties up well. It

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eventually led to Andy's mom being the owner of Jessie and the cowboy hat. In this scenario, the slew of events and the environments associated with it helped uncover the Andy's cowboy hat's narrative as well as exposing the owner's identity.

The Room (Fireproof Games, 2012), on the other hand, is another form of environmental storytelling that deals with objects to reveal their intended narratives. It offers a complex puzzle game using intricate boxes to unravel the mystery behind them. The game is led by using different objects or items around the box, which could unlock a level of the story. The puzzle-laden boxes are nicely designed such that the narratives are embedded yet engaging. In a way, the tangible affordance of the boxes in The Room is not accessible in the game. It would potentially create a more immersive experience if it was developed as physical puzzle game boxes. The nooks and crannies of the boxes would be felt by the players, which add to immersion of the story and the object itself.

Accordingly, there are other engaging forms of physical objects developed over the years. SAGE (Umaschi, 1997) is a good example of a physical object that tells a story through a computer assisted environment. The study argues that children have close relationships with their stuffed animals. It is therefore a good proposition to engage the children to interact with the toys to develop their own story. The study conveys the affordance of objects as a physical medium, and as a container for narrative information. This study, however, did not assimilate the exploration of the passive touch. The Sensory Fiction (Heibeck, Hope, & Legault, 2013), conversely, offers the passive touch that the SAGE lacks. The physicality of a book affords the tangibility of the medium, as well. The passive touch is

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incorporated by wearing a haptics vest which could warm up, increase pressure and vibrate to set up the mood of the page content. This exploration of both active and passive touches, as well as the narrative information, is an ideal set up for further investigation. Instead of using a separate medium for the passive touch, it would be meshed with the object itself.



FIGURE 3. THE ROOM. FIREPROOF GAMES

3 NARRATIVE ANALYSIS

3.1 STORY SELECTION

The Necklace (See Appendix C) is a one of the popular stories by Guy De Maupassant. It was first published on the 17th of February 1884 in the French Newspaper Le Gaulois. It was written in the form of a literary realism, wherein observable details and facts are described instead of romanticizing or stylizing it. It also reveals that the unexpected plots and twists of the ending mimics the spatial stories' concept of allowing enabling multiple player-authored interpretations of stories.

3.2 STORY SUMMARY

“The Necklace” first introduces Mathilde Loisel, a middle-class woman who believes that her charms and beauty deserve to be in the higher-class society. However, her husband, Monsieur Loisel, is only an artisan and a lowly clerk at the Ministry of Education. No matter how much her husband tries to lavish her with jewelries and clothes, Mathilde could not be satisfied.

The Loisels were later invited to attend a party at the Ministry of Education. Upon reading the invitation, Mathilde was displeased because she didn't have attire for it. So Monsieur Loisel gave her money to buy a fancy dress and told her that she should borrow jewelries from her friend, Madame Forestier. Mathilde then went to Madame Forestier's home to borrow a diamond necklace.

At the night of party, Mathilde had the time of her life. Her dream of being loved and entertained by the higher-class society came true. She and her

NARRATIVE ANALYSIS

husband stayed at the party until 4 in the morning. But they hastened to get home because Mathilde didn't want to be seen in a shabby coat.

When they got home, they were shocked when they noticed that the necklace was missing from her neck. They searched around the places they could have passed by but they did not manage to find it. To make it seem that the necklace was not lost, Mathilde told Madame Forestier that the necklace's clasp broke and they are having it fixed. Meanwhile, they tried to find a similar necklace in the jewelry stores. They later found a similar necklace worth forty thousand francs but it was discounted for thirty six thousand francs. They bought the necklace by using their fortune, selling their house, and loaning money from different people. After selling their house, they moved to a garret under a roof. They worked all day and all night to pay off the debt from the necklace.

Ten years later, Mathilde, who looked disheveled and old, saw Madame Forestier and started a conversation. While they were talking, Mathilde told Madame Forestier the hardships the Loisels encountered as they tried to replace the necklace she borrowed. Madame Forestier took Mathilde's hands and said that the necklace was an imitation and was worth at most five hundred francs.

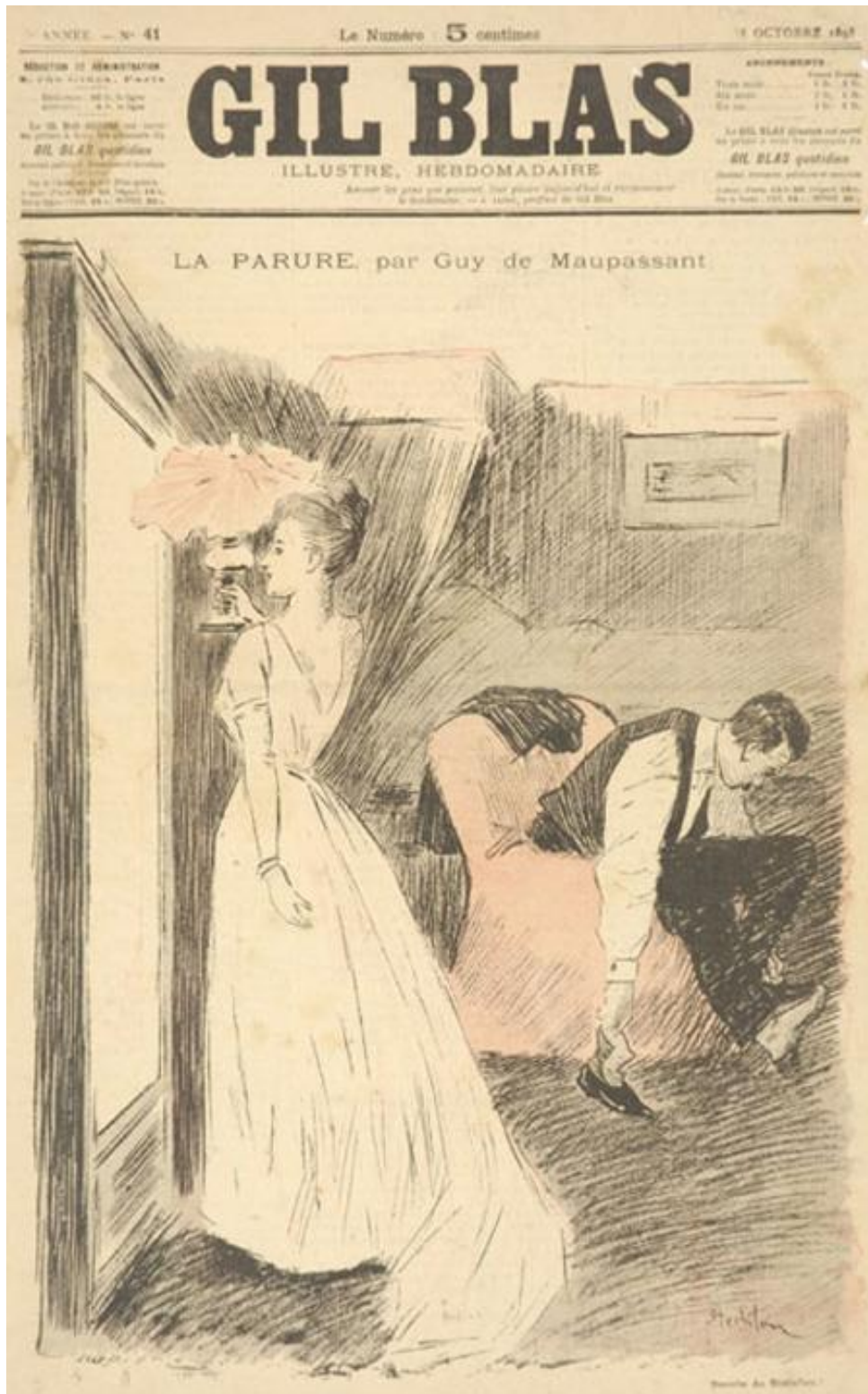


FIGURE 4. "LA PARURE" IN FRENCH. THE NECKLACE.
[HTTP://UPLOAD.WIKIMEDIA.ORG/WIKIPEDIA/COMMONS/B/B5/LA_PARURE_-_GIL_BLAS.JPG](http://upload.wikimedia.org/wikipedia/commons/b/b5/LA_PARURE_-_GIL_BLAS.JPG)

3.3 STORY ANALYSIS



FIGURE 5. CARL SPITWEG'S THE POOR POET. 1837.

As seen in Table 1. Characters from the story, *The Necklace*. Mathilde Loisel is the protagonist among three characters in the story. She is an artisan who thinks that her charms should attract upper class men. She experiences a constant struggle within herself about her possessions and the life richer life she imagines she should have.

