AESTHETICS OF IMMERSION IN INTERACTIVE IMMERSIVE ENVIRONMENTS: A PHENOMENOLOGICAL CASE STUDY OF *LIGHT STRINGS*

by

Jinsil (Hwaryoung) Seo

B.A., Seoul Women's University, 1995
M.A., Kyung Hee University, 2002
M.F.A., School of Visual Arts, 2004

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Examining Committee:

Chair:

_____

Dr. Marek Hatala
Associate Professor, School of Interactive Arts and Technology

_____

Dr. Diane Gromala
Senior Supervisor
Associate Professor, School of Interactive Arts and Technology

_____

Dr. Thecla Schiphorst
Supervisor
Associate Professor, School of Interactive Arts and Technology

_____

Dr. Andrew Feenberg
Supervisor
Professor, School of Communication

_____

Dr. Chris Shaw
Internal Examiner
Associate Professor, School of Interactive Arts and Technology

_____

Dr. Maria Lantin
External Examiner
Director, Intersections Digital Studios and S3D Centre
Emily Carr University of Art + Design

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ABSTRACT

This dissertation examines the aesthetics of immersive experience in *Light Strings*, an interactive immersive environment. One of prominent aspects of Interactive Art is the notion of immersion. The concept of immersion is generally defined as a viewer "forgetting" the real world outside of the virtual environment and by a sense of being in a make-believe world generated by computational hardware and software. Immersion has been explored in various disciplines (Literature, Game, Architecture, Aesthetics, etc.), but many Virtual Reality (VR) scientists and artists have actively examined the concept by focusing on creating new immersive environments that push the boundaries of new technology. This approach is often aimed at countering the disembodying tendency of virtual reality concerns.

As an interactive artist and researcher, I conceive of immersion as any experience where integrated bodily, conscious, and pre-conscious states thoroughly intertwine with the world. Moreover immersion is where mind, body and environment interweave and communicate with each other inside of technically-mediated, spatially enclosed, and sensuously-interactive computational environments. *Light Strings* was created based on my previous art practice and research into immersion as a way to study participants' experiences with the artwork and how meanings are co-created by artists and participants. This research exemplifies 'Research through Art' applied in the context of immersion for interactive art.

In the participant study of *Light Strings*, participants were encouraged to describe the felt experiences of the installation through phenomenologically oriented research methods. This allowed the gathering of different data about participant experience, focusing on various qualities of immersion and how they were constructed and assimilated over time. As a result, an experiential model of the participants' experiences was developed by exploring bodily, spatial, and contextual consciousness with temporal considerations. Through this research, I bring insight into the aesthetics of immersive experience in interactive immersive environments where the ideas of materiality and embodiment are at the forefront.

Keywords: Immersive Experience; Aesthetics of Immersion; Immersive Consciousness; Interactive Immersive Environment

DEDICATION

To my family

for their lifelong support

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1: INTRODUCTION

One prominent aspect of Interactive Art is a notion of immersion. Immersion has been historically explored mostly by literary and film theorists and more recently, by Virtual Reality (VR) scientists and artists. It is generally defined as a viewer "forgetting" the real world outside of the virtual environment and by a sense of being in a simulated world generated by computational hardware and software. Most research into immersive experience has been conducted from a scientific perspective. The scientific research tradition typically standardizes or objectifies results and doesn't focus on the meanings and qualities of experience. Similar to other scientific studies, immersion researchers have largely used quantitative/empirical methods, such as measuring physiological data and conducting surveys after the participants' experience (Bangay & Preston, 1998; Pausch, Proffitt, & Williams, 1997; Slater & Usoh, 1994).

In a movement parallel to Computer Science research, many Interactive Artists have also explored immersion within VR environments in collaboration with computer scientists in many times. Their general approach to immersion is somewhat different from those of scientists. Artists have explored full-body, sensory immersion through their artistic creations (Davies, 2005; Gromala & Sharir, 1996; Laurel, Strickland, & Tow, 1994). Their approaches countered the disembodying tendency of virtual reality discourses and their artistic pursuit was centred on creating immersive experiences using new technology (new hardware or complex systems). Rather than quantifying the participants' immersive experience, their focus was on creating new immersive experiences.

As an artist, I create interactive immersive installations exploring the idea of embodiment and materiality. My artist skills and interests have led me to experimenting with soft materials and light to create immersive environments. From over 15 years of experience with digital technology in Interactive Art, I believe that technology can help us to experience nostalgia and relive our memories, reawaken habituated senses and provide opportunities to perceive new things in a creative way. For my PhD research, I created *Light*

Strings and conducted participant study to examine how participants experience immersion and how immersion is constructed in my installation. This dissertation analyzes aesthetics of immersive experience collected from a case study.

1.1 Research Questions

My artistic explorations and observations of the previous research in interactive immersive art converge on two questions.

1.1.1 What are the aesthetics of immersion in the realm of Interactive Art?

To answer this question, I created a physically immersive environment and conducted a study of how participants experience immersion and what the main qualities are of the environment. Participants were encouraged to describe their felt experiences through phenomenologically-oriented research methods. This allowed me to gather various data on participant experience, focusing on qualities of immersion and how they are constructed and assimilated over time.

1.1.2 What is the relation between artistic vision/creation and participants' felt experience?

In contemporary arts, audience participation has been encouraged in various ways. Originating from kinetic art or participant art (Weibel, Jansen, & Kunst, 2006), Interactive Art focuses on the participant's response, exploring Barthes's idea that the author/artist is not only one who defines the meaning of the work and suggesting that we need to pay attention to the participants in order to see how meaning is co-created by artists & participants (Barthes, 1977). Interactive artists consider interaction not as a technical requirement or an outcome of artistic practices but as an opportunity for designing new aesthetic experiences that artists want to explore (Krueger, 1991). Although an interactive artist's main focus is interaction, there is not much research on participants' interactive experiences with artworks and how the artist's artistic vision may transfer to or be co-created by the participants' experience. My research considers how artists and participants co-create meanings of immersion throughout an art creation process and participant study.

1.2 Artist's Background

I am an interactive artist. I have always been attracted to innovation, which has progressively led me from painting and photography, to new media art and then to augmented reality and finally interactive installation and wearable art. I also have been fascinated by the aesthetic qualities of human experience, the relationships that emerge through interactions within artworks, the underlying beauty and pattern inherent in nature, and the organization of matter, energy, and eastern culture. I have created several interactive environments that evoke these experiential properties of immersion. Even though my work is primarily based in technologies such as computer/electronics, I have always integrated physical materials, such as soft textured fabrics or inflatables, sensors, LEDs, and optical fibers to enhance bodily experience. My interactive art practice investigates the intersection between body, nature and technology.

1.2.1 Cultural Background

Though it has somewhat changed, Korean society, at least when I grew up, demanded every member to conform to its standards, always pointing fingers at those who deviated from them and hardly embracing nor even acknowledging each individual's uniqueness. Similar to other typical Korean mothers, my mother rarely stopped pushing me until I left home to go to college. In my recollection, my childhood was to a great degree sacrificed to my rigorous study of rituals and extracurricular activities. I often stayed up until the early morning hours doing my homework and pouring over books to be recognized by my teachers and took piano, dance, and art lessons on the side to excel among my peers. I have no memory of hanging out with my friends and going to parties. Not only that, I did not even learn how to play cards.

I felt pressured to study assiduously and work around the clock to not fall behind. It was inconceivable for me to dare to surround myself with nature to refresh and rejuvenate. In addition, nature has long been exploited for our short-term good. For instance, water uncannily gives me pleasure through my senses of vision, hearing, smell, taste and touch. I enjoyed the spa, the scenery of the winter beach, and the meditative sound of waves.

Through my work, I have unconsciously longed to be completely immersed in nature, breathing it and relaxing in it. My works are almost always designed to proffer a place for participants to relax away from the hectic civilization. They are in a sense compensation for ambition.

However, it is not always true that nature is a refuge that provides shelter and comfort, as all entities in the world have both sides: virtue and vice, life and death. While seeking comfort amongst lush trees and crisp air, a person may also feel apprehensive and fearful about the possibility that a creature may appear from the forest and attack. When I went to the beach with my family, I did not know how to swim at all. I just sifted, dug in, and molded the sand. I will never forget the dread I had when I was first taken into the sea by my father. It was a totally alien world. When I finally realized that there was nothing I could put my feet on in the water, I thought I might be sucked into the bottom of the ocean. I was petrified. Unfortunately, I still cannot swim, and yet have always found much amusement in imagining playing with water. Furthermore, I have always drawn pictures about the radiant sea and creatures living under the surface and even tried to create my installations in relation to the water's undulating characteristics including tenderness, flux, softness, and buoyancy.

Since we are ultimately inseparable from nature, I, through my art works, intend to convey a message that teaches how to approach nature with sensitivity and reverence and preserve the earth's regenerative, organic state. Nature was always a nostalgic inspiration for my artistic pursuit and became one of core elements for my research. In another sense, my art is a refuge from nature, an idealized immersion, immersion without vulnerability. Understanding the intimate relationship between the human and nature/the world is further elaborated through my specific philosophical background, the Korean framework of Buddhism.

1.2.2 Philosophical Background

I grew up in Korea, where my family has a strong Buddhist background. Buddhism is not only a religion for my family but also a way of living. Korean Buddhism has been integrated and dissolved in Korean traditional culture and is a belief system that is influenced by the Yin/Yang theory and the concept of Ki (Chi or Qi in Chinese). In Asian

philosophy, Ki is a fundamental concept of traditional culture, most often translated as *air* or *breath* and, by extension, *life force* or *spiritual energy that is part of everything that exists* (Han-gi, 2004; Zhang, Rose, & Huan, 2002). I believe that Ki circulates in channels within the body and between the body and the world. Therefore it becomes possible that Ki experts cure patients by giving good Ki and pulling out bad Ki in traditional eastern medicine. In my firsthand understanding of Ki from my culture, Ki is a pervasive energy that helps me to be balanced in relations within myself and with other people or the world. Ki is a longstanding way of understanding the interconnectedness of the world (Yuasa, 1993; Yuasa & Kasulis, 1987).

I believe that immersive experience implies and necessitates a flow of energy from the external phenomena of the installation through the tactile surface of the artwork and the skin to the internal body. These are 'flows' similar to rivers, veins, and ocean currents, which I attempt to express through my artwork. An invisible force, like energy surrounding us, fills us up and gives us life (Suzuki, McConnell, & DeCambra, 2002). To move, to breathe, to see, to grow, and to metabolize, energy is needed.

The notion of Ki is an essential aspect of my worldview and helps me to define my work as an artist. In addition, because Ki is about interconnectedness, it has guided me in adopting a phenomenological stance to develop my artistic perspective and to frame my research methodology. I have found a very close relationship between Ki, Buddhism and Maurice Merleau-Ponty's Phenomenology. Both focus on human experience and our relationship with the world. These are not separate processes, but are on-going, back-and-forth relations. In *The Visible and the Invisible,* Merleau-Ponty argues that all dualistic entities (mind and body, subject and object, etc.) are associated by reciprocal definition. He finds examples in "our embodied situations: touching and being touched, looking and being looked at, or the sentient and the sensible" (Merleau-Ponty, 1969, p.123). According to Merleau-Ponty, we cannot touch ourselves, or even somebody else, without this recognition of our own tangibility and capacity to be touched by others. Further, we cannot exist in the world only touching or only being touched. Our embodied subjectivity, say Merleau-Ponty, stands in the intertwining of these two aspects, or where the two lines of a chiasm intersect with one another (Merleau-Ponty, 1969).

Immersion can be considered a phenomenologically interwoven state between environments/nature and the human, where the mental and physical merge like the seashore. From my art practice, I found that many participants' subjective experiences of my projects share similar qualities; terms reoccur: meditative, playful, natural, therapeutic, and poetic. The phenomenological perspective and Ki-oriented philosophical stance together account for my concern with a subjective creative experience which is continuously influenced by the participants' experiences. Moreover they (Ki, phenomenology and immersion) provide a framework for better understanding subjectivity in general because they account for interconnectedness and focus on mind and body.

1.2.3 Practice-based Research Approach

While traditional aesthetics begins by exploring the specifics of a work of art and it's aesthetic features, some contemporary art theorists (new media art, interactive art) define artworks as "non-self-evident issue" (Sullivan, 2005). According to Janez Strehovec (2008), contemporary art is more about a process, an artistic software, an experience, a service devoted to solving a particular problem, a method of research, an interface. Its purpose is redirected from traditional art. Interactive art is a part of contemporary art, but its focus is less on the artefact and more on the interaction of participants and the artist through the piece, as co-creators.

My research also initiates from practice, where questions, problems, and challenges are identified and formed by the needs of artist and participants. I find compelling concepts or questions from my previous practice and develop inquiry after iterative conversations with my participant. These questions always lead experiments of technology and materials to actualize concepts. My creative strategy is carried out through practice using research methodologies in order to better understand the nature of co-creation.