Looking deeper into the environments where she inhabited (Table 2. Environmental properties from the story, *The Necklace*), the garret under the roof that she and her husband lived during their financial struggles is fitting to

incorporate narrative elements in it. It has the essential feeling that she disliked and it can be embedded with the past events that happened to them.

The story was set in the late 1880s in France. Paintings, architectures and interior designs from that era were researched and the garret under a roof. Carl Spitzweg's the poor poet painting (Figure 5. Carl Spitzweg's The Poor Poet. 1837.) (Spitzweg) resembles a poor man's space. Prominent items in this garret include the bed and the stove.

3.4 ENVIRONMENT CREATION



FIGURE 6. GARRET UNDER THE ROOF ENVIRONMENT. MODELED, TEXTURED AND RENDERED IN MAYA 2014.

The garret and the environmental items related to the story are then modeled and textured in Maya 2014. Low-polygonal meshes were created to determine the feel of the environment. The stove, the bed and the desk were noticeable because those are the bare necessities in the story. The stove was

NARRATIVE ANALYSIS

Characters	Description
Mathilde Loisel	The lead character. She is married to a little clerk. She feels that her beauty and charms deserved more than being born in a family of artisans.
Monsieur Loisel	He is Mathilde Loisel's husband. He works at the Ministry of Education and lives in one of the houses at Rue de Martyrs.
Madame Jeanne Forestier	She is Mathilde Loisel's rich friend. She lent her a diamond necklace in a black satin case for the Minister's party.

TABLE 1. CHARACTERS FROM THE STORY, THE NECKLACE

NARRATIVE ANALYSIS

Environment	Environmental Items
House at Rue de Martyrs	francs/coins/banknotes, “mean walls”, worn chairs, “ugly curtains”, round table, 3-day old cloth, soup tureen, large envelope, printed card, dress worth 400 francs
Mathilde’s Imaginary Life	silent antechambers, Oriental tapestries, torches in lofty bronze sockets, 2 large armchairs, stove, saloons, antique silks exquisite pieces of furniture supporting priceless ornaments, small, charming perfumed rooms, delicate meals, gleaming silver, tapestries people on the walls with folk of a past ago and strange birds in faery forests
Madame Forestier’s salon	dressing table, large box, pearl necklaces, Venetian cross in gold and gems, black satin case, diamond necklace
Garret under the roof	bed, table, lamp, stove

TABLE 2. ENVIRONMENTAL PROPERTIES FROM THE STORY, THE NECKLACE

Events
<ol style="list-style-type: none"> 1. The Loiseles got invited to the Minister of Education's party at the Ministry 2. Mathilde did not have anything to wear for the party, so Monsieur Loisel gave him four hundred francs to buy a dress 3. Mathilde, still unsatisfied with the dress, felt the anxiety that she still did not have jewelries to complement with the dress. Monsieur Loisel suggested that she borrow jewels to Mathilde's rich friend, Madame Forestier 4. Mathilde went to Madame Forestier. 5. She borrowed a diamond necklace in a black satin case. 6. The Loiseles went to the party 7. Upon going home, Mathilde lost the necklace. 8. The Loiseles looked all over for the necklace but did not manage to find it. 9. They looked for a replica of the necklace which was worth forty thousand francs, but was discounted for thirty six thousand francs. 10. They bought the necklace by borrowing money from other people, and moving to a garret under the roof. 11. They returned the necklace to Madame Forestier. 12. The Loiseles spent 10 years paying off the debt by selling their flat, living in a garret under the roof and paying off their debt. 13. One day, Mathilde saw and greeted Madame Forestier. Mathilde told her the necklace story to Madame Forestier 14. Madame Forestier told Mathilde that her necklace is only an imitation and worth five hundred francs.

TABLE 3. EVENTS FROM THE STORY, THE NECKLACE.

NARRATIVE ANALYSIS

modeled after the Carl Spitzweg's poor poet painting. The bed was modeled after looking through different beds from a poor man's house. The desk was modeled after Monsieur Loisel's occupation. Since he is a clerk and a writer, a desk is appropriate in this environment.

The garret under the roof environment was imported into Unity3D. Unlike the rendered image from Maya, items which are algorithmically produced, such as the newspapers, the bed sheet, hanging fabric, and the lights could not be imported into Unity3D.

The interactivity in Unity3D are designed that each object in the environment are surrounded with Trigger Functions, so that when the user passes by it, a few notes of the narrative would be revealed to them. On Figure 7, the green square lines indicate that trigger area wherein the user could interact with the virtual object. Snippets of conversations were also incorporated to understand the narrative behind every object. The grayscale effect was applied to add to the late 1800s style of the environment.

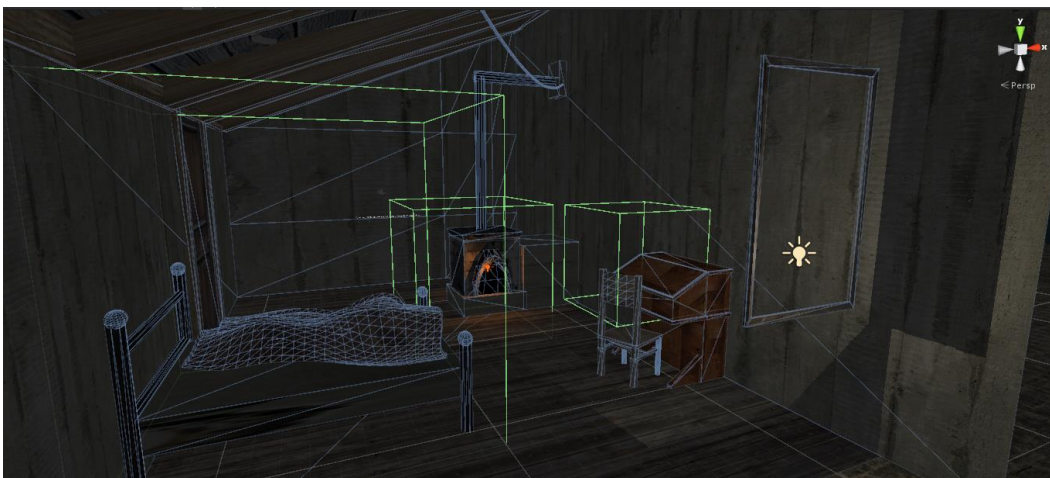


FIGURE 7. IMPORTED MODELS TO UNITY3D. SQUARE LINES INDICATE THE TRIGGER AREA OF THE OBJECT.

NARRATIVE ANALYSIS



FIGURE 8. RENDERED VIRTUAL OBJECTS TO BE TRIGGERED BY THE USER. MODELED AND TEXTURED USING AUTODESK MAYA 2014.



FIGURE 9. ORTHOGONAL RENDER VIEWS OF THE GARRET UNDER THE ROOF. RENDERED FROM MAYA 2014

NARRATIVE ANALYSIS



FIGURE 10. FINAL VIRTUAL ENVIRONMENT DESIGN WHICH CAN BE TRIGGERED IN UNITY 4.3

4 TANGIBLE PROTOTYPES

4.1 TECHNOLOGY REVIEW

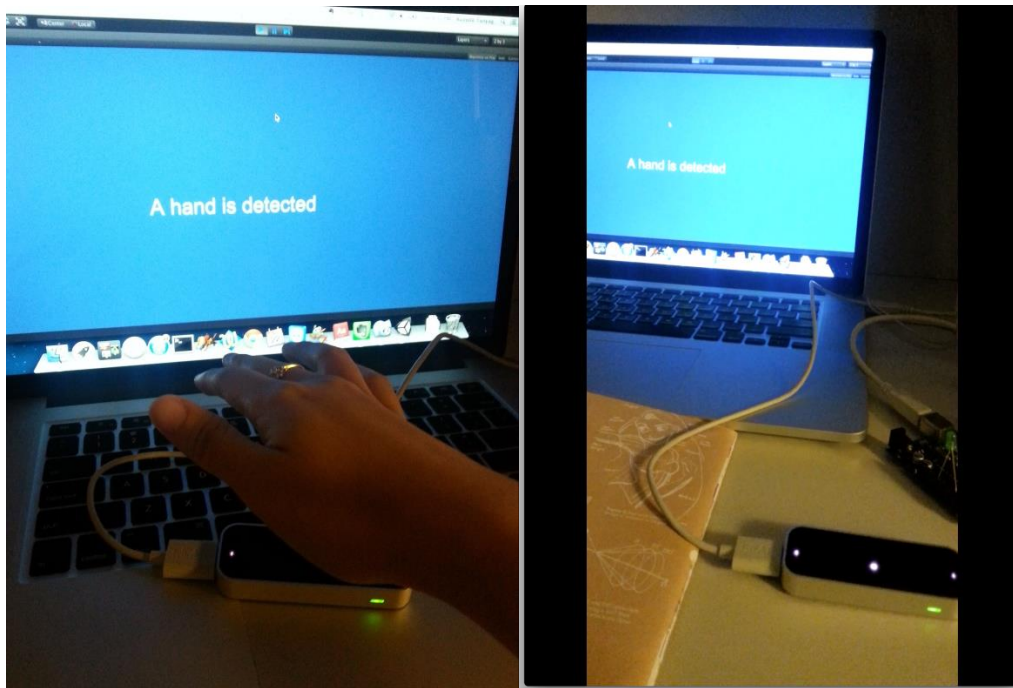


FIGURE 11. TECHNOLOGY REVIEW. USING LEAPMOTION CONTROLLER WITH UNITY 4.3

4.1.1 DESCRIPTION

Technologies such as an Arduino Microcontroller, Leap Motion Controller, and Unity3D (See Appendix D) were explored to understand how to provide the tactile sensations perceived from virtual objects.

The pins of the Arduino Microcontroller were connected to an actuator, and an LED. It is then wired using a standard USB cable (A plug to B plug) to the computer. Afterwards, the Uniduino library was imported onto the Unity3D so that

it can communicate to the Arduino Microcontroller. The Arduino Microcontroller was then programmed such that when the user presses the spacebar, the LED would light up. Similarly, when the user presses the “b” key, the actuator would vibrate on a HIGH level.

After configuring the Arduino Microcontroller, the Leap Motion Controller was connected to the computer. Next, the Leap Motion installer was initiated and installed to be able to get frame data from the Leap Motion Controller. The Leap Motion SDK was downloaded from the Leap Motion website so that the needed libraries can be imported inside Unity3D. A simple test was programmed to determine if the Leap Motion Controller was successfully connected. If the user’s hand is placed on the Leap Motion’s detection area, then a GUI Text in Unity3D will change to “A hand is detected.” If no hands are detected, the GUI Text changes to “No hands are detected.”

To add another level of interaction, the Arduino Microcontroller, the Leap Motion Controller were programmed to communicate with each other using Unity3D. Since the Arduino Microcontroller is hooked up to an actuator and the LED, the Leap Motion Controller served as its input controller. The Leap Motion Controller reads the translations of the hand and converts these translations into virtual space. Cube models were arranged to look like a block hand with cube fingers and parented to an empty GameObject. The GameObject with block hand was moving around the virtual space by reading the Leap Motion Controller’s translation data. Afterwards, more cube models were added into the virtual space. Also the random cube models were included with triggering functions so that when the block hand intersects with the cube model, the actuator would

vibrate and the LED would light up. The actuator would stop vibrating and the LED would dim if the user's translation data is not intersecting with the random cube models.

4.1.2 FEELINGS

The researcher was confident in using these technologies even though prior knowledge was limited. The main reason behind it was that there were no issues that hindered the exploration. Most of the instructions were found on their respective websites so it was easy to follow through and implement the technology.

4.1.3 EVALUATION

The overall objective of the technology review is to test the technologies and determine if the interaction between these technologies work well as one unit. The gestural interaction of the Leap Motion Controller worked very well with Unity 3D. The incoming data from the Leap Motion Controller was instantaneous so no delays were experienced throughout the experiment. The outgoing data from the Unity3D was also not laggy. During one of the tests, the trigger function was not detecting any triggers. It seems that the trigger should stay for a long period before it is recognized as being triggered.

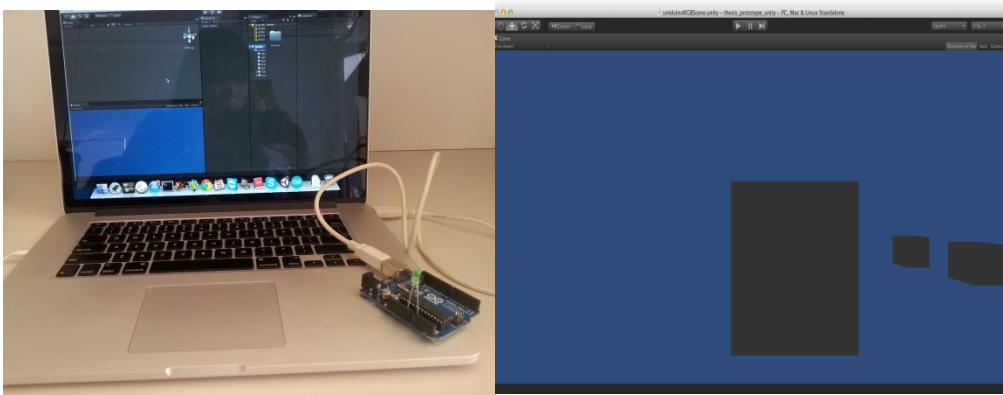


FIGURE 12. TECHNOLOGY REVIEW. COMMUNICATING THE ARDUINO UNO TO UNITY3D AND USING BOXES TO INCORPORATE INTERACTION.

4.1.4 ANALYSIS

The Leap Motion Controller served as a hand gestural interaction which would be enhanced by recreating a haptic glove to get the feel of the interaction between the hands and the virtual space. Also, the Arduino microcontrollers were easily programmable inside Unity 3D using the Uniduino library.

4.1.5 CONCLUSION

The intention of the technology review is to gain an understanding of the technologies that the researcher will use to conduct the user evaluation. Since prior knowledge about these technologies is limited, the researcher was able to assess how much these technologies can be explored and be used for the first prototype. The exploration of the technology review was a success because it felt that having a gestural based interaction would be more appropriate to move

around the environment. Also if the user is constrained to having another piece of object as a controller, it would be more confusing to interact with.

4.1.6 ACTION PLAN

Since the technology review was a success, the next step to be taken is to create an environment where these interactions would take place. Also, the use of a haptic glove would be beneficial as an initial basis for the interaction. The next goal of the prototype would to determine how efficient the haptic glove will be in interacting with a 3D environment.

4.2 GLOVE



FIGURE 13. THE GLOVE. THE HAPTIC GLOVE

4.2.1 DESCRIPTION

The garret under the roof, which was analyzed and configured in Chapter 3 Narrative Analysis, was used as the environment for interacting with the Leap Motion Controller and the Arduino Microcontroller. The translation data from the user-tracked hand using Leap Motion Controller translates the camera movement of the environment.

Actuators were hot-glued to garter rings which would fit to the user's fingers. They were soldered to longer wires so that it would be easier to arrange it into the glove. The glove used for the haptic glove was an ordinary fabric glove. The finger areas were cut to allow the user's hand to breathe more. The wires that the vibration motors are soldered onto are then connected to the PWM modules of the Arduino Mini Pro. During the testing, instead of soldering the wires onto the PCB board, the wires are connected through the breadboard and placed at the back of the glove.

The haptic glove vibrates when the nearby virtual objects tries to disclose the narrative through short-timed vibrations. Three short-timed vibrations indicates that an object nearby would disclose a piece of the story. If the user stays longer on the triggering area of the viewed virtual object, the vibrations would change in random patterns unique to that virtual object. The vibrations would stop if the user moves away from the virtual object.

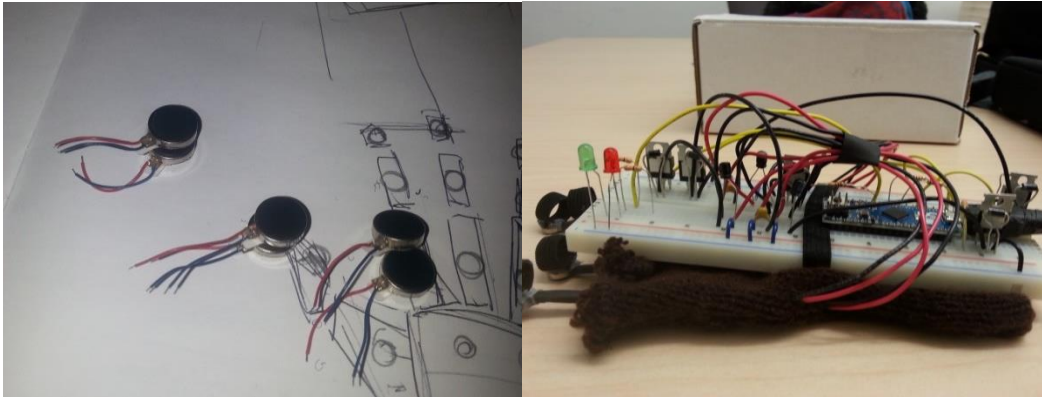


FIGURE 14. A) PHOTO OF THE VIBRATION MOTORS USED. B) THE HAPTIC GLOVE AND ITS WIRES.