There is an important concept, "reflective practice" coined by Donald Schön. Schön was trying to articulate the rigorous aspects and the nature of artistic and design practice to computer scientists. The reflective practice that he refers to has long been standard in artistic practice. He identifies art as "knowing in action". This is a creative way of knowing *how* rather than knowing *what*. Reflective practice is a critical research skill and part of process of review, evaluation, and analysis (Schön, 1983). This dynamic, reflective process is an

important concept in the development of qualitative research methodologies. I agree with Carole Gray and Julian Malins that the most outstanding feature of professionals is "the capacity for self-evaluation and self-improvement through rigorous and systematic research and study of his or her practice where the problems of practice are open to reflection and inquiry" (Gray & Malins, 2008, p.23).

To investigate how my artistic process evolves, I conducted case studies adopting or modifying other research methods as well as further developed my reflective research method. Research methodologies and methods are important for artists to gain credibility. This notion of credibility will be revisited later in Chapter 4, *Methodological Background*.

1.3 Scope and Limitations

My main research focus is on the phenomenon of immersion that participants experienced and felt in interactive immersive environments. The concept of immersion in this realm has been researched in areas such as Virtual Reality (Dixon, 2007; Grau, 2003; Heim, 1998; Nechvatal, 1999; Sherman & Craig, 2003), Interactive Narratives (Murray, 1997; Ryan, 2001), Videogame Design (Douglas & Hargadon, 2000), Architecture (Beesley & Macy, 2007), and Physical Activities (Harris, 2011). In my research, I will not exhaust all the different approaches to ideas of immersion. It is beyond the scope of this thesis. My research is about qualities and meanings of immersion created from specific types of interactive immersive environments that consist of physically immersive art installations integrated with interactive systems. I will also develop a structure of understanding how the immersive experience relates to participants' experiences in an interactive artwork. Therefore, the findings of my research may not directly apply or generalize to other research areas for immersion. However, the experiential model developed in this thesis has implications for related areas such as education, entertainment, and therapy.

1.4 Contribution

The goal of my research is not to create a technical framework for immersive environments or an ideal one. Instead, the research is focused on the aesthetics of immersive experience examining bodily experience, felt experience and experiential qualities / meanings. How do people experience immersion through the body and create meanings which arise on a spectrum between artist and participant views? This research will begin to fill a gap between art practice/research and scientific research that has previously separated the terms of aesthetics and immersion. As a result of this research, I set forth an experiential model of immersion that synthesizes sensorial, spatial and contextual awareness to provide insights to artists and scientists. In particular, the structure of immersive experience can be adopted and experimented with, by other immersive artists or interactive artists in order to explore different qualities or meanings of immersion.

1.5 Definitions of Terms

1.5.1 Immersion

As an artist and researcher, I conceive of immersion as any experience where integrated bodily, conscious and pre-conscious states thoroughly intertwine with the world. Immersion in interactive art contexts means that mind, body and environment interweave and communicate with each other inside of technically-mediated, spatially enclosed, and sensuously-interactive computational environments. For immersion, space is one of the fundamental requirements. However space can be loosely interpreted at any level of scale (culture, architecture, clothes, or light) because space can be understood in a broader more inclusive sense as internal space or space can even be conceived as an enveloped space. In the working definition, immersive consciousness is a paradoxical perception of vastness and proximity that occurs at the same time. In addition, an embodied sense of immersion that occurs when a intertwined sense of body, mind and the relation to the world arise, will be considered the most critical elements of immersion in this thesis.

1.5.2 Aesthetics

I acknowledge immersion is a primary aesthetic phenomenon not just because it is created within artistic environments but because the experience is fundamental to our senses, realized through bodily interaction in its wholeness, and actualized in collaboration with artists (Fraleigh & Hanstein, 1999). Immersion is rooted in aesthetics. Dating back to Alexander Gottlieb Baumgarten's definition of aesthetics in 1750, "aesthetics" is an area related to human perception and sensory experience. He drew the term from the Greek definition of the word, literally, to mean "perception by the senses" (Berleant, 2010, p.26). However Baumgarten was also concerned with notions of beauty, taste and judgment. Hence when speaking of aesthetics, there is some confusion with the notion of "beauty."

In The *Meaning of the Body*, Mark Johnson states that aesthetics must become the basis of any profound understanding of meaning and thought. For Johnson, aesthetics is properly an investigation of everything that goes into human meaning-making (Johnson, 2007). In speaking of aesthetics, I go beyond beauty and objects that are pleasing and focus on experiential qualities and meanings. I am using a more contemporary understanding of the term, aesthetics that emphasizes the ancient notion of "to perceive via the senses" but more akin to Barthes' notion of artist & viewer/participant co-creating.

1.5.3 Interactive Immersive Environment

In my study of immersion, an immersive space is one of the fundamental requirements. In the Interactive Art history, there are a few forms of art that directly deal with immersion: projection-based interactive installations and VR (Virtual Reality) art (See 2.4).

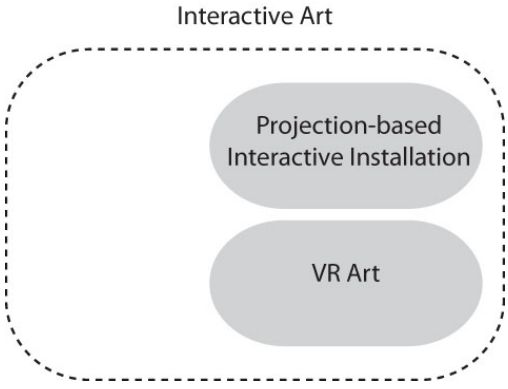


Figure 1. Immersive art forms in contemporary interactive art

In VR art, artists deal with a virtual space that participants cannot physically experience in the materially enveloping sense I use but phenomenologically perceive of virtuality. However it is important to acknowledge that the experience of a virtual space is often integrated with the physical/material aspects of technologies (computer equipment, global networks) and the physical effects of specific technologies (one could easily make someone vomit in VR). From a VR artists' perspective, my immersive environment can be considered an alternative immersive space because I do not use standard head-mounted displays (HMDs) or a CAVE. I am influenced by responsive environments from architecture, soft sculpture, and kinetic/optic art from the 1960s in terms of aesthetics. Although my work could potentially be situated in responsive environments, my concern for immersive experiences and the interconnectedness of participants, technology and interactive art is more properly an alternative to other immersive environments than it is to responsive environments.

My immersive environments consist of physical materials, such as soft textured fabrics or inflatables, sensors, LEDs, and optical fibers, used to evoke bodily interaction. I consider "light" to be one of the main components in creating or enhancing immersion in artistic immersive environments. Interactive visual and sonic components are always integrated with participant's motion tracking systems in these immersive environments. I have questioned how people become immersed while physically interacting with light in the environments and have examined the tactile and kinetic qualities of light while investigating other components of interactive immersive environments.

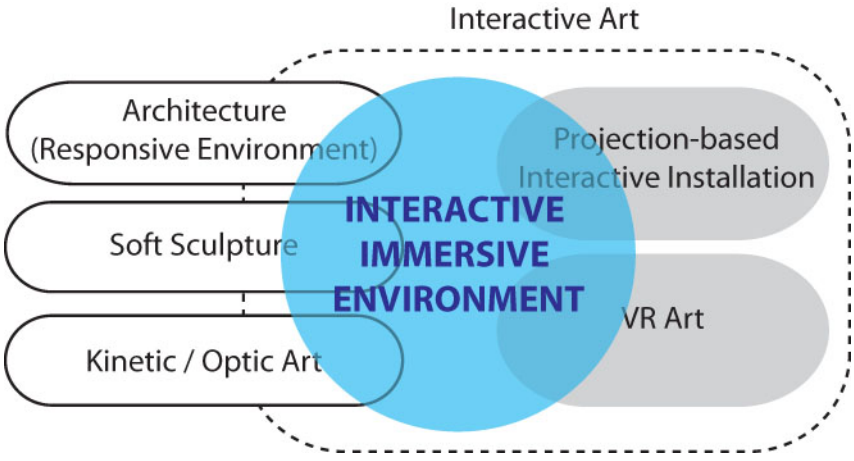


Figure 2. Influences from other artistic areas

1.6 Organization of the Dissertation

This section provides an outline of the structure of the rest of this dissertation. In Chapter 1, I discuss the reasons for this research and provide a brief background of this study. Chapter 2, *Literature and Prior Arts Review*, provides an overview of the history of the field and discussion of the key concepts and literature. Prior artworks are reviewed and a taxonomy of immersive artworks in the context of interactive art was created. This shapes an understanding of different immersive artworks in consideration of the space continuum. In Chapter 3, I present two preliminary projects (*Sky Reverie* and *nite_aura*) and studies using them. They provide an artistic trajectory of immersive environments focusing on concept development, material experiments, and technical research. In addition, they construct a preliminary understanding of participant experience in physically immersive environments. In Chapter 4, I discuss my methodological background inspired by phenomenological approaches. I take a closer look at phenomenological research methods being used in other disciplines. I will be taking Merleau-Ponty's body-centered approach in the relation of mind and world and Francisco J. Varela and Jonathan Shear's first-person approach with holistic views of blending first, second and third person perspectives. In Chapter 5, I explain the main project, *Light Strings*. This chapter covers the history of the project, concepts, material/technical research, and implementation of the physical environment and the interactive system. In Chapter 6, I illustrate the participant study process using *Light Strings*. It consists of detailed procedures of participants' first-person, second-person, and third-person data collection and data analysis with a phenomenological attitude. In Chapter 7, I analyze participants' immersive experiences triangulating different data sources. Through the analysis, I develop an experience model of immersion considering immersive consciousness (bodily, spatial and contextual consciousness) and temporal consciousness. In Chapter 8, I discuss a collaborative relationship with participants in the process of my art creation and participant studies. In Chapter 9, I discuss meanings of the immersive experience model in this dissertation and discuss conclusions. In Chapter 10, I present thoughts on the future of this research.

2: LITERATURE / PRIOR ARTS REVIEW

2.1 Understanding Immersion

The sense of immersion has been explored for a long time but there is no set or universally agreed upon definition for this term because all approaches converge on the word immersion from different knowledge areas. The term is widely used for describing immersive virtual reality, installation art and video games, but no one meaning dominates. Its meaning remains vague, but common to each meaning is the connotation of being absorbed, engaged and embraced. Different disciplines use these different definitions. This means that immersion has multiple, flexible qualities that can be applied in different situations.

In the *Compact Oxford English Dictionary* (Soanes & Hawker, 2005), "immerse" is defined as:

> *1) To dip or plunge into a liquid; to put overhead in water, etc.,*
>
> *2) To plunge or sink into a (particular) state of body or mind; to involve deeply, to steep, absorb, in some action or activity.*

From the dictionary definitions, it becomes clear that immersion has two folds – one is physical and the other is mental.

The word "immersion" comes from the Latin word, in (into) + mergere (plunge, dip). This verb is still used in modern English in the form of (to) merge, meaning to "to plunge or sink in[1]." The word is therefore also used to describe the act of baptizing. The origin of "immersion" seems to be the literal meaning of "absorption in some interest or situation" and

[1] http://www.etymonline.com/index.php?search=immersion&searchmode=none

it is more about sensuous experience that expands to being plunged into a mental activity[2]. This etymology parallels with Janet Murray's notion of immersion.

In her study, *Hamlet on the Holodeck* (1997), Murray explores the future of narrative and new technologies for storytelling. According to her, digital media will become as "explorable and extensive" as the 'real' world. Murray defines immersion as "the sensation of being surrounded by another reality that takes over all our attention" (p.98).

> *"The experience of being transported to an elaborately simulated place is pleasurable in itself, regardless of the fantasy content. We refer to this experience as immersion. Immersion is a metaphorical term derived from the physical experience of being submerged in water. We seek the same feeling from a psychologically immersive experience that we do from a plunge in the ocean or swimming pool: the sensation of being surrounded by a completely other reality, as different as water is from air, that takes over all of our attention, our whole perceptual apparatus."* (Murray, 1997)

Her understanding of immersion provides us some insight of immersion: its all-encompassing nature, the way it takes over all attention.

Recently computer scientists and game researchers have conducted research on immersion in connection to presence, a state of being engaged; in their view, presence is a psychologically emergent property of an immersive system. One of the most prominent researchers of immersion in VR, Mel Slater understands immersion to be "a technical condition for presence in a virtual environment" (Slater & Usoh, 1993). He emphasizes that immersion requires that there is mapping between the participant's proprioceptive feedback about body movements and the information generated on the displays. In his recent paper, he redefined immersion as "a property of the valid actions that are possible within the immersive system" (Slater, 2009).

In *Rules of Play* (2003), game theorists and designers Katie Salen and Eric Zimmerman discuss "the immersive fallacy." They define the immersive fallacy as an idea.