4.2.2 FEELINGS

While testing the haptic glove onto the environment, the researcher was curious if the interaction would work with the users. Because the vibrations were on the maximum, the researcher would sometimes get surprised with the interaction because the vibrations were sometimes harsh. It was an uncomfortable experience because the researcher's hand is sensitive to pain.

4.2.3 EVALUATION

During the testing, the actuators were on a maximum vibration level to understand how harsh the sensation would be. Also the garter rings were tight around the researcher's fingers. There is a little bit of delay as well before the actual unique sensation can be experienced.

4.2.4 ANALYSIS

Understanding how uncomfortable the maximum vibrations, the researcher wonders if users would find it uncomfortable. To prevent this, the vibration intensities were adjusted from 100% intensity to 60% intensity. The tightness of the garter rings would present as a problem if users with larger fingers were to test the haptic glove.

4.2.5 CONCLUSION

The goal of the haptic glove is to determine the interaction between the 3D environment built from Chapter 3 Narrative Analysis, the Leap Motion and the haptic glove. The haptic glove vibrates when the user is on the triggering area of the virtual object. Rhythms and patterns would start if the user stays longer the virtual object. The haptic glove's tactile sensations were found to be harsh so the researcher adjusted the actuator's intensity level of the vibrations. The garter rings for the actuators were also found to be too tight so it would be challenging for users with larger fingers to interact without feeling uncomfortable.

4.2.6 ACTION PLAN

The haptic glove fit the researcher well, although it is preferable to recreate the haptic glove with a nicer fabric and a more comfortable way of putting the actuator on the user's fingertips comfortably.

However, the haptic glove was created to determine if the interaction between the environment and the tactile sensation would work. The use of

physical objects would be suitable for the next prototype to create a connection between the 3D environment and the physical object.

Since the title of the story is called, The Necklace, and the analysis from Chapter 3 Narrative Analysis revolves around the necklace. It would be better to apply the tactile sensations from the haptic glove to a necklace prototype.

4.3 THE NECKLACE



FIGURE 15. THE NECKLACE.

4.3.1 DESCRIPTION

A necklace was used for this prototype to identify whether physical objects related to the story would have an effect into understanding the narrative presented on the 3D environment. Also, it is to determine whether the same rhythms and patterns from the haptic glove would be perceived differently on the necklace.

The necklace was built using three separate necklaces with big pieces of crystals to form one slightly bigger necklace. A conductive thread was used to tie together the bigger pieces of the jewelry and to wrap around the clasp. That connectivity served as the ground for the actuators around the necklace. Afterwards, thin ribbons sewn with conductive thread inside so that it would not affect the connectivity from the ground. The actuators were placed on the areas with the red circles, as seen on Figure 15. They were hot-glued and wrapped around with a black cloth to hide the technology.

A back pocket was created to hold the Arduino Microcontroller and PCB board together. The conductive threads around the necklace were connected by wires on the PCB board. And the other resistors and transistors were connected to a Lilypad Microcontroller.

The tactile sensations were programmed as seen on Figure 16. The numbers represent the timing that the vibrations would start. They are all abrupt vibrations that indicate the sensations from the virtual objects.

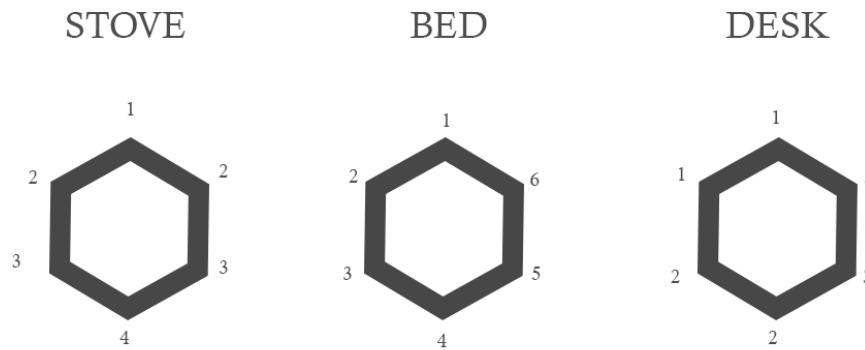


FIGURE 16. TACTILE SENSATIONS ON THE NECKLACE. NUMBERS ARE REPRESENTED AS TIMING.



FIGURE 17. BACK PART OF THE NECKLACE. LILYPAD VIBRATOR MOTORS ARE ATTACHED.

4.3.2 FEELINGS

While wearing the haptic glove, the researcher felt unfamiliar with the tingling sensation because the researcher's neck is unfamiliar to different external sensations. Also, the intensity of the vibrations was not as harsh on the neck compared to the intensity on the hands. Also, the experience from the different sensation from the necklace seemed similar to each other.

4.3.3 EVALUATION

Although the necklace as a physical object was related to the story presented in the 3D environment, the tactile sensations being perceived around the neck was unfamiliar to the researcher. There is a possibility that the users experiencing the tactile sensation would react similarly. If the user's clothes are thicker, then the sensation would be felt less.

Another set of necklace was developed to create a more lightweight prototype for the exhibition. It uses the same wiring design as the big necklace; however, the big necklace is intended for prototype user testing only.

4.3.4 CONCLUSION

The necklace served as the initial physical object related to the story by Guy De Maupassant. The placement of the vibration motors around the necklace provided a wider coverage of tactile sensation. The intensity of the vibrations may be lessened when thicker fabric is worn by the user.

4.3.5 ACTION PLAN

User testing may be the best course of action after the necklace prototype. The goal of the user testing would be to determine how the sensations are felt and how it can be related to the story. Furthermore, more physical objects which are related to the story so that different tactile sensations may be explored.

5 THE USER STUDY



FIGURE 18. USER TESTING USING THE NECKLACE PROTOTYPE

5.1 RESEARCH ETHICS AND USER SAMPLING

This study was approved by the OCAD University Research Ethics Board on January 31, 2014 (See Appendix B). This study has been allowed to conduct user evaluations and testing to OCAD University undergraduate and graduate students. Selection of the participants is gender, age and ethnicity unbiased.

The user study used opportunity sampling for participant recruitment. Five graduate students from the Digital Futures Graduate Program were asked to participate in the user study. They were scheduled to participate in the study according to their availability.

5.2 USER STUDY PROCEDURES AND EXPERIMENT DESIGN

The user study was performed to determine how users perceive the tactile sensations so that it presents the narrative of an object. The study used the within-subjects experiment design for user testing. The study asked the users to test the tangible prototypes, the haptic glove and the necklace, under the same condition.

The user study was conducted for at most 30 minutes per participant. The study was initially discussed for 5 minutes. Afterwards, they were asked to sign the invitation and consent form. The participants were asked to perform a task involving the first prototype – the haptic glove. They were told to think aloud to identify their concerns and experiences during their interaction with the prototype. Afterwards, the participants were asked to perform the same task with the second prototype – the necklace. They were also asked to think aloud to understand any differences and similarities with their interaction. Several post interview questions were conducted to the participants, and they were recorded using an audio recorder to be transcribed for further analysis.

5.3 INTERVIEW QUESTIONS

Sense of Touch

1. Did the tactile sensations helped in navigating you towards the narrative?
2. What was your interpretation of the tactile sensations when the narratives showed up?

Navigation and Exploration of the Narrative

1. Which actions did you think were intuitive during the test?
2. Which navigations were unintuitive during the test?
3. Could you tell me the story behind the prototype?

5.4 RESULTS

The participants have indicated the following experiences from the study. All of them were sure that they did not understand the tactile sensations as an aid towards understanding the narrative. However, they were focused on the rich visual narrative elements of the virtual environment. They also preferred the richness of the tactile sensation when they wore the glove prototype, compared to the necklace. And few suggestions were made by the participants as they were conducting the think aloud protocol.

The interviews collated from the participants indicated that they did not understand the tactile sensations as an aid to the narratives presented in the virtual environment. They understood that different tactile sensations were different from each virtual object; however, it didn't add more information of how

it is related to the story. The vibrations were also confusing to the participants as they try to connect it with the rhythms of the music being played, how close they are to the virtual object, or how the tactile sensations as patterns relate to the texture of the virtual object. Another comment indicated that they did not notice the patterns from the tactile sensations because they were too focused on the virtual environment.

Furthermore, the users preferred the tactile richness being felt with the glove prototype over the necklace prototype. One of the main comments which were made was because the neck is not as sensitive when it comes to feeling or being tactilely aware of the vibrations. The tactile sensations as patterns were perceived more using the glove because it fit exactly on the tips of the fingers. However, the necklace prototype did not exactly fit to the participants' necks. They were either too loose or too tight so the sensations were perceived differently.