> *"The pleasure of a media experience lies in its ability to sensually transport the participant into an illusory, simulated reality. According to the immersive fallacy, this reality is so complete that ideally the frame falls away so that the player truly believes that he or she is part of an imagined world."* (Salen & Zimmerman, 2003)

Their position on immersion was strong because they consider that game designers/developers have a big desire about immersion and often connect immersion to

[2] http://oxforddictionaries.com/definition/immersion

photo-realism, yet the outcome is not strong enough. They suggest that game players are fully aware of the game character as an artificial creature and build a "game world" considering other game aspects. Therefore game play becomes rich and multi-layered experience with this double consciousness: that players may both feel immersed but at some level they are aware that they are also in a video game (Salen & Zimmerman, 2003).

Interactive Artists also explore immersion in VR environments. Immersive VR artist Char Davies pursued immersion as "a quality of being spatially encompassed by being sensuously enveloped, as if by a lover or sea water or even the air itself pressing upon the skin" (Davies, 2005, p.32). According to Oliver Grau (2003), a media theorist, "immersion can be an intellectually stimulating process; in most cases immersion is mentally absorbing and a process, a change, a passage from one mental state to another" (p.13). Frank Popper characterized immersion by "diminishing critical distance from what is shown and increasing emotional investment in what is happening" (Popper, 2007, p.181).

Other scholars connect immersion to optimal human experience. James F. Harris integrates mental absorption with physical engagement, which he termed "kinaesthetic immersion." He defines it as "experiences of just a few seconds duration that are so qualitatively distinct and sublime that they are still registered indelibly in people's memories decades later" (Harris, 2011, p.132). Harris finds examples in the physical performance of athletes. Similar experiences result from what Mihaly Csikszentmihalyi has called "Flow." Flow is the mental state of operation in which a person in an activity is fully immersed in a feeling of energized focus, full involvement, and success in the process of the activity. He finds flow states from physical performance and learning (Csikszentmihalyi, 1990).

Historically, the many immersive works have been focused on generating visual illusions exclusively. Some scientific research suggests that adding other sensory modalities enhances or provides unique qualities of immersive experience (Thalmann, 1997). Since immersion has often been examined as an ideal or subliminal design of human-environment and human-technology relationships, it is better investigated as a holistic experience not so much focused on a single ocular-centric sense, but multimodal.

This chapter examines different historical and contemporary perspectives of immersion from various disciplines, exploring immersive aesthetics from other art forms. It

helped me to establish the theoretical framework of my research and provide broad understandings of other people's works.

2.2 Historical Traces

The contemporary notion of immersion appeared in our recent era concurrently with the rise of Virtual Reality and 3D Games. However immersion is not a totally new concept. We can easily find various traces of immersive aesthetics from Literature, Architecture, ancient frescos and even cave paintings. Immersion can refer both to diegetic (narrative) immersion and mimetic (illusive) immersion. Diegesis and mimesis have been contrasted since Plato's and Aristotle's times. Diegesis is a style of representation in fiction but also film et al. Mimesis shows rather than tells, by means of action that is enacted (Pfister, 1988).

According to Murray, the predominant explanation for immersion in Literature is "the willing suspension of disbelief" attributed to Samuel Taylor Coleridge in his *Biographia Literaria*, published in 1817. The willing suspension of disbelief is the break of the knowledge or belief that what the observer watches or reads is not real. Coleridge suggests that a writer's ability to infuse a "human interest and a semblance of truth" into a fascinating narrative will make the reader "suspend judgement concerning the implausibility of the tale." Therefore the concept of "willing suspension of disbelief" is explained as how an audience might continue to enjoy a story[3]. Murray points out that for her, this suspension is too passive. In our desire for immersive experiences, we use our perception to reinforce the reality of the experience rather than to question it (Murray, 1997, p.110).

As Grau and others have shown, the concept of immersion has a long history in Western visual culture. He traces an archaeology of immersive image spaces, in particular those that seek to enclose viewers within the fabric of the image itself. For Grau, the immersive totality of the panorama is shown to be central to the prehistory of contemporary virtual media technologies. Grau starts his historical account with frescoes dating from 20 BC and in continuing through the development of the image, he moves towards a larger description of the aesthetic, social and economic factors of the panorama, as introduced by

[3] Wikipedia http://en.wikipedia.org/wiki/Suspension_of_disbelief

Robert Barker in 1789 (Grau, 2003). Grau places the panorama in the cultural historical context where art forms were beginning to be used not only to represent reality, but to constitute alternative realities.

There have been different approaches to understanding immersion from different disciplines. In neurophysiology research, John C. Lily developed the flotation tank in 1954. There had been an open question as to what keeps the brain going and the origin of its energy sources (Lilly, 2007). One hypothesis was that the energy sources are biological and internal and do not depend upon the outside environment. It was argued that if all stimuli are cut off to the brain then the brain would go to sleep. Lily decided to test this hypothesis and, with this in mind, created an environment which totally isolated an individual from external stimulation (Hutchison, 1984). He focused on measuring neuro-physiological data. His focus was not about immersion, but about meditation as a healing method (Lilly, 2007). He also had several other questions in mind: notably whether he could communicate with dolphins who were in a tank close to the isolation chamber and how hallucinogens activated immersion into alternative states of consciousness. He argues that repetitive stimulus induces imagination, and the mind when it is not immersed becomes restless and invents ways to be immersed.

2.3 Contemporary Views

2.3.1 Immersion in New Media

Since the 1990s, more in-depth research on immersion has been conducted in the Arts and Humanities. The result is two streams of scholars and artists. One stream explores various immersive experiences in different realms: videogames, narrative, and human experience. The other stream focuses on building immersive experience within immersive VR spaces.

According to Murray, all successful modes of storytelling eventually become transparent, as will digital media. In her view, immersion is the sensation of being surrounded by another reality that feeds our whole perception. She thinks it is essential that the medium itself disappears from our perception. The boundary between what is

represented and what is physically present fades and eventually disappears. Bolter and Gromala challenged this in *Windows and Mirrors* (2003). According to them, it is not always true that the interface or technology needs to disappear in order to be immersed. By feeling immersed in DisneyLand or a laser light show, they argue, one remains aware that it is fake (DisneyLand) or that the participant is aware of the technology. For Bolter and Gromala, a participant's awareness oscillates between feeling immersed and being aware of an immersive environment. Similarly, Salen & Zimmerman call this phenomenon "double consciousness," that the game player is fully aware of the character as an artificial construct. They argue that this makes character-based game play a rich and multi-layered experience (Salen & Zimmerman, 2003). I agree with both positions. In terms of the degree of immersion, disappearing the boundary between the medium and contents seems to create full and total immersion. However participants most of the time are still aware of the real environment and get immersed from the interplay between real media and virtual contents. Both positions offer ways to account for the degree of immersion or qualities of immersion.

As previously stated, however, Grau provides a useful definition for immersion in his book *Virtual Art: From Illusion to Immersion* (2003), arguing that "immersion can be an intellectually stimulating process; in most cases immersion is mentally absorbing and a process, a change, a passage from one mental state to another." From panoramas to VR, immersion is entangled within the history of representation. Grau provides an explanation of how immersion is created:

> *"Immersion arises when artwork and technologically advanced apparatus, message and medium, are perceived to merge inseparably. In this moment of calculated "totalization", the artwork is extinguished as an autonomously perceived aesthetic object for a limited period of time. Then conscious illusion, as in the weaker form of trompe d'oeil, can shift right around for a few moments into unconscious illusion."* (Grau, 2003)

Immersion occurs the moment the observer shifts from conscious illusion (seeing a landscape in the panorama) to unconscious illusion (seeing the panorama as the landscape). It somehow triggers memories which overlay and enhance the sense of entering into the work. Grau's perspective on how immersion should be pursued becomes clear when he delineates his use of the term immersion. He limits his study to only those alternative realities that intervene with perception, which offer "particularly through their totality, the option of fusing with the image medium, which affects sensory impressions and awareness"

(Grau, 2003, p.13). For Grau, immersion is an overwhelming sensory experience. This must be embodied in a medium that surrounds the viewer so completely. It can convincingly hide its own nature or materiality. The materiality of space and how it is represented are essential to Grau and largely determines whether a viewer finds himself or herself involved in a different reality.

In *Narrative as Virtual Reality*, Marie-Laure Ryan (2001) links the concept of immersion to interactivity as well as to the aesthetics of illusion, similar to Murray and Grau. Immersion to Ryan means an experience through which a fictional world becomes an autonomous reality. For this to happen, the medium has to become transparent. She distinguishes three forms of textual immersion.

1. Spatial: the reader develops a sense of place, a sense of being on the scene of the narrated events.

2. Temporal: the experience of a reader caught up in narrative suspense, the burning desire to know what happens next.

3. Emotional: the phenomenon of developing a personal attachment to the characters, of participating in their human experience.

In her book, narrative techniques are evaluated in terms of their ability to promote these various types of immersion, and immersivity is shown to be more important to the effect of literary realism than the life-likeness of the fictional world (Ryan, 2001).

In the digital domain, many researchers have focused on the desire to use technology as the defining factors in immersion; they describe the term "immersion" as immersion into presence, a state of being engaged; in this way presence is a psychologically emergent property of an immersive system. Immersion describes a condition; presence describes an associated state of consciousness (Schneider & Feustel, 1999). To restate VR researcher Slater's view, immersion is a technical condition for presence in a virtual environment. Carol Manetta and Richard Blade defined immersion as an observer's emotional reaction to being part of a virtual world (Manetta & Blade, 1998). They consider immersion as mental process created during the use of immersive VR systems that include HMDs and other equipment. Immersion can be stimulating process, but in most cases immersion "absorbs and provokes a process, a change, and a passage from one mental state to another" (Grau, 2003, p.13).

2.3.2 Immersion in Interactive Art

Immersion is in part a spatial experience, in the sense of enveloping the participant in a discrete and panoramic space. Moreover, it is also a temporal experience when combined with computational components. It creates an intimate connection as "a constitutive element of reflection, self-discovery, and the experience of art and nature" (Grau, 2003, p.286). Immersion is considered paradoxically as distance, as absorption, and as space and time blur in the immersive environment.

Since the 1990s, the concept of immersion has been explored mainly by VR artists. The pioneering immersive artist Davies explored the concept of immersion using the metaphor of scuba diving (submersing in water) and using a concept of cognitive absorption in her projects (Davies, 2005). Although *Osmose* was not the first VR artwork per se, it was developed in the early days (right after the Banff Center's Virtual Environments' 6 projects) and still remains the most visible and cited.

Around the 1960s, early new media artists conducted experiments related to immersion. It was started from "Happenings." "Happenings" emphasize the organic relationship between art and its environment and it a form of participatory media art, focusing on an interaction between the artist and the audience. Since this movement, many interactive artists have continued to explore the concept of immersion in various kinds of perspectives and technologies (Wardrip-Fruin & Montfort, 2003).

Immersive technologies are currently flourishing mostly because of the entertainment, military, medical simulation and space industries. Artists and designers have new possibilities for interactive immersive works become more accessible and more powerful with programming tools. In relation to VR art, the sense of immersion is being explored in art projects that encourage the active involvement of the participant and evoke senses and/or fully engage with attention. Interactive artists often try to use limited, inexpensive technology but in creative ways to examine the sense of immersion because it is hard for them to use very expensive equipment and because the sense of immersion does not require photo-realistic or technologically complex multi-sensory environments. "Immersion can be created from perceptual cues" (Proske, 2010).

Although a good sense of immersion seems to be highlighted in interactive art and science, research recognizes that there are some negative aspects of immersion and immersive environments can create negative valences, such as loneliness, sadness, isolation, fear (Banos, et al., 2004).

2.4 Taxonomy of Immersion in Interactive Art

In the following section, I detail a taxonomy of immersion based on my definition which defines the scope of my research. In my understanding of immersion, the spatial condition is very critical. Therefore I utilize a taxonomy of immersion based on a continuum of virtuality inspired by the computer scientists Paul Milgram and Fumio Kishino (1994).

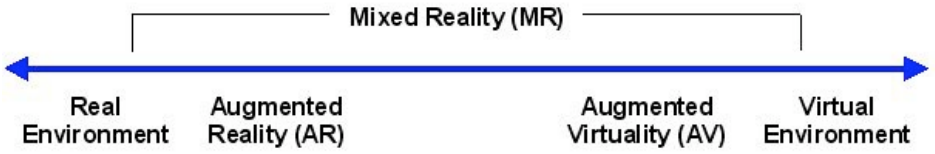


Figure 3. The virtuality continuum

This continuum (Figure 3) spans from full physicality to full virtuality. Even though immersion research involves mostly virtual environments, I would like to explore immersion in a greater range of possible environments, embracing both virtual and physical. A further taxonomy will be organized examining physical, embodied and sensory immersion based on the variation of physical and virtual environments. I chose about 5 art projects in each category in the continuum. First of all, I included immersive art projects that I have experienced in person and I felt immersion in the pieces, for example, *Screen* by Noah Wardrip-Fruin, *Vectorial Elevation*[4] by Lozano-Hemmer Rafael and *Text Rain*[5] by Camille Utterback & Romy Achituv. In addition, I included art projects that I experienced through their documentations (videos and images) and they seem to create bodily and spatial

[4] http://www.lozano-hemmer.com/vectorial_elevation.php

[5] 1st Media Seoul Festival was the show where I experienced the piece in person. This piece has been shown numerous times from 1999 until 2007. http://camilleutterback.com/projects/text-rain/

immersion, such as *Osmose* by Char Davies and *Blur Building*[6] by Elizabeth Diller and Ricardo Scofidio. I was also consulted by other scholars and books.

Immersive spaces create subliminal awe (Griffiths, 2008), helping the viewer/participant become aware of inherent or internal body senses. In the virtuality continuum, physical environments do not include normal architectural rooms or spaces where we live in the everyday life. Even though we are physically surrounded by a room or nature and may be engaged to something in the space, it is hard to call the phenomenon immersion. When we are habituated to the space, we are rarely aware of our connections to the environment and the reciprocal relationships within the space. In my definition of immersion, it is therefore critical to recognize that immersive consciousness is constructed through embodied experience in the relationships among body, mind and the world.

Alison Griffiths argues that unusually big screens draw us in, generate awe and possibly leave us with sensory overload (Griffiths, 2008). As mentioned previously, historical art at huge scales, such as Soviet Art or dioramas along with contemporary domes, Panorama, IMAX, and projected screens are considered as immersive spaces or screens. The common trait of these spaces is a sense of vast size. These spaces offer us visual spectacle that fills our field of vision, especially our peripheral vision – drawing us deeper into the view than traditional forms of exhibition such as 2D movies or panel painting (Griffiths, 2008).

2.4.1 Virtual Environment

New media theorists and practitioners such as Erkki Huhtamo, Bolter and Richard Grusin and Grau, along with Michael Heim (1998), Ken Hillis (1999), Lev Manovich (2001) and Joseph Nechvatal (1999), maintain that VR systems are one of the most effective forms of immersive technology (Bartlem, 2005). "Virtual" means that there is no real (physical) space but rather a "perceptual experience of such space" realized by technologically-enabled multi-sensory effects (Davies, 2005). Virtual Reality is often used to describe a wide variety of applications commonly associated with immersive, highly visual, interactive 3D environments.

[6] http://www.dillerscofidio.com/

In VR systems, many computer scientists and interactive artists use Head-Mounted Display (HMD) technology because they believe that the sensations of full-body immersion are most effectively enabled through an HMD. An HMD consists of two small rectangular LCD screens, each projecting a slightly different and overlapping view of the computer generated 3D graphics so as to recreate the effect of human binocular vision with stereoscopic spatial depth. The LCD display changes as the head moves because of a head-tracker. We can find many VR artists that used HMDs for their projects.

In 1994, the first immersive VR art projects were presented at the Banff Centre for the Art, in Banff, Canada. The Banff Centre selected 8 VR art proposals from an international open call and supported artists over 2 years to realize their ideas. These projects were mostly done in artistic teams supported by a group of programmers[7]. All pieces used a Head Mounted Display (HMD), a dataglove and 3D, stereoscopic, interactive graphics. *Dancing with Dervish: Virtual Bodies* (Figure 4.) by Diane Gromala & Yacov Sharir began with a performance and continued thereafter as an interactive VR experience for individual users. Body parts from MRI scans of Gromala's body comprised the immersive 3D environment. Each body part was texture-mapped with Gromala's erotically-changed poetry. As users navigated within the body parts, they deformed and reformed according to users' movements. Texture-maps also changed when users "touched" surfaces with datagloves. When users "entered" body organs, instead of being small, cramped spaces, they paradoxically were instead huge, seemingly endless and surreal spaces. According to the artists and many users, the lack of rectilinear and gravitational indicators enhanced the proprioceptive sense of "flying" or "floating." 3D, spatialized sound also functioned as navigation. Users went toward the heartbeat to get to the literal body parts.

[7] Banff hired programmers to support the artists as technicians. Gromala and Sharir were the only two who demanded a collaborative effort, since the medium was so new. This is often cited in their publications, which were in art and computer science venues.

Figure 4. *Dancing with Dervish*[8] by Diane Gromala and Yacov Sharir (1993-2003)

Placeholder[9] by Brenda Laurel & Rachel Strickland was primarily a small, one-time theatrical performance that later became available through video documentation. Each performer "became" a virtual avatar, such as a crow. The environment was an abstraction of nature (lake, cave). In *Topological Slide*[10] by Michael Scroggins & Stewart Dickson, users stood on an unstable, surfboard-like device that acted as a controller for the stereoscopic display in the HMD. Visualizations of mathematical ideas were examined as the interactive visuals. *Inherent Rights, Vision Rights* by L. P. Yuxweluptun was the first VR project at Banff and it was a virtual recreation of a First Nation tribal house.

As already mentioned, the pioneering immersive artist Davies realized the concept of immersion using the metaphor of scuba diving as well as using a concept of absorption. Davies and her team (Banff's original VR technical team) created two immersive VR projects, *Osmose* (Figure 5) and *Ephemere*[11]. Each project accentuates "the quality of being spatially surrounded and sensuously embraced, questioning how the immersant[12]'s own interior, embodied, sense of self becomes the ground or medium of experience" (Davies, 2005, p.51).

[8] Gromala, D., & Sharir, Y. (1996). Dancing with the Virtual Dervish: Virtual bodies. In M. A. Moser, Macleod D., & Banff Centre for the Arts (Ed.), *Immersed in Technology: Art and Virtual Environments*. Cambridge, Mass.: MIT Press.

[9] http://www.tauzero.com/Brenda_Laurel/Placeholder/Placeholder.html

[10] http://emsh.calarts.edu/~aka/topological_slide/Introduction.html

[11] http://www.immersence.com/ephemere/

[12] She defines the participant being immersed as immersant.

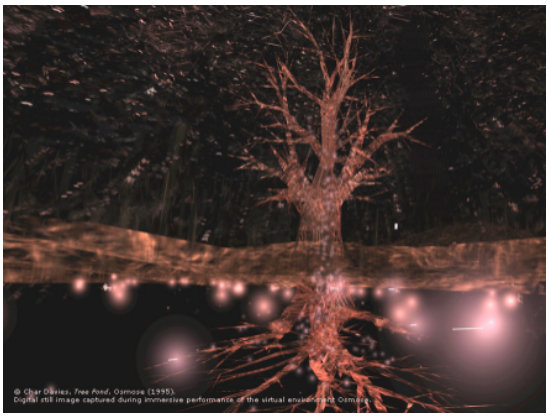


Figure 5. *Osmose*[13] by Char Davies (1995)

Osmose offered participants a Virtual Environment that they could explore using HMDs (Head-Mounted Displays) and a real-time motion tracking system that was by then standard in the mid 1990s. According to the artist's description from her dissertation, *Osmose*'s virtual world consisted of different virtual spaces such as a Forest, Pond, Tree and Cloud in a 360 degree spherical and enveloping space. The participant was able to move upward by breathing in and fall downward by breathing out. Davies states that an immersive virtual environment is a means of transforming and dehabituating perception. Davies describes the experience participants had as something like floating or swimming, being enveloped by the virtual images. For her, this experience is immersion (Hansen, 2006). She created a semi-abstract, translucent graphic quality and a misty and dark environment to provoke an eerie feeling. *Osmose* was one of the VR Artworks that examined the relationship between a technologically-mediated virtual world and real bodies rather than investigating the technological aspects of VR as most computer scientists did or continue to do (Popper, 2007). Davies insists that an HMD was perfect equipment for her to create artistic body-enveloping and encompassing spatiality. By not showing the participant's body through HMD, it seems she makes separation between the virtual world and our body. However she understands a chiasmatic relationship between our body and world. Therefore she approaches the participant's body as a subjective "lived-body or "I-body" inhabiting virtual space (Davies, 2005).

[13] http://www.immersence.com/osmose/

Yet it seems that VR technology still has constraints. For example, most of the HMDs do not offer peripheral vision and other wearable equipment is typically not comfortable enough for users to explore easily. Some people often feel dizzy during HMD-based immersive experiences, and thus the technology has not been more widely adopted. Additionally one viewer is usually wired to the system and cannot have another person in the virtual space unless they are in the rare networked Virtual Environments (See Margaret Dolinsky's networked VEs[14]).

In the 1990s, several virtual environments (VEs) deemed "immersive" were developed as therapeutic treatments for numerous ailments. These VEs were created using HMDs, trackers and sensors. Several of these virtual environments are currently in use in medical realms and continue to be developed. Research strongly suggests that the immersive properties of these HMD-based[15] virtual environments were crucial to their effectiveness (Hoffman, 2004). One study demonstrated that standard videogames displayed on computer monitors were not, for example, nearly as effective as the immersive environments in "distracting" patients from their acute pain (Hoffman, Hollander, Schroder, Scott, & Furness, 1998).

In contrast to pain "distraction" then, the *Meditation Chamber*[16] was designed as a VE combined with a biofeedback device. It enables meditators — particularly those who had never meditated or have trouble trying to meditate — to get real-time feedback of their physiological states. The *Meditation Chamber* is currently in use at Virtually Better as a training tool for users to help in controlling their pain, and in reducing their anxiety and stress. In the spirit of the *Meditation Chamber,* traditional variants of meditation are under examination by Gromala and her collaborators to determine if any aspects of digital technology would make sense in elucidating or aiding users in developing these meditative practices (Barnes, Gromala, Squire, & Song, 2011).

The CAVE (CAVE Automatic Virtual Environment) is another immersive space widely being used in scientific and artistic research. The CAVE is a surround screen and sound and projection-based system. The viewer explores the virtual world by moving

[14] http://dolinsky.fa.indiana.edu/CAVE/

[15] The term "HMD-based VR" will refer to VR systems that utilize HMDs. These generally include components such as trackers, datagloves, sensors, peripherals and requisite software.

[16] http://www.sfu.ca/~dgromala/thesis/DGR_thesis/MC_concept.html

around inside of the cube. Instead of wearing helmets to experience a virtual world, participants of CAVE put on lightweight stereo glasses. The CAVE is capable of accommodating more than one person but usually there is only one active user controlling the environment while other people view passively. Many CAVE systems are being used for scientific visualizations, virtual heritage, flight training, and simulation games.

Recently CAVE systems have been constructed for artistic research and information visualization research. *Screen* (Figure 6) by Noah Wardrip-Fruin is a CAVE environment that participants can interact with 3D texts created on the wall of CAVE. 3D texts surround the participant and create a bodily interaction with texts touching with a controller (Carroll, Coover, Greenlee, McClain, & Wardrip-Fruin, 2004). The CAVE screen almost covers the peripheral vision and is claimed to build an almost fully immersive environment. The main participant who holds a controller can get immersed through playing with texts while other participants who wear stereoscopic glasses experience the visual-spatial aspects of the project.

Figure 6. Cave environment in *Screen*[17] by Noah Wardrip-Fruin (2002-5)

These forms of virtual immersion imply that the user experiences a sense of fusion with a technologically-generated space, a virtual environment (VE). The user becomes immersed in this illusory space and the boundaries between the computer-generated stimuli of the VR system and the embodied space of the participant-viewer seem to disappear.

2.4.2 Mixed Reality: Augmented Virtuality

Similar to Davies, many interactive artists have been trying to evoke full-body immersion by manipulating sensory impressions and internal awareness. There are many

[17] http://www.noahwf.com/screen/index.html

installations using projection screens and sometimes physical objects/materials that respond to participants in immersive spaces. In addition, remote camera systems are used to capture the participants' motion and images, while video or audio responsive to viewers are interactively presented (Rozin, 1999; Utterback & Achituv, 1999). Myron Krueger, one of the pioneers of interactive art was the first artist to create this type of interactive art that he termed Artificial Reality (Krueger, 1991). Krueger created interactive environments in which the computers "perceived" the visitors' movements through sensory floors and video cameras; the spaces then responded with electronic sounds and environmental scale displays (Popper, 2007).

Early Interactive Artists, Myron Krueger and Jeffrey Shaw (Figure 7) created interactive immersive environments using a computer control system and a projection screen that grants participants' full-body interaction and sensory immersion. Their immersive space was realized by projection techniques. This provides greater freedom of movement for participants because instead of being tethered by HMD or enclosed in a CAVE with wearable sensors. Participants physically explored the environment and were said to have experienced unexpected interactions in the manner of exploring a playground. This style of installation became popular as an interactive and immersive technique among interactive artists and designers and continues in contemporary work. Many artistic creations have been created that range from pure abstract interactions to embodied, sensual interactions (Popper, 2007).