On another note, the participants were able to distinguish the visual narrative behind the virtual environment. They were able to identify that it is a poor man's home and that it set in an early 1800s to early 1900s period. They were able to deduce it from the music that was played throughout the exploration and the black and white tone of the environment. However, the visual narrative that it was a garret under the roof was not interpreted accurately as they were able to see the ground and not the building from the window. When they tried connecting the relationship between the story and the prototypes, the necklace prototype was thought to be an insignificant to the overall story. They added that the necklace

was an object that a poor man could not afford; therefore, it should not be related to the story

A few suggestions were made by the participants. They mentioned that as the tactile sensations did not add to the overall narrative of the virtual environment, they enhanced the user experience as they progress to the narratives. Adding more intensity as the participants go towards the virtual object and decreasing it as they move away from the virtual object would help in establishing more ties between the tactile sensations and the virtual objects. Another suggestion was that to include visual instructions inside the virtual environment as the users explore the virtual object. And lastly, the research may well be received by museums as they focus on providing physical objects or artifacts and each artifact contains a narrative of the intended theme of the exhibit.

6 THE VANITY TABLE



FIGURE 19. THE VANITY TABLE AT THE DFI GRADUATE SHOW

6.1 CONCEPT

The vanity table is an exploration of both physical and virtual objects placed in an environment. The idea behind it came from the thought that most objects from the study, virtual and physical, should live in an environment where people would potentially interact with them.

During the *The Necklace's* (See Appendix C) period, the ladies wear these jewelries while sitting in a vanity table. The ladies pamper themselves with perfume, hair accessories, make up and jewelries to make themselves pretty and

THE VANITY TABLE

distinguishable to society. To induce the feeling and the connection of the prototypes to the story and the events that happened, the vanity table should look vintage to acquire the essence of that period.

In the story, it can also be noted that Mathilde Loisel likes lavish things – things that she does not actually have. In this case, it could be implied that having a vintage vanity table with jewelries is a satirical form of her stature in society. Recall that during the narrative analysis, the necklace signifies as the bane of her existence for ten years. Therefore, having the necklace on the vintage vanity table adds further background information to the story behind the prototypes.

6.2 EXHIBITION PROPOSAL



FIGURE 20. THE VANITY TABLE PROPOSAL.

The intended set up is to be arranged at the 49 McCaul. The vanity table and a chair would be situated in a corner, or a spotlight centered area. Jewelries and

THE VANITY TABLE

other grooming accessories would populate the top of the vanity table. Story-related items, such as the Minister's invitation or old lavish photographs, will also be added to further intensify the context of the story. The prototypes will then be placed on fancy cases so that they are visible and eye-catching to the audience.



FIGURE 21. INTENDED INTERACTION DURING THE EXHIBITION

The screen on the vanity table will act as an ordinary mirror when the audience is not around the table. Once a specific prototype is touched, it would start the interaction of the narrative and the user. The screen fades out from a mirror and then it would fade in to the narrative. It is up to the audience to interact with that prototype. The latest prototype will be interacted during the DFI Graduate Exhibition, while the other will be on display as proofs of progress.

Once the audience leaves the vanity table, the screen returns back as a mirror and resets the narrative explored by the former audience. This way, the new set of audience will also have similar experiences with the prototype.

During the exhibition, it is quite possible that the audience will not interact with the prototypes presented. It may be caused by the collection of the artifacts at the exhibition that will limit their interaction per artifact. A solution to this is to create a presentation or demo video that will allow the audience to see the prototypes, and watch what the research is all about.

6.3 EXHIBIT TRAILER VIDEO

A trailer video of the study will be prepared so that it would be played during idle times at the exhibit. It will be a 2-minute, loop able video that would be played on the “mirror” of the vanity table. The audio will be constrained to using pleasant background music and voice narrations will discouraged since the exhibition is expected to contain various sounds from the surrounding artifacts. A storyboard was drawn to determine how to present a part of the study yet be condensed in a 2 minute video. A storyboard of the trailer video, as seen on Figure 22), was drawn out to determine which should be filmed and which should be animated.

THE VANITY TABLE

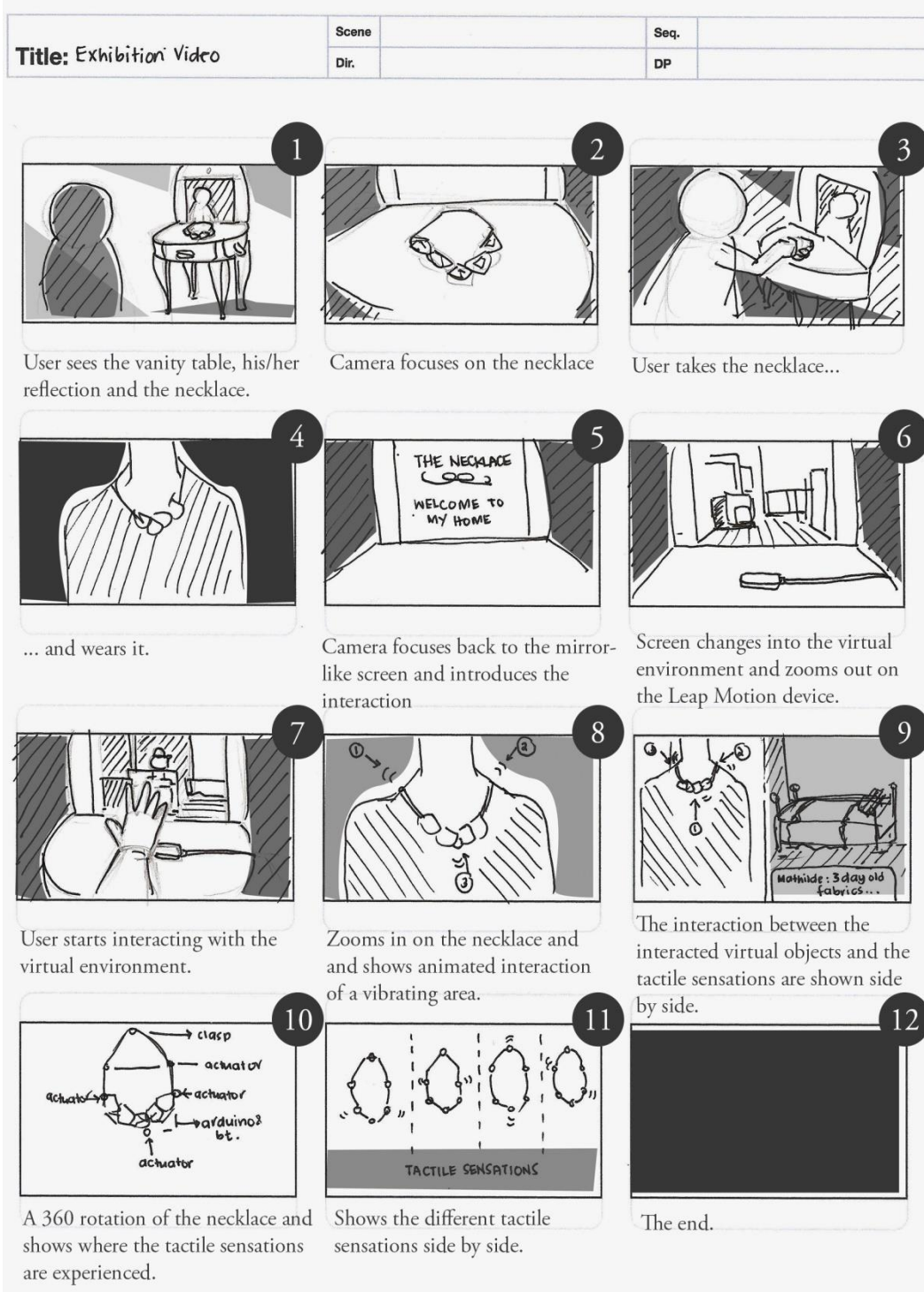


FIGURE 22. THE STORYBOARD FOR THE EXHIBIT'S TRAILER VIDEO.