According to the virtuality continuum (Figure 3), interactive artworks using projection screens are often considered as augmented reality or mixed reality. Participants can experience virtuality and reality engaging with a physical space, animated images (virtually) projected on the wall or floor, and/or spatial sound. Even though the visuals are contained in a frame and participants can see the boundary that separates them from the background, these kinds of works may provide a more embodied interface, bodily interaction, playful settings and so on. Therefore participants can be immersed playing with their own shadows or interacting with interactive objects. Artists such as Jeffrey Shaw, Camille Utterback, Rafael Lozano-Hemmer (see below) among others, use digital, screen-based and projection technologies to immerse the viewer in various aesthetic, structural and perceptual states.

The Legible City (Figure 7) is a projection-based Interactive Art Installation that consists of a big screen and a bicycle in front of the screen. A participant could ride a bicycle, looking at the screen to navigate. The participant navigated the computer-generated 3D world of a city that was constituted with letters and sentences related to the streets of the city. Shaw created three versions of the 3D environment (Manhattan, Amsterdam, and Karlsruhe versions) and mapped the existing architecture of the city to a textual form (Grau, 2003). I have watched the documentation videos created by the artist. From the video, the participant explored the city represented by letters by pedaling a bicycle. They looked like they were getting immersed into the computer-generated space as well as the emergent narratives by reading the letters. Even though simple, the cycling metaphor seemed intuitive enough to connect a participant's bodily experience to the computer-generated, virtual environment.

Figure 7. *The Legible City*[18] by Jeffery Shaw (1989)

Text Rain (Figure 8) by Camille Utterback & Romy Achituv is one of the early interactive art installations that I was inspired by. *Text Rain* is an interactive installation where participants play with falling letters on the projected screen using the entire body. Participants stand or move in front of a large projection screen and they see a mirrored projection video of themselves in gray scale. Falling letters look like rain or snow so that they fall down and land on participants' bodies. The letters respond to the participants' motions and can be caught, lifted, and then let fall again (Utterback & Achituv, 2000). When I experienced *Text Rain* in Korea in 2000, people seemed not to know what to do with *Text Rain* because they (even myself) had never seen this kind of interactive work before.

[18] http://jeffrey-shaw.net/html_main/show_work.php?record_id=83

However they immediately figured out how it worked and how to interact with it. Notably people seemed to forget how long they played in front of *Text Rain*. This is one of the most intriguing aspects of immersion: the temporal distortion.

Figure 8. *Text Rain*[19] by Camille Utterback & Romy Achituv (1999)

Luc Courchesne is another artist who is delving into alternative immersive spaces. He has been examining hemi-spherical panoramic screens focusing on light and perception along with research on the sense of immersion. As an artist, he emphasizes creating experimental panoramic images and environments, using different sizes of dome structures and four surrounding projection walls. *The Visitor: Living by Numbers* (Figure 9) is one of his early projects that interactive panoramic video projected on a suspended immersive dome space. In the installation, a visitor can explore the Japanese countryside through images projected on a dome surface. To interact with this project, a visitor enters the dome and adjusts the height of the structure. Once the structure is placed in comfort, a visitor can navigate by saying any numbers between one and twelve. Depending on the numbers, the system shows different roots and scenery (Courchesne, Langlois, & Martinez, 2006).

[19] 1st Media Seoul Festival was the show where I experienced the piece in person. This piece has been shown numerous times from 1999 until 2007. http://camilleutterback.com/projects/text-rain/

Figure 9. *The Visitor: Living by Numbers*[20] by Luc Courchesne (2001)

Paul Sermon examined alternative screens for projection. He explored natural materials like water, fog and soft fabrics. One of his early projects, *Body of Water* (Figure 10) explores immersion in a telematic way. It is a video installation consisting of three parts, a chroma-key room, the coal miners' changing room and the shower room. The three areas are networked though live videos. The people in the individual installations are separated using chroma-key processes and projected on a mist curtain. The video images from all the locations were assembled into a TV/projection image, leading to non-verbal, gestural communication between the visitors in these physically separate situations. Since the artist mainly explores tele-presence through many of his works, his works do not seem to deal with immersion per se. However, because of his concept of tele-presence, a participant travels around spaces created by physical materials, such as fabrics and water, thus emphasizing sensuality. Therefore, I included this project as an example of immersive projects.

[20] http://www.fondation-langlois.org/html/e/page.php?NumPage=129

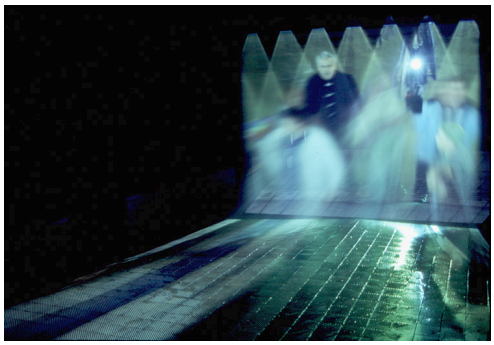


Figure 10. *Body of Water*[21] by Paul Sermon (1999)

According to David McConville, a researcher and co-founder of *Eluminati* which produces immersive visualization environments, domes are considered ideal immersive spaces (without HMDs) because they create a sensually enclosed environment and help participants to be fully immersed and engaged. Because of this, domes can be found cross-culturally in many forms, including ritual, scientific, entertainment, and educational applications (McConville, 2007). Traditional immersive spaces (including domes, cathedral structures, panorama, and IMAX) are not usually interactive but spaces where projected images or the structure itself may create immersive consciousness. Contemporary dome structures often incorporate interactive immersive digital systems with camera motion tracking systems. In this way, technology augments an immersive effect (of the space) that has been around for a long time (McConville, 2007).

Building on Krueger's contribution, many artists have explored immersion as embodied visuals without interactivity. Bill Viola, and even Hollywood cinema have popularized the idea that video/film is sufficiently engaging to be considered immersive (Lord & Marchessault, 2007). Other artists have developed systems that allow extensive user control of images or sounds, such as Rafael Lorenzo-Hemmer's works[22] and David Rokeby's works[23]. These artists belong to an interactive immersive tradition that uses scale and artificial intelligence to amplify the sense of presence.

[21] http://creativetechnology.salford.ac.uk/paulsermon/herten/
[22] http://www.lozano-hemmer.com/projects.php
[23] http://homepage.mac.com/davidrokeby/home.html

2.4.3 Mixed Reality: Augmented Reality

The next space of the virtuality continuum is "Mixed Reality" including "Augmented Reality" and "Augmented Virtuality" (Milgram & Kishino, 1994). In my dissertation, I do not distinguish between two spaces, "Augmented Reality" and "Augmented Virtuality." Rather I have an integrated a concept that a space deals with some physicality that evokes bodily movement and invites touch. Projects and research in this realm have inspired and guided me to explore a concept of immersion concentrating on bodily experience and materiality of the space. Movement is one if the conditions for our sense of what our world is like and who we are. According to Mark Johnson (2007), our perceptual knowledge comes from movement, both bodily motions and our interactions with moving objects. In my dissertation, how participants experience immersive environments through their bodies focusing on qualities and meanings of the experiences in intertwinement with mind and the world will be a core part of a qualitative evaluation of how light defies categories, provoking physical states that are both ancient and contemporary, reverential and technical, psychological and physical.

2.4.3.1 Responsive Architecture

Architects and engineers have created many responsive facades using lights, sensors, and actuators. Textile engineers have also joined this movement. Some experimental architects have examined the quality of space and dwellers' spatial senses by creating responsive facades or interactive art installations (Beesley & Macy, 2007). As an interactive artist, I have learned that physical interaction is an important aspect in creating immersion, and that materiality and scale provoke intuitive and spontaneous interactions.

Philip Beesley is one of the architects whose research on interactive architecture is prominent. His recent work, *Hylozoic Soil* (Figure 11) is an example of tactile, interactive, immersive environments formed of clusters responsive membranes. These hanging responsive surfaces create interactive environments on an architectural scale. *Hylozoic Soil* used proximity sensors to detect the participants' movements which triggered movements of parts of the structure via muscle wires and actuators (Beesley, 2006). Because it surrounds the participants, it invites greater physical interactions including touch and created a sense of immersion. Because of the organic form of the installation, participants do not feel

compelled to push a button or figure out how the technology works. There is also the important issue of participants seeing and understanding cause and effects. His piece blurs the boundaries between interaction and passive enjoyment. It is simply enough to feel a part of the "natural" space (Beesley & Macy, 2007).

Figure 11. *Hylozoic Soil*[24] by Phillip Beesley (2007)

From the documentation video by Beesley, parts of the structure quivered and responded to the participants' presence once they were detected by the sensors. As the whole system was networked using microprocessors and the shape of the structure looked organic, it seemed like a huge, living organism that surrounded and communicated with the body (Beesley, 2006). I think this project is an example of tactile, interactive, immersive environments because the environment was physically semi-enclosed. In terms of material, Beesley used mostly acrylic for the surface and metal for actuation. I was fortunate to participate in a workshop that Beesley organized. At the workshop, he showed the material components of *Hylozoic Soil*: acrylics, sensors, muscle wires and actuators. The materials were repeatedly interconnected and built into a large mesh surface. Though I don't use the same materials as he did, my artistic pursuit through materiality is closely aligned with his artistic vision, particularly his use of materials and movements that come from nature. Further, he used thousands of pieces of material in a huge scale that was somewhat akin to the complexity of nature.

Breathing Room (Figure 15) is an interactive installation created by Mette Ramsgard Thomsen with Karin Bech. *Breathing Room* consists of a big fabric wall that changes shape. The user can change and move the space by pulling a series of weights in the structure. This

[24] http://www.philipbeesleyarchitect.com/sculptures/0635_HyloSoil_Large/hylozoic.html

affects the sense of immersion by the slow movement of the environment. The membrane of *Breathing Room* also breathes and opens itself and closes according to its own internal rhythms (Beesley, 2006). Through these projects, Thomsen investigates what she terms a Robotic Membrane and Metabolic Structure on an architectural scale. As an architect, her focus is not immersion per se, but she examines similar technological and aesthetical issues to my research in terms of ambient responsiveness between the human and the world.

Figure 12. *Breathing Room*[25] by Mette Ramsgard Thomsen (2006-7)

Interactive artists often examine non-physical immersive space to explore the concept of immersion. According to Merleau-Ponty (1992), "space is not the setting (real or logical) in which things are arranged, but the means whereby the position of things becomes possible" (p.284). We can use Merleau-Ponty's definition of space in immersion that involves the body and/or architecture. If our bodily experience is a main focus, conceptual and virtual spaces also can be considered as part of immersive spaces. The real space does not need to be vast because the conscious space is evoked.

2.4.3.2 Kinetic Light Art

Light has been privileged as a metaphor for truth in Western thought (Vasseleu & ebrary Inc., 2002). Light is not just an object or environment but it is that which creates the relative quality of luminosity. According to Jack Burnham (1968), "luminosity acts as an emotional stimulant" because to an observer, light seems to be perceived as the internal energy in the art works. In early times, especially the 1920s and 1930s, large boxes, walls and entire rooms were created with reflecting materials and real, kinetic lights. Light itself became an artistic medium, energy and a material. From fire to oil-lanterns, from the simple

[25] http://cita.karch.dk/

light bulb via the neon tube, from cinematographic film to HD, from the laser beam to augmented and actuated architecture, from the fluorescent lamp to stadium-size LED screen, from ultraviolet heat-lamp to basement plasma screens, the development of light art is co-determined by the application of technical innovations (Weibel, et al., 2006).

Light transforms and deconstructs space by illuminating. It creates hallucinative and phenomenal spaces that participants perceive through their body engaging multi-modal experience (Weibel, et al., 2006). As an interactive artist who also uses light as a main artistic material, I am fascinated by the aesthetic and affective qualities of light and explore different light sources with physical materials in order to evoke immersion.

Lozano-Hemmer is a prominent environmental installation artist. Lozano-Hemmer 's *Vectorial Elevation* (Figure 13) is an interactive artwork that allowed participants to transform the sky over the Zócalo Square in Mexico City. Using a three-dimensional interface, the web site lets people design huge light sculptures with 18 robotic searchlights located on and around the Plaza. A web page is made for each participant with photos of their design from four cameras located around the city. The artist examines the collaborative, cooperative space created by laser beams (Lozano-Hemmer, 2000). Because of the huge scale and novelty of the piece, participants get immersed by just looking at moving laser beams on the sky. Lozano-Hemmer doesn't limit space for art and light-art to conventional materials. He expands his canvas to buildings, squares, parks and sky and the sky canvas is expanded by networked participants. Regardless of the size of the space, it is light which fills and transforms space into an imaginative and playful environment (Lozano-Hemmer, 2000).

Figure 13. *Vectorial Elevation*[26] by Lozano-Hemmer Rafael (1999)

[26] http://www.lozano-hemmer.com/vectorial_elevation.php

Olafur Eliasson is another well-known light artist who is creating kinetic, interactive, immersive light arts that are integrating with elemental materials such as water and air temperature to enhance the viewer's experience. *The Weather Project* (Figure 14), exhibited at the Tate Modern in 2003[27] uses representations of the sun and sky. In this project, Eliasson has sought to bring a part of London, its own weather into the building. The light and fog in the composition of the ephemeral elements of *The Weather Project* align with the unpredictable weather in London (May, 2003).

Figure 14. *The Weather Project*[28] by Olafur Eliasson (2003)

2.4.4 Physical Environment

Physical environments expand the boundary of our vision and create imagination evoking immersive feelings from materials that affect with perceptions of dimension. *Blur Building* (Figure 15) by Diller & Scofidio is a pavilion built for Swiss Expo 2002 at the lake Neuchatel in Yverdon-les-Bains, Switzerland. This pavilion is made of fine mist through 31,500 fog nozzles, creating a huge artificial cloud. Visitors need to walk down around 400 feet to experience the building, and then they arrive at the big mist mass. The mist is generated and controlled by a computer system adjusting the strength of the solenoid nozzles according to climate conditions (temperature, humidity, wind speed, and direction) (Vogelaar, 2005).

[27] http://www.tate.org.uk/modern/exhibitions/eliasson/default.htm
[28] http://www.olafureliasson.net/works/the_weather_project.html

Figure 15. *Blur Building*[29] by Diller & Scofidio (2002)

This project is not an interactive project in a general sense even though the artists planned to integrate interaction. Therefore I included this project in a category of a physical immersive environment. I have not experienced *Blur Building* first hand, but I watched the artists' documentation videos from inside and outside of the mist. Once I watched them, I could immediately recall my experience from Niagara Falls. The experience seemed a bit different. People were walking in normal speeds in the mist and the condition of mist was stable on the videos. Even though the experience in the mist of Niagara Falls was brief and the entering in the mist was very sudden, I felt drenched and fully immersed in the mist and the moment of immersion was remarkable. It was a strong inspiration of the artists' exploration with natural elements, water and mist, in the natural environment.

Contemporary installation artists often explore materiality through space. Yayoi Kusama is a Japanese artist who creates paintings, collages, soft sculptures, performance art and environmental installations using repetitive patterns and accumulation. One of her installations, *Love Forever* (Figure 16) is an immersive installation covered with mirrors. The lights on the ceiling create an infinitely mirrored room. The piece is visually mesmerizing, but also seems to be the perfect combination between the abstract concept of infinity and physical, sensual materiality. Although it is just a mirror experiment, well-placed patches of color, lighting, and crystal-still pools of water create an immersive experience (Zelevansky, Hoptman, & Kusama, 1998).

[29] http://www.dillerscofidio.com/

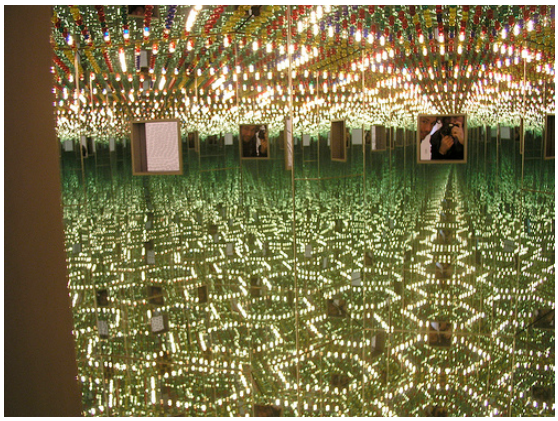


Figure 16. *Love Forever*[30] by Yayoi Kusama (1998)

Jésus Rafael Soto's *The Penetrable* (Figure 17) is an environment made from a long, rope-like ribbon. In each exhibit, the color of the ribbon changes. *The Penetrable* is the materialization of the idea about the state of the space of the universe, completely occupied by relations (Pau-Llosa, 1999). The experience of the participant by going into *The Penetrable* will create sensory immersion in the surrounding. Although this is not a technologically interactive piece, it emphasizes physical interaction and sensorial experience. Honestly, I was not aware of this project after I built my thesis project, *Light Strings* which is structurally similar. The artist's intention and vision seems close to mine in terms of creating a space for sensorial experience.

Figure 17. *The Penetrable*[31] by Jésus Rafael Soto (1997)

[30] http://www.moma.org/interactives/exhibitions/1998/kusama/

2.5 Other components for Immersion

The concept of immersion is complex and subjective; there are many factors involved with immersion: the users' physical senses and mental processes, the technology, the types of interaction, artistic framing and the specific application. The psychological aspect of immersive experience seems particularly difficult to analyze since what makes experience immersive differs from individual to individual. Immersion is qualitative and ambiguous. However from my preliminary artistic research, the major finding is that immersion can be created in interactive immersive environments that do not necessarily require complex or scientific hardware (HMDs, CAVEs, other VR environments, etc.) and only minimal elements are necessary for immersion. This notion is parallel to Slater's idea of the "minimal cue" set necessary to provoke immersion. In this next section, I will discuss the previous list of definitions in more detail and introduce key factors which I believe are the most important to arrive at a coherent sense of immersion's various definitions. Please keep in mind, the elements which will be discussed are not required all together but can be selectively usable.

2.5.1 Bodily Interaction

In immersive works, people's bodies become the main media triggering the creation of interactivity and immersion. So I include "bodily interaction" as one of the key factors for immersive projects. Once the senses reach a sufficient belief that the digital environment is real, the user must then be able to interact with the environment in a natural, intuitive manner. Various immersive technologies such as gestural controls, motion tracking, and computer vision respond to the user's actions and movements.

Merleau-Ponty's philosophy considers the human body as the centre of the experiential world. Inside of immersive environments, in spite of the dominance of vision, bodily movement can be represented by people's touch which becomes a very powerful means of communication. Juhani Pallasmaa (2005) states that eyes can touch; the gaze implies an unconscious touch, bodily mimesis and identification. Martin Jay remarks that we touch the sun and the stars through vision when describing Merleau-Ponty's philosophy of the senses (Vogelaar, 2005).

[31] http://www.jr-soto.com/fset_sonoeuvre_uk.html

When hands touch artworks, they make intimate connections. The tactile sense is significant for our experience and understanding of the world. Hands bring us knowledge of the world. Hands feel. They probe. They practice. They give us sense. Hands also discover. They have a life of their own that leads them into explorations. They don't just hold: they grasp, they pinch, they press, they guide. They pick up experience (McCullough, 1996).

Although touch sense may be the most intriguing sense of creating immersion, touch works with other senses and creates synthesized experience. Also there is an experiential quality that is not just a sum of visual, tactile and audible senses. People perceive in a total way with their whole being (Vogelaar, 2005).

2.5.2 Immersive Consciousness

Generally, art has used traditional media (e.g. painting, literature, music, etc.) to connect with consciousness, but technological developments (like VR) create unprecedented conditions and open up new opportunities. New digital virtuality permits three-dimensionality, interactivity, immersion and multi-media phenomena. This invites us to wonder about the potential forms of consciousness that may arise from these technological opportunities (Bermudez, 1999).

Nechvatal illustrates immersive consciousness focusing on aesthetic perception of the immersive aspect of virtual reality in his PhD dissertation. He acknowledges that aesthetic immersion fosters Kendall Walton's theory of make-believe and immersive art invites "self-modification via the immersant's participation in the creative process" (Nechvatal, 2009, p.25). According to Nechvatal, "immersion's ideal of a 360° display offers the immersant an internal experience by re-locating inner being within the enclosed environment" (p.30). Immersive consciousness is "a cognitive challenge to our habitual senses, a challenge to find the possible cognitive-visual resources to deal with the expended context of immersive art's excess" (p.30).

When people experience immersive art, they can fall into a dream-like state of consciousness quite different from normative cognitive processes. In interactive art, however, they are often required to be involved in changing consciousness. This state can be described as a transcendent state of consciousness, a hypnagogic or reverie state of mind or a subliminal state of awe evoked by the spectacle of the situation's spatial elements. Research

on immersion is therefore concerned with exploring human spatial cognition and consciousness. It questions how people continuously create and update their sense of the space that surrounds and engages them (McRobert, 1999). Nechvatal defines this as a "transmissible hyper-state" that exceeds, transcends and overwhelms our original inner state. In immersive art, according to Nechvatal, the audience often experiences two different grades: cocooning and expanding. Nechvatal states that transmissible hyper-state is only possible when the two fundamental grades of immersive sensibility cooperate. When the two directions of perception connect and integrate within a vast, synthetic, aesthetic, immersive world, audiences feel a subliminal and immersive state. Nechvatal also points out that within immersive arts, immersants may attempt to break out of their architectural bodily constraints through virtual reality. The capability of navigating virtual worlds through 360° displays saturates their perceptual and mental states and expands their "private adaptability" (Nechvatal, 2009). Nechvatal is an artist and writer who talks about immersive consciousness intensively; his writing is based on his artistic and philosophical implications. His research led me to build my own perspective of a participant's immersive consciousness.

2.5.3 Mind/Body Relationship

The immersive experience is sometimes interpreted as an out-of-body experience, and as such it perpetuates the persistent Christian-Cartesian split between mind and body (Penny, 1995).

However a user immersed in a VR art installation negotiates new experiences that weave thoughts from the mind and body together with emotion and physical sensation (D. E. Eber, 2001). Experience in physically immersive environments can be said to be flows of energy from the external phenomena of the installation through a tactile surface of the artwork touching the skin or perceived by the sense to the internal body of the audience. The concept of flow is based on the recognition that ambient but invisible forces, like latent energy surrounding us, fill us up and give us life (Suzuki, et al., 2002). Life has boundaries like the boundary where the sea meets the land, gaps in-between external elements and internal elements, between perceptive faculties and interiors which co-exist and share energy. These abstract and tangible boundaries can be considered as interfaces between the body

and work or the body and the world. Adding to Eber's idea, I understand that immersion is ideally a phenomenological state between environment and human where the mental and physical merge like seashore and body and mind fuse in shared fluid energy.

In Asian philosophy, 'Ki (Chi or Qi in Chinese)' most often translated as air or breath and, by extension, life force or spiritual energy that is part of everything that exists[32]. People believe that Ki circulates in channels within the body. Ki works like light. In addition, Ki is known to travel between bodies and between body and environment. Through this journey, Ki is believed to create balance between the forms it passes through. This mystical phenomenon is relevant and offers insights to understand the sense of immersion. In many ways, it seems to parallel Merleau-Ponty's notion of Chiasmic, reversibility: self and world are chiasmically intertwined. Both ideas help to define how I understand and pursue immersion in my research.

[32] http://www.wikipedia.org

3: PRELIMINARY PROJECTS

Before I delve into my dissertation project, *Light Strings*, I would like to introduce two previous projects, *Sky Reverie* and *nite_aura*, that share an artistic concept, interactive technology and many other aspects. This emphasizes that *Light Strings* does not stand alone. Rather it is an outcome of cumulative and iterative knowledge building and experience gathering based on all my previous research. *Sky Reverie* worked as a first conceptual & technical realization of my artistic intention. While I was creating *Sky Reverie*, I was drawn to exploring the notion of an enveloping spatial quality, building an interactive system and experimenting with the material qualities of light. *nite_aura* expanded my research inquiry into the aesthetic qualities of immersive experience. In addition, I was able to use fiber optic lights to examine the tactile qualities of light. Through journaling and documenting all the processes of creation, I was able to embody art as research.

3.1 *Sky Reverie*

Sky Reverie[33] is an immersive environmental installation created in 2004. *Sky Reverie* is an inflated cloud-like translucent plastic structure that is large enough for human occupants. The shape represents an imaginary natural sky environment which people can easily identify with from their daily lives and dreams. In this piece, natural elements (sky, stars, and air) are used as the inspiration for an immersive interactive world. Inside of the cloud, an intimate zone is created by the play of LEDs and stars projected on the inflatable's inner surface. The *Sky Reverie* immersive space invites visitors to explore contemplatively. People do not need to look for anything specific. It just gives people access to a natural experience. The piece is intended to evoke memories and imagination through interacting with spatial elements.

[33] http://immersion.iat.sfu.ca/?p=278

Figure 18. A participant touching *Sky Reverie* outside

In *Sky Reverie*, physical body movement is an important factor for being immersed or engaged. Visitors are encouraged through subtle responsive cues to physically play with the swarm of stars projected on the interior of the huge inflated plastic cloud. When visitors stretch their hands up inside of the cloud, as if whispering their hopes to the sky, hundreds of star images fall into line to create a constellation triggered by fluctuations of viewers' shadows.