6.4 EXHIBITION PROCESS

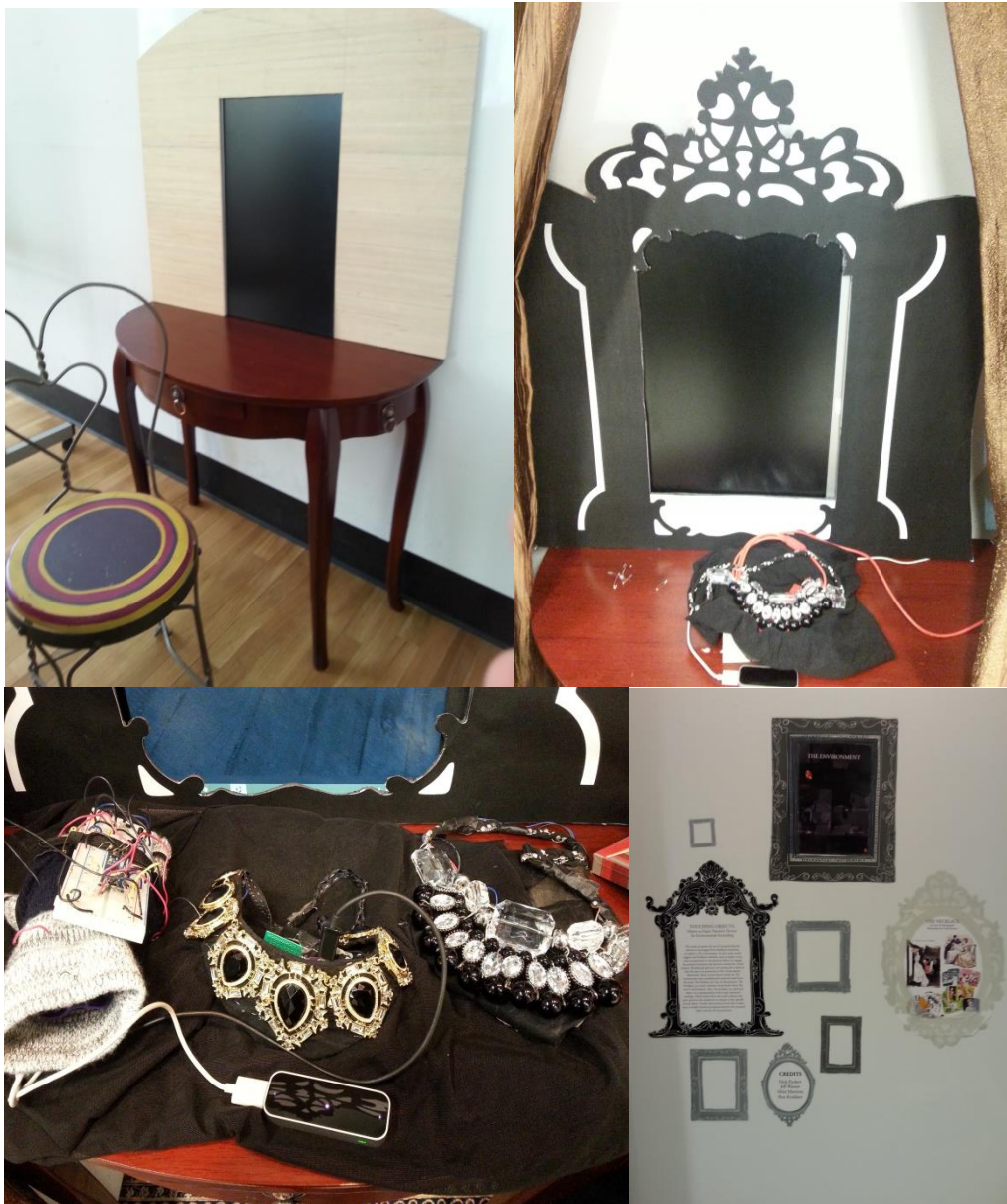


FIGURE 23. THE EXHIBITION PROCESS. (FROM TOP-LEFT, TOP-RIGHT, BOTTOM-LEFT, BOTTOM-RIGHT) A) INITIAL FRAME BOARD DESIGN, B) FINAL FRAME BOARD AND NECKLACE LAYOUT. C) PROTOTYPES ARE LAID OUT ON THE TABLE. D) INFORMATION ABOUT THE RESEARCH ARE POSTED AS WALL FRAMES.

The vanity table consisted of two separate pieces of materials – a normal vintage desk and a frame board to cover the monitor screen behind (as seen on

THE VANITY TABLE

Figure 23a). The initial frame board used a different wood as the vintage desk and it was a challenging to match the color of the desk to the frame board. Another solution was implemented wherein a black and white printout of a frame (See Figure 23b) with the size 80cm x 60cm was used to fit the width of the desk. It was the glued to a black, 3/16" thick, 32"x40" foamcore. Afterwards, it was cut to remove the excess foamcore and outer white printouts. The white rectangular printout inside the black printout was also removed so that the monitor screen would be seen from the frame board. The monitor screen was then mounted by tying the monitor around the sides of the desk using a solid piece of thick string.

The initial set up of the exhibit was that only the necklace prototype would be presented during the exhibit (See Figure 23b). However, it was also important to show the previous prototypes which were previously designed and built. So the prototypes were laid out on three 4"x6" wooden frame panels, which are covered with sheer black fabric. Since the haptic glove is needed to be worn to be able to see what it would look like, another smaller piece of glove was stuffed with pieces of fabric so that the haptic glove would be seen in its full form. The middle prototype was slightly elevated to indicate that it would be the primary prototype to be used for the exhibit interaction (See Figure 23c). And further information about the study and the exhibit was posted on decorative wall frames to add to the ambience of a vanity area. A short text about the research was posted, along with images about the environment and the story.

6.5 OBSERVATIONS



FIGURE 24. USER INTERACTION AT THE DFI GRADUATE SHOW.

Few user interactions were observed during the exhibition. When the show opened, people were instantly attracted to the overall setup of the exhibit. Their first instinct was to look at the monitor screen, and then they look at the prototypes. Afterwards, they read the information from the wall frames and went back to the prototypes to feel the tactile sensations. This interaction was a recurrent situation for the users. Another observation was that upon reading the word, “haptic,” they thought that the necklace would constantly vibrate even when the interaction has not initiated. So they would start feeling the necklace for any signs of vibrations. Also, because the prototypes were presented they interpreted them as objects that talk to each other. One user would hold the primary necklace prototype, while another user would hold the haptic glove. In some situations, the virtual environment was ignored throughout the exhibit.

7 CONCLUSION

7.1 SUMMARY

Objects are tangible and contain narrative information. And they can elicit emotions when the user is engaged with the interaction. Touching objects are often undervalued due to the sufficient visual attributes the objects provide to understand the underlying narrative. Narratives, however, often can transform into an experience when the user physically engages with the objects (Pearce, Objects as meaning; or narrating the past, 1994). In environmental storytelling in games design, the objects often serve as accessories to the virtual environment. This reduces the tangible functional properties and affordances of the objects. On another note, haptics research provides ways of simulating and stimulating our sense of touch. But it loses the underlying narratives of the object being touched virtually. A solution to the problem is to use physical objects, combine it with the different sensations to engage the users to explore the underlying narrative.

The short story by Guy De Maupassant was used to develop and embed narratives onto the objects. The design process used for the building the prototypes was Gibb's Model of Reflection. The researcher started off with the technology review to determine how to create an interaction and communication using the technologies presented. Afterwards, a haptic glove was prototyped to determine if the tactile sensations would fit into the interaction between the user and the environment. The glove was an unrelated object to the story; however, it acted as a starting point to play around with different tactile sensations. Following

CONCLUSION

the glove prototype, the necklace was then developed to create a bond between the object and the narrative. The necklace prototype only had the tactile sensations, similar to the glove prototype. Observations from the necklace prototype reveal that the tactile sensations did not seem engaging enough to uncover the narrative behind it. According to the user study, although the tactile sensations were not engaging, the users identified that tactile sensation from the virtual objects are unique from each other. They were able to identify one virtual object from the other. The users felt that further exploration would be needed for them to fully identify which virtual object it is.

7.2 FUTURE DIRECTION AND ITERATIONS



FIGURE 25. FUTURE ITERATIONS INCLUDE PHYSICAL MOVEMENT OF OBJECTS

7.2.1 FURTHER ITERATIONS

This study provides as an initial precedent study to encourage researchers and game designers to use physical objects to enhance the narratives in a story. The haptics and different tactile sensations can play a role in building the users' anticipation and experience in a story. The research indicates that further study must be conducted in order to develop a language that could help haptic objects become narrative devices for environmental storytelling. Performing a more thorough quantitative and qualitative testing and analysis will be most useful in this study. Providing numerical data on this study may show the efficacy of the sensations to the users.



FIGURE 26. A VINTAGE DIARY WITH ATTACHED SENSORS THAT TRIGGER A SPECIFIC OBJECT IN THE VIRTUAL ENVIRONMENT

From the user study and exhibition observations, next iterations of this study can be focused on how to balance the interaction between the virtual

CONCLUSION

environment and its embedded narrative, the physical objects as haptic devices, the interaction for user navigation, and the narrative behind the physical environmental setting. The amount of information behind separate pieces of interactions, experiences and embedded narratives in almost every object are almost overwhelming for a user to analyze instantly. An idea to solve this is to conduct several experiments and design process to determine the best way to balance the information, narrative and the experience behind the study.



FIGURE 27. TILTING THE FRAMEBOARD WOULD TRIGGER A CERTAIN NARRATIVE ON THE MIRROR.

An example of the study's proposed iterations would include different multiple objects talking to each other to expose their supposed narratives. The exhibition provided a valuable observation that users like to interact with multiple objects with multiple people. Doing so would help the users engage themselves with the objects and the story. Different physical items, such as a vintage diary, a picture frame may be set up, and added sensors which communicates to the

CONCLUSION

virtual environment. A good example of this proposed iteration may be seen on Figure 26. A vintage diary may be attached with sensors that trigger the specific events in the story, such as the Ministry of Education Party narrated over a virtual gramophone. Another instance would be using the frame board of the vanity itself (See Figure 27). Tilting the frame board may trigger a certain tactile sensation on the vintage diary until the other user has flipped it through the right story page. This proposal may create an ambience of the period and the character of the story.

As an enhancement to the necklace prototype, the overall mechanics should be redeveloped to adapt to the purpose of the object. And, face tracking may be incorporated to create another layer of input from the user.

7.2.2 FUTURE DIRECTIONS

This study may be pursued further in the context of exposing narratives through the sense of touch on museum artifact replicas to immerse the visitors with the artifact-in-hand. Museum replicas may be incorporated with this study so that they can be physically be explored and can show more interactivity through the virtual environments created.

Another direction would be to use tactile-enhanced objects as a precursor to movies. There is a possibility that movie goers may feel a strong connection to the tactile-enhanced object that is related to the movie.

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APPENDICES

APPENDIX A.GLOSSARY

Affordance	A term to denote an invisible action perceivable by a person (Norman, 1988).
Active Touch	The act of voluntarily being in contact with something. Also denote <i>touching</i> (Gibson, 1962).
Environmental Art Asset	Mostly used in games design, it is an object that is 3D-modeled and textured to be placed in an environment. They populate the game environment to help the player navigate through the story (Burch, 2012).
Environmental Storytelling	A form of sculpted spaces or worlds with narrative inclination (Jenkins, 2004).
Force-Feedback	The sensation produced from a mechanical production of information (McGee & Wall).
Haptics	A term to denote the relationship with the sense of touch.
Haptic icon	Short computer-generated signals using force-feedback to communicate simple tasks to the user. It functions similarly to visual and auditory icons (Enriquez, 2002).
Material Culture	A study that relates objects as an association of beliefs, values, ideas, attitudes, and assumptions of man's nature in society at a point in time (Prown, 1982).
Narrative	A represented art form of an event or story (Narrative).

Object	A thing that is tangible and visible. It can elicit a specified emotion when the user's attention and interest is directed towards it (Object).
Passive Touch	The act of receiving the tactile information. Also denote <i>being touched</i> (Gibson, 1962).
Tactile	A term to denote the pressure information affecting the skin (McGee & Wall).

APPENDIX B. RESEARCH ETHICS BOARD APPROVAL FORM



Research Ethics Board

January 31, 2014

Dear Ruzette Tanyag,

RE: OCADU 165 "Using Touch Perceptions to Enhance Interactive Environmental Storytelling Experience."

The OCAD University Research Ethics Board has reviewed the above-named submission. The protocol and the consent form dated January 31, 2014 are approved for use for the next 12 months. If the study is expected to continue beyond the expiry date (January 30, 2015 you) are responsible for ensuring the study receives re-approval. Your final approval number is **2014-08**.

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 before you graduate. The template is attached.

Best wishes for the successful completion of your project.

Yours sincerely,

A handwritten signature in cursive script, appearing to read 'Tony Kerr'.

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

FIGURE 28. RESEARCH ETHICS BOARD APPROVAL FORM

APPENDIX C. THE NECKLACE BY GUY DE MAUPASSANT

She was one of those pretty and charming girls born, as though fate had blundered over her, into a family of artisans. She had no marriage portion, no expectations, no means of getting known, understood, loved, and wedded by a man of wealth and distinction; and she let herself be married off to a little clerk in the Ministry of Education. Her tastes were simple because she had never been able to afford any other, but she was as unhappy as though she had married beneath her; for women have no caste or class, their beauty, grace, and charm serving them for birth or family, their natural delicacy, their instinctive elegance, their nimbleness of wit, are their only mark of rank, and put the slum girl on a level with the highest lady in the land.

She suffered endlessly, feeling herself born for every delicacy and luxury. She suffered from the poorness of her house, from its mean walls, worn chairs, and ugly curtains. All these things, of which other women of her class would not even have been aware, tormented and insulted her. The sight of the little Breton girl who came to do the work in her little house aroused heart-broken regrets and hopeless dreams in her mind. She imagined silent antechambers, heavy with Oriental tapestries, lit by torches in lofty bronze sockets, with two tall footmen in knee-breeches sleeping in large arm-chairs, overcome by the heavy warmth of the stove. She imagined vast saloons hung with antique silks, exquisite pieces of furniture supporting priceless ornaments, and small, charming, perfumed rooms,

created just for little parties of intimate friends, men who were famous and sought after, whose homage roused every other woman's envious longings.

When she sat down for dinner at the round table covered with a three-days-old cloth, opposite her husband, who took the cover off the soup-tureen, exclaiming delightedly: "Aha! Scotch broth! What could be better?" she imagined delicate meals, gleaming silver, tapestries peopling the walls with folk of a past age and strange birds in faery forests; she imagined delicate food served in marvellous dishes, murmured gallantries, listened to with an inscrutable smile as one trifled with the rosy flesh of trout or wings of asparagus chicken.

She had no clothes, no jewels, nothing. And these were the only things she loved; she felt that she was made for them. She had longed so eagerly to charm, to be desired, to be wildly attractive and sought after.

She had a rich friend, an old school friend whom she refused to visit, because she suffered so keenly when she returned home. She would weep whole days, with grief, regret, despair, and misery.

*

One evening her husband came home with an exultant air, holding a large envelope in his hand.

"Here's something for you," he said.

Swiftly she tore the paper and drew out a printed card on which were these words:

"The Minister of Education and Madame Ramponneau request the pleasure of the company of Monsieur and Madame Loisel at the Ministry on the evening of Monday, January the 18th."

Instead of being delighted, as her husband hoped, she flung the invitation petulantly across the table, murmuring:

"What do you want me to do with this?"

"Why, darling, I thought you'd be pleased. You never go out, and this is a great occasion. I had tremendous trouble to get it. Every one wants one; it's very select, and very few go to the clerks. You'll see all the really big people there."

She looked at him out of furious eyes, and said impatiently: "And what do you suppose I am to wear at such an affair?"

He had not thought about it; he stammered:

"Why, the dress you go to the theatre in. It looks very nice, to me . . ."

He stopped, stupefied and utterly at a loss when he saw that his wife was beginning to cry. Two large tears ran slowly down from the corners of her eyes towards the corners of her mouth.

"What's the matter with you? What's the matter with you?" he faltered.

But with a violent effort she overcame her grief and replied in a calm voice, wiping her wet cheeks:

"Nothing. Only I haven't a dress and so I can't go to this party. Give your invitation to some friend of yours whose wife will be turned out better than I shall."

He was heart-broken.

"Look here, Mathilde," he persisted. "What would be the cost of a suitable dress, which you could use on other occasions as well, something very simple?"

She thought for several seconds, reckoning up prices and also wondering for how large a sum she could ask without bringing upon herself an immediate refusal and an exclamation of horror from the careful-minded clerk.

At last she replied with some hesitation:

"I don't know exactly, but I think I could do it on four hundred francs."

He grew slightly pale, for this was exactly the amount he had been saving for a gun, intending to get a little shooting next summer on the plain of Nanterre with some friends who went lark-shooting there on Sundays.

Nevertheless he said: "Very well. I'll give you four hundred francs. But try and get a really nice dress with the money."

The day of the party drew near, and Madame Loisel seemed sad, uneasy and anxious. Her dress was ready, however. One evening her husband said to her:

"What's the matter with you? You've been very odd for the last three days."

"I'm utterly miserable at not having any jewels, not a single stone, to wear," she replied. "I shall look absolutely no one. I would almost rather not go to the party."

"Wear flowers," he said. "They're very smart at this time of the year. For ten francs you could get two or three gorgeous roses."

She was not convinced.

"No . . . there's nothing so humiliating as looking poor in the middle of a lot of rich women."

"How stupid you are!" exclaimed her husband. "Go and see Madame Forestier and ask her to lend you some jewels. You know her quite well enough for that."

She uttered a cry of delight.

"That's true. I never thought of it."

Next day she went to see her friend and told her her trouble.