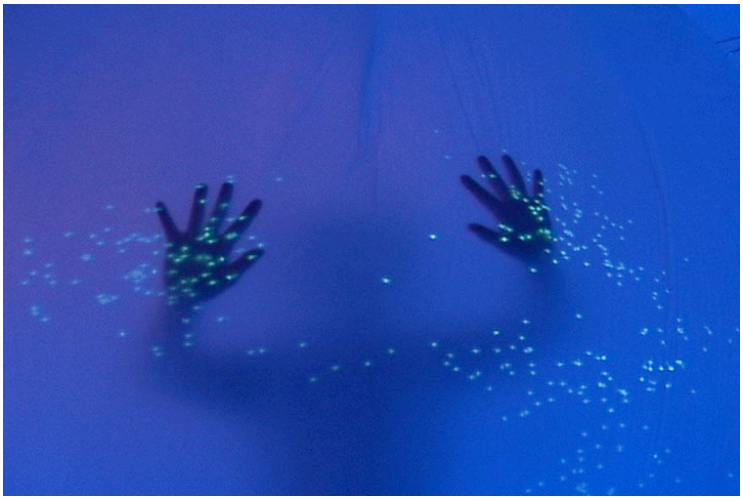


Figure 19. Projected star images create constellations around a participant's shadow

Meanwhile a profusion of blue LEDs which reacts to visitors' movements facilitates people's immersion into an atmospheric celestial ambience. James B. Steeves writes that experience is received not only with the mind, but with the body as well. Traversing through physical space invites sensorial expectation and creates immersive and seductive states of tactile presence and connectedness (Steeves, 2004).

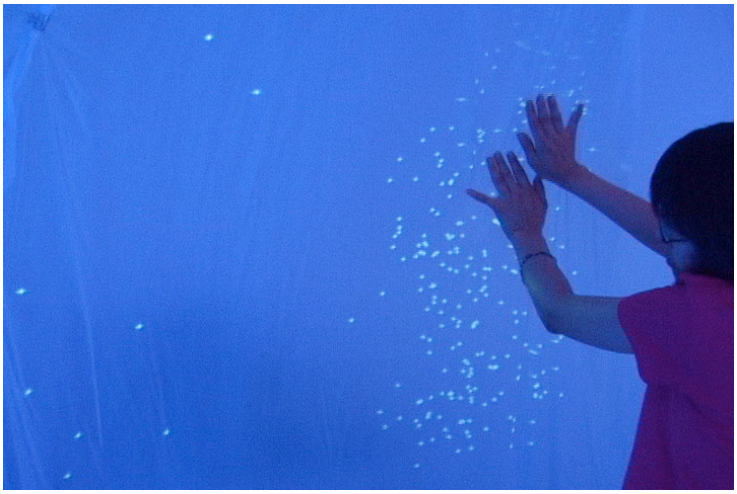


Figure 20. A participant touches *Sky Reverie* interacting with stars

Based on the spatial cues, visitors can learn how to touch and experience the piece. The piece requires people's soft touches or caresses. This reinforced action (soft touch) drives people to explore reveries and mental material that are normally buried in the subconscious.

The piece's fluorescent-driven blue and purple haze serves as, in author Patricia Troyer's words, "primal substance, tangible but intangible at the same time, one that transforms the visitors experience into a kind of extension of self into the sphere of the greater universe." The translucent plastic used in its fabrication relates to the notion of the permeability of boundaries and space. This is also evoked in Miyazaki's heart-felt film, *Kiki's Delivery Service,* when, with halcyon dreams of lush growth in their garden, kids and pets exuberantly lift their hands from knees to air. Numerous rituals from earlier cultures involve gestures of reaching for the sky to solicit abundance and power beyond the indifferent vicissitudes of nature.

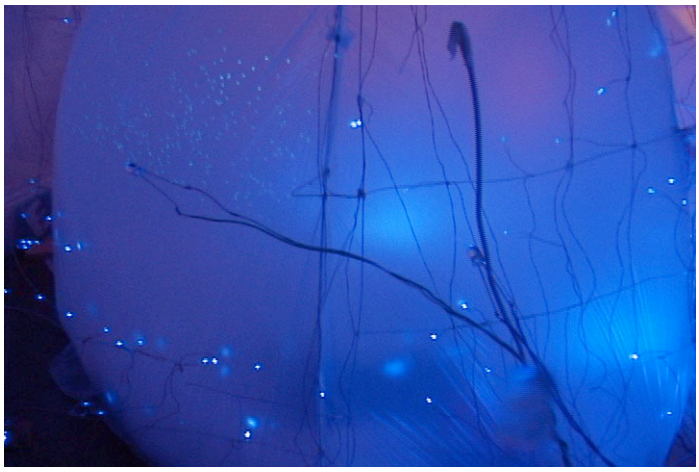


Figure 21. Blue LEDs create interactive lights around the inner *Sky Reverie*

To symbolically represent 'flow of energy' in *Sky Reverie*, I utilized air and light. The structure is kept inflated using forced air; forced air paradoxically suggests a sense of openness and formlessness within a contained small space. In classical symbology, air and sky have significant meanings. Air is considered to be a space for rational human thought and imagination; sky is the immeasurable and endless (Steeves, 2004). In the installation, lights have life-cycles. They are continuously turned on and off. This is their birth-death cycle. This is their story. The lights' activity resembles an archetypal interior human conception of life and death; the LEDs' life-death cycle similarity to the archetype of life-death is intended to elicit in the viewer an intimate encounter with the viewer's own story, life, dreams, and memories within themselves.

Figure 22. A participant in the inner chamber of *Sky Reverie*

3.1.1 Creation

3.1.1.1 Cloud

Sky Reverie's inflatable structure was made out of many sheets of translucent plastic[34]. They were tailored and attached together with a portable electronic plastic sealer. To create a bubble structure for *Sky Reverie*, two roles of 3M masking film (144in. x 60 ft.) were used. The attached plastic was inflated by two box fans (20in. x 20in.) intended for general home use. One keeps the inner structure inflated and the other works on the outer shell.

3.1.1.2 Interactive Constellation System

When the participant touches or caresses the inner surface of *Sky Reverie*, a web camera captures participants' movements, mainly consisting of hand movements. A Processing[35] application takes the movement data and generates constellations on the screen. This star imagery is projected on the inner surface of *Sky Reverie* where the participant is touching. Therefore the participant can see interactive constellations wherever they touch and be engaged through the interaction.

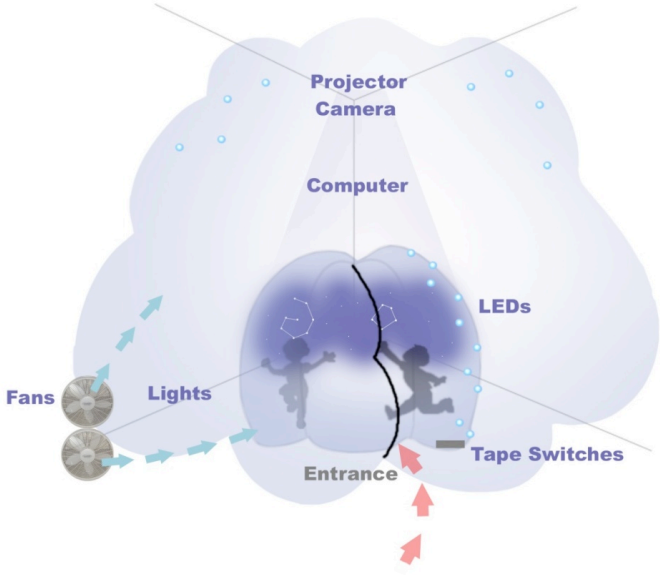


Figure 23. *Sky Reverie* System Illustration

[34] 3M™ Hand Masker™ Pre-Folded Masking Film
[35] http://processing.org/

In this piece, I offered participants a full-scale experience of immersion that includes the important factors in defining 'immersion' in a new, contemplative, yet embodied and active way. When I created *Sky Reverie*, I focused on my artistic exploration to create an immersive installation and interactive constellation system. However, while I was creating and exhibiting it in a gallery, I found interesting qualities of immersion in the participant and myself. The most common feedback that I had from the participant was "I want to have this at home, can you install this for me?" Why does this question occur to the participant? This response inspired me to pursue research on immersion and conduct material explorations in my PhD research.

3.2 *nite_aura*

My second preliminary project was *nite_aura*[36]: an audio-visual, interactive installation exploring visuality, sound, and materiality through motion within an immersive environment. This project was done collaboration with a sound artist, Greg Corness. His main role was creating an interactive sound system for the piece. However, we worked together throughout the process. From environment design to interaction design, we had many discussions and came up with iterative outcomes. In this way, we were able to have all components integrated well into a whole piece.

Many children imagine themselves flying through a night sky full of stars and often whisper wishes to the stars. *nite_aura* embodies these memories and experiences allowing for visitors to whisper to the air and play with fields of stars surrounding them. In this project, we tried to create an interactive immersive art project focusing on sensual and physical interaction with audio and visual aspects. The work investigates the effect of the texture of space, light and sound in providing a comforting, relaxed immersion.

[36] http://immersion.iat.sfu.ca/?p=35

Figure 24. *nite_aura* exterior

3.2.1 Design Concept

3.2.1.1 Space

In this project, I focused on what kind of enclosed or enveloping space will enhance immersion and the aesthetic experience in the work. I examined different types of spaces and different coverage of our peripheral vision. From my experience in *Sky Reverie*, it seems that being physically enclosed really helps the participant to feel immersed. Figure 25 & 26 show the ideation process of the space design.