Madame Forestier went to her dressing-table, took up a large box, brought it to Madame Loisel, opened it, and said:

"Choose, my dear."

First she saw some bracelets, then a pearl necklace, then a Venetian cross in gold and gems, of exquisite workmanship. She tried the effect of the jewels before the mirror, hesitating, unable to make up her mind to leave them, to give them up. She kept on asking:

"Haven't you anything else?"

"Yes. Look for yourself. I don't know what you would like best."

Suddenly she discovered, in a black satin case, a superb diamond necklace; her heart began to beat covetously. Her hands trembled as she lifted it. She fastened it round her neck, upon her high dress, and remained in ecstasy at sight of herself.

Then, with hesitation, she asked in anguish:

"Could you lend me this, just this alone?"

"Yes, of course."

She flung herself on her friend's breast, embraced her frenziedly, and went away with her treasure. The day of the party arrived. Madame Loisel was a success. She was the prettiest woman present, elegant, graceful, smiling, and quite above herself with happiness. All the men stared at her, inquired her name, and asked to be introduced to her. All the Under-Secretaries of State were eager to waltz with her. The Minister noticed her.

She danced madly, ecstatically, drunk with pleasure, with no thought for anything, in the triumph of her beauty, in the pride of her success, in a cloud of happiness made up of this universal homage and admiration, of the desires she had aroused, of the completeness of a victory so dear to her feminine heart.

She left about four o'clock in the morning. Since midnight her husband had been dozing in a deserted little room, in company with three other men whose wives were having a good time. He threw over her shoulders the garments he had brought for them to go home in, modest everyday clothes, whose poverty clashed with the beauty of the ball-dress. She was conscious of this and was anxious to hurry away, so that she should not be noticed by the other women putting on their costly furs.

Loisel restrained her.

"Wait a little. You'll catch cold in the open. I'm going to fetch a cab."

But she did not listen to him and rapidly descended the staircase. When they were out in the street they could not find a cab; they began to look for one, shouting at the drivers whom they saw passing in the distance.

They walked down towards the Seine, desperate and shivering. At last they found on the quay one of those old nightprowling carriages which are only to be seen in Paris after dark, as though they were ashamed of their shabbiness in the daylight.

It brought them to their door in the Rue des Martyrs, and sadly they walked up to their own apartment. It was the end, for her. As for him, he was thinking that he must be at the office at ten.

She took off the garments in which she had wrapped her shoulders, so as to see herself in all her glory before the mirror. But suddenly she uttered a cry. The necklace was no longer round her neck!

"What's the matter with you?" asked her husband, already half undressed.

She turned towards him in the utmost distress.

"I . . . I . . . I've no longer got Madame Forestier's necklace. . . ."

He started with astonishment.

"What! . . . Impossible!"

They searched in the folds of her dress, in the folds of the coat, in the pockets, everywhere. They could not find it.

"Are you sure that you still had it on when you came away from the ball?" he asked.

"Yes, I touched it in the hall at the Ministry."

"But if you had lost it in the street, we should have heard it fall."

"Yes. Probably we should. Did you take the number of the cab?"

"No. You didn't notice it, did you?"

"No."

They stared at one another, dumbfounded. At last Loisel put on his clothes again.

"I'll go over all the ground we walked," he said, "and see if I can't find it."

And he went out. She remained in her evening clothes, lacking strength to get into bed, huddled on a chair, without volition or power of thought.

Her husband returned about seven. He had found nothing.

He went to the police station, to the newspapers, to offer a reward, to the cab companies, everywhere that a ray of hope impelled him.

She waited all day long, in the same state of bewilderment at this fearful catastrophe.

Loisel came home at night, his face lined and pale; he had discovered nothing.

"You must write to your friend," he said, "and tell her that you've broken the clasp of her necklace and are getting it mended. That will give us time to look about us."

She wrote at his dictation.

*

By the end of a week they had lost all hope.

Loisel, who had aged five years, declared:

"We must see about replacing the diamonds."

Next day they took the box which had held the necklace and went to the jewellers whose name was inside. He consulted his books.

"It was not I who sold this necklace, Madame; I must have merely supplied the clasp."

Then they went from jeweller to jeweller, searching for another necklace like the first, consulting their memories, both ill with remorse and anguish of mind.

In a shop at the Palais-Royal they found a string of diamonds which seemed to them exactly like the one they were looking for. It was worth forty thousand francs. They were allowed to have it for thirty-six thousand.

They begged the jeweller not to sell it for three days. And they arranged matters on the understanding that it would be taken back for thirty-four thousand francs, if the first one were found before the end of February.

Loisel possessed eighteen thousand francs left to him by his father. He intended to borrow the rest.

He did borrow it, getting a thousand from one man, five hundred from another, five louis here, three louis there. He gave notes of hand, entered into ruinous agreements, did business with usurers and the whole tribe of money-lenders. He mortgaged the whole remaining years of his existence, risked his signature without even knowing if he could honour it, and, appalled at the agonising face of the future, at the black misery about to fall upon him, at the prospect of every possible physical privation and moral torture, he went to get the new necklace and put down upon the jeweller's counter thirty-six thousand francs.

When Madame Loisel took back the necklace to Madame Forestier, the latter said to her in a chilly voice:

"You ought to have brought it back sooner; I might have needed it."

She did not, as her friend had feared, open the case. If she had noticed the substitution, what would she have thought? What would she have said? Would she not have taken her for a thief?

*

Madame Loisel came to know the ghastly life of abject poverty. From the very first she played her part heroically. This fearful debt must be paid off. She would pay it. The servant was dismissed. They changed their flat; they took a garret under the roof.

She came to know the heavy work of the house, the hateful duties of the kitchen. She washed the plates, wearing out her pink nails on the coarse pottery and the bottoms of pans. She washed the dirty linen, the shirts and dish-cloths, and hung them out to dry on a string; every morning she took the dustbin down into the street and carried up the water, stopping on each landing to get her breath. And, clad like a poor woman, she went to the fruiterer, to the grocer, to the butcher, a basket on her arm, haggling, insulted, fighting for every wretched halfpenny of her money.

Every month notes had to be paid off, others renewed, time gained.

Her husband worked in the evenings at putting straight a merchant's accounts, and often at night he did copying at twopence-halfpenny a page.

And this life lasted ten years.

At the end of ten years everything was paid off, everything, the usurer's charges and the accumulation of superimposed interest.

Madame Loisel looked old now. She had become like all the other strong, hard, coarse women of poor households. Her hair was badly done, her skirts were awry, her hands were red. She spoke in a shrill voice, and the water slopped all over the floor when she scrubbed it. But sometimes, when her husband was at the office, she sat down by the window and thought of that evening long ago, of the ball at which she had been so beautiful and so much admired.

What would have happened if she had never lost those jewels. Who knows? Who knows? How strange life is, how fickle! How little is needed to ruin or to save!

One Sunday, as she had gone for a walk along the Champs-Élysées to freshen herself after the labours of the week, she caught sight suddenly of a woman who was taking a child out for a walk. It was Madame Forestier, still young, still beautiful, still attractive.

Madame Loisel was conscious of some emotion. Should she speak to her? Yes, certainly. And now that she had paid, she would tell her all. Why not?

She went up to her.

"Good morning, Jeanne."

The other did not recognise her, and was surprised at being thus familiarly addressed by a poor woman.

"But . . . Madame . . ." she stammered. "I don't know . . . you must be making a mistake."

"No . . . I am Mathilde Loisel."

Her friend uttered a cry.

"Oh! . . . my poor Mathilde, how you have changed! . . ."

"Yes, I've had some hard times since I saw you last; and many sorrows . . .
. and all on your account."

"On my account! . . . How was that?"

"You remember the diamond necklace you lent me for the ball at the
Ministry?"

"Yes. Well?"

"Well, I lost it."

"How could you? Why, you brought it back."

"I brought you another one just like it. And for the last ten years we have
been paying for it. You realise it wasn't easy for us; we had no money. . . . Well,
it's paid for at last, and I'm glad indeed."

Madame Forestier had halted.

"You say you bought a diamond necklace to replace mine?"

"Yes. You hadn't noticed it? They were very much alike."

And she smiled in proud and innocent happiness.

Madame Forestier, deeply moved, took her two hands.

"Oh, my poor Mathilde! But mine was imitation. It was worth at the very
most five hundred francs! . . ."

APPENDIX D. LIST OF SOFTWARE AND HARDWARE USED

Autodesk Maya 2014	http://www.autodesk.com/products/autodesk-maya/overview
Unity 3D 4.2	https://unity3d.com/unity/download
Arduino Microcontrollers	http://www.arduino.cc/
Leap Motion Controller	https://www.leapmotion.com/product

TABLE 4. LIST OF SOFTWARE AND HARDWARE USED