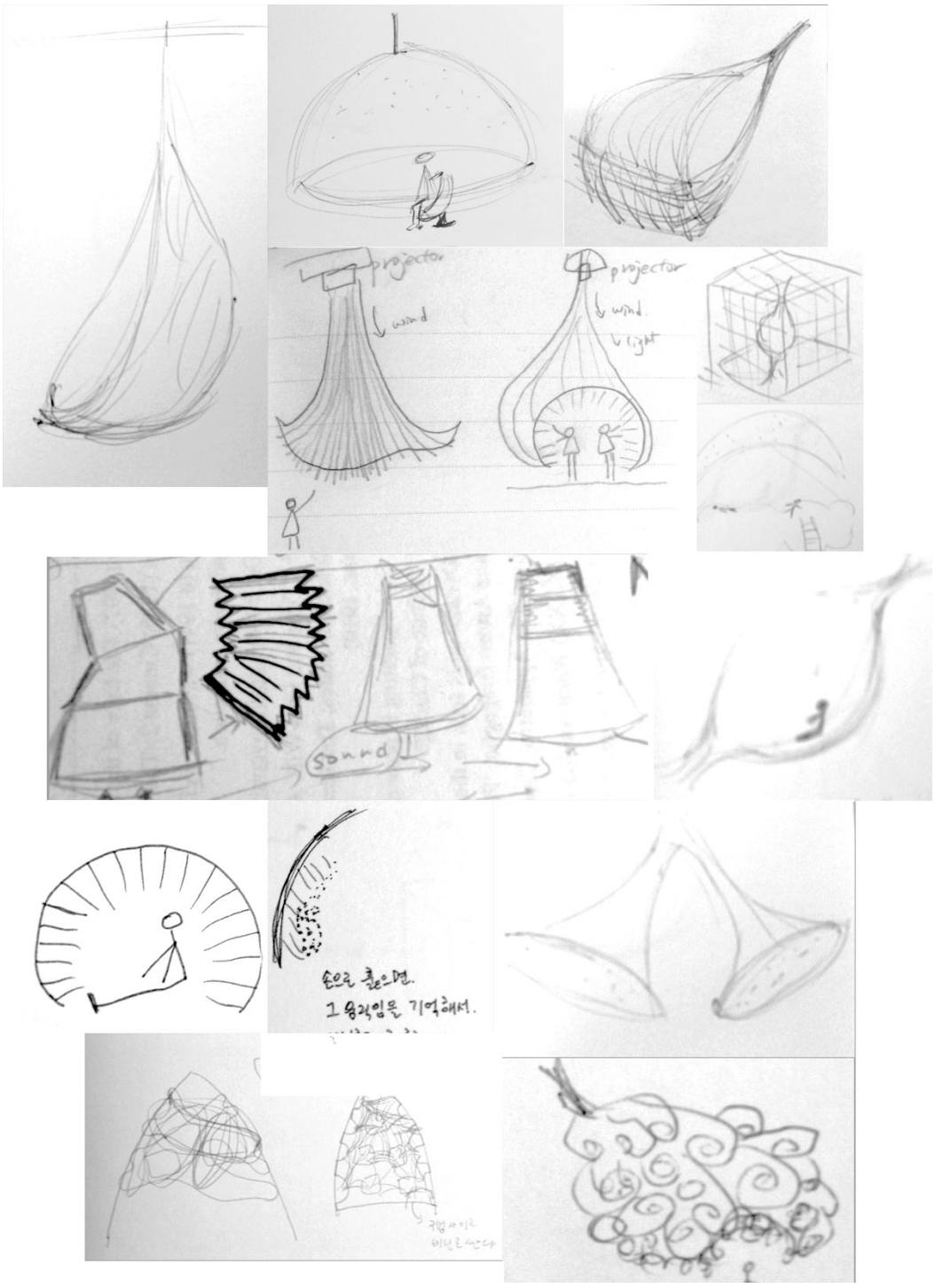


Figure 25. Ideation Sketches I

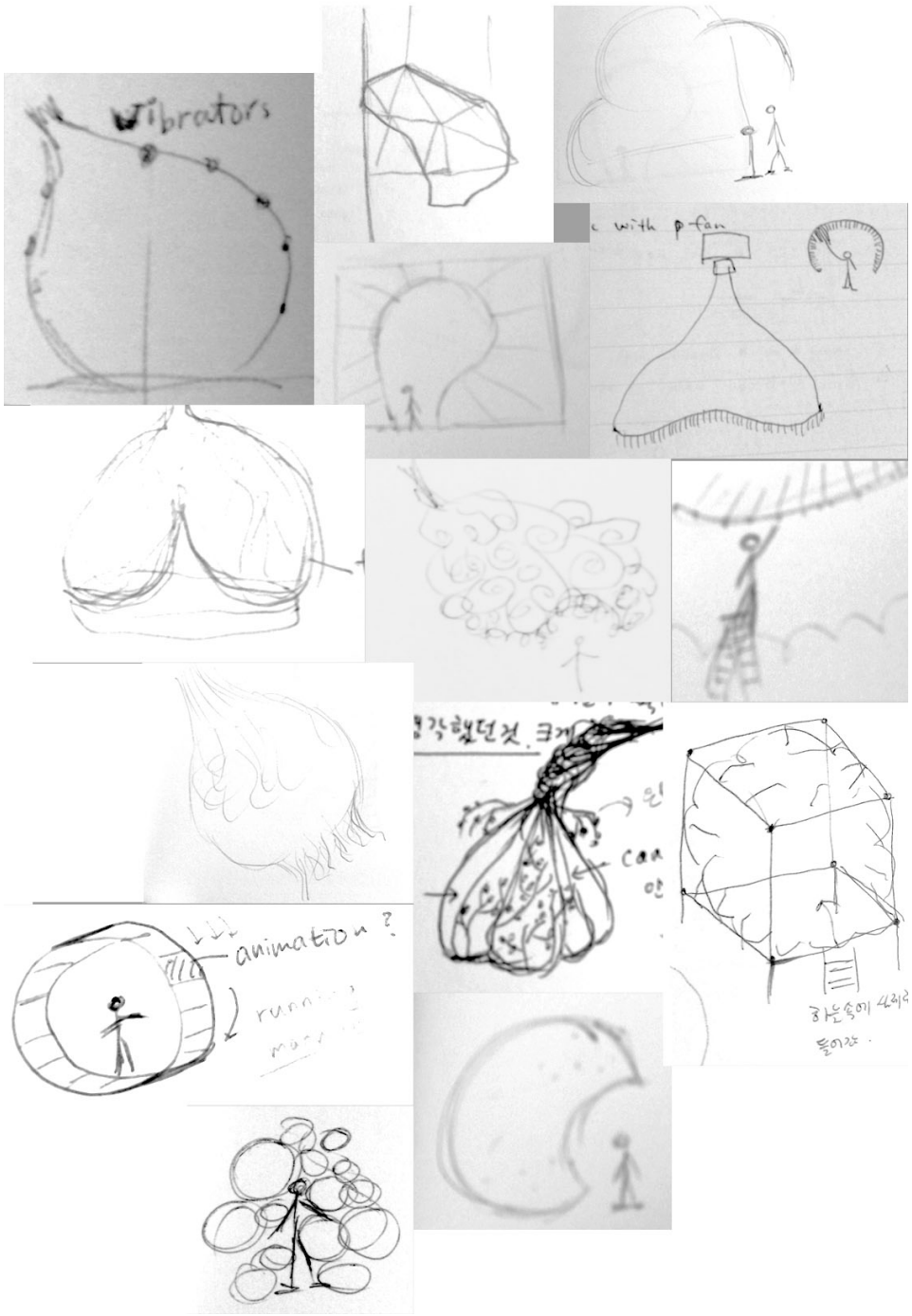


Figure 26. Ideation sketches II

The overall shape of the space, a bell or skirt shape, is an experiment in the effect of shape on immersion. The fluted bottom provides the entrance to the environment. Once

inside there is an awareness of a constriction towards the top. We chose a diameter for the space that produces this sensation while not impeding the interaction.

Figure 27. Entering *nite_aura*

Users inside the structure may physically engage with the structure's motion by pulling on ropes attached to the top of the structure as one would pull on a rope to ring a church bell. This organic motion provides the basic vocabulary for the phrasing of the user's engagement. This motion encourages a harmonic engagement with the environment. The user may instead allow the structure to settle and experience the environment in a more contemplative mode, experiencing the visceral textures of light, sound and fabric. The design of the environment allows the user to more passively experience the effect of their presence in the space.

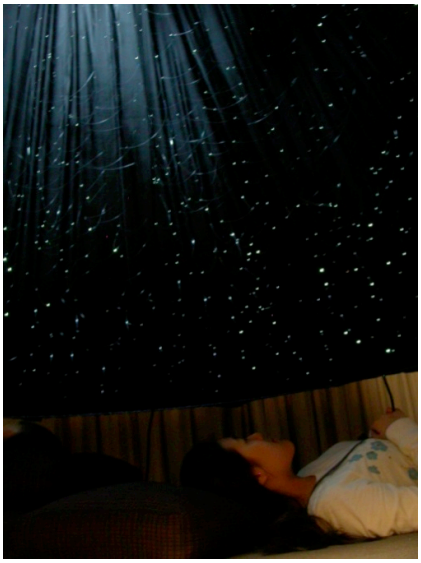


Figure 28. A participant being relaxed in *nite_aura*

3.2.1.2 Light as Space

Along with the shape experiments for *nite_aura*, I have been keen to explore different materials to create an interesting, constellation-like, illuminating texture. From the beginning of the project, light was the most important component because simple lights represents very limited information but should be compelling for people to touch and interact with. Moreover, light was integrated as a part of the structure, creating a space with lights that people can physically feel, like a dream space. For this reason, I did not consider to use stationary, flat, and untouchable lights for *nite_aura*.

I was looking for a unique light source that utilizes similar interaction to *Sky Reverie*'s visual system and provides tactility. I was inspired by many interactive wearable projects that have glowing patterns using fiber optics. It seemed that their material quality was congruent with my artistic intention. Fiber optics are long, transparent strands that can transmit light. The light is emitted through an opening at the end of the strand, creating a very small point of light and at the same time light is visible through the length of the tube. Given the physical flexibility of the product, fiber optics are widely used to create lighting effect for unusual, flexible surfaces. Touching and interacting with lights in the installations were perceived very differently than in natural spaces under sun light. Some configurations of artificial lighting can cause mysterious visual hallucinations and an alteration in consciousness; this is something that humans have known ever since the discovery of fire (McRobert, 1999).

3.2.1.3 Interaction

nite_aura may not look like a welcoming environment from outside because there is no obvious entrance and the space is dark. However, the participant can hear some sounds and see a subtle glow from inside of it. At first, participants tend to creep down and peer inside. Most of them become very astonished by the fiber optic lights filling the space. They enter the structure and find enough room to stand and touch the lights.

Figure 29. A participant touching fiber optic lights inside of *nite_aura*

The basic structure is a cloth bell hanging from a single point, which allows the structure to swing freely when the users pull ropes tied to the metal frame that contains the lighting and sensing equipment. An accelerometer attached to the top of the structure tracks the motion of the structure and relays the information to a computer. In response, the computer creates and sends manipulated light and sound patterns.

Figure 30. A participant playing with ropes to control *nite_aura*

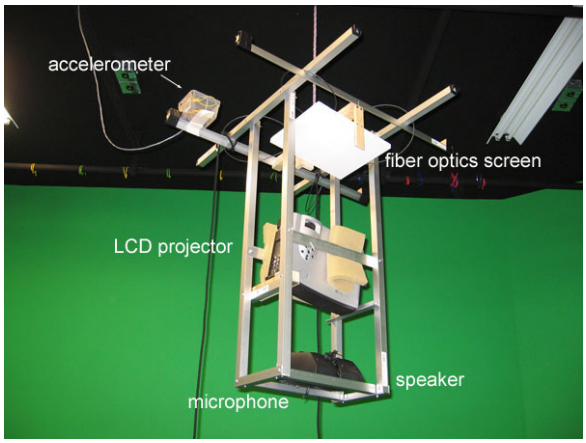


Figure 31. structure for electronics in *nite_aura*

The information from the accelerometer relates to the motion of the space. This is used to morph an abstract color shape generated by a computer. The animated color pattern is projected on a tight matrix of fiber optics. The tight matrix of fiber optics then breaks out around the outside of the structure. Each individual strands then pierces back in through the fabric making the light tip visible to the user on the inside. The effect is that of constellations of light specks covering the walls of the environment, enveloping the user. The animated color shifts are perceived as pixelated, shifting textures like twinkling stars or the firing of synapses in some imagined consciousness.

The sound texture parallels the light texture in concept. Granular synthesis techniques are used to morph sounds recorded in the space into abstract memories of being. Microphones around the surface of the structure and in the middle of the structure record sounds produced in the space to several buffers. Highly directional microphones are used to focus on the user's sound and minimize the extent to which the playback sound is rerecorded. Sound detection algorithms are used to further privilege the user's sound and reduce the amount of dead space in the recordings. On playback, the buffers are cut into sound grains 30 – 80 ms in length. These grains are played back and mixed with grains from other buffers to varying degrees. This technique allows the sounds to morph in timbre and time while still retaining some semblance of their original structure. The effect varies from recognizable voices and words to abstract night sounds of animal chirps and the crackling of fire. The sound texture is then further embodied within the space by applying a set of resonating filters tuned to mimic the resonance of a large bell. The recognition of the vocal

textures suggests to the user that their presence is having some effect and yet they do not need to be actively involved.

My short-term goal for this project was to observe users' experience in order to gain insight into whether such an experience becomes immersive, while my long term goal was to understand the effect of the shape of a space on the sense of immersion.

3.2.2 Experience of *nite_aura*

Through several exhibitions and presentations, I was able to observe and hear about participant experience. *nite_aura* was exposed at different places: NIME art show, Surrey Art Gallery, Vancouver Science World and labs at Simon Fraser Univerisity. The participants' experiences collected from unofficial observation and conversation were quite similar across different venues, ages, and occupations. Rather there was a tendency to show different qualities of experience depending on the number of people in the environment. When there was only one person in *nite_aura*, the space inside of *nite_aura* became a quiet and meditative space. Participants played with ropes to create different constellation patterns but didn't make sound to interactive with the sound system. The environment was illuminated with thousands of fiber optic light points waving by movement of the structure. The participants set on the floor or laid down mainly looking at lights. Their experience time was various but many participants liked staying long. After their experience, many participants talked to me that they saw stars and the visual effect made them very calm and relaxed. The quality of those experiences was rather contemplative and meditative. This was also observed when there were two or more people together.

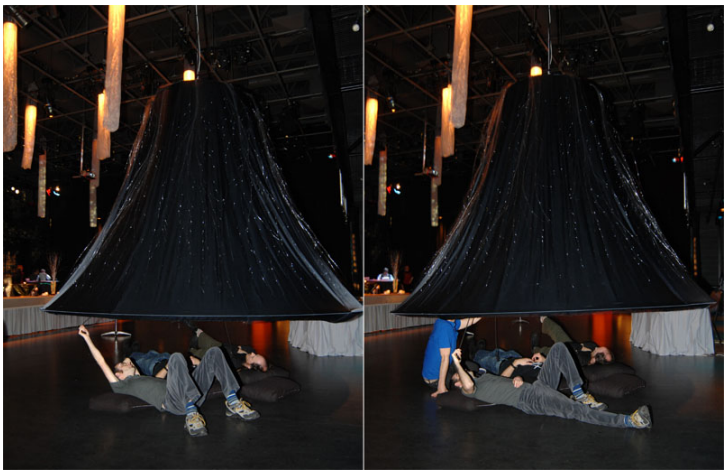


Figure 32. Participants in *nite_aura* in Surrey Art Gallery

nite_aura sometimes turned to a very playful space to participants. The installation elicited physical interaction with multimedia elements (visual, sound, and tactile). Participants touched fiber optics with the hands, made noise to create responsive sounds, and pulled the ropes to swing the entire structure. When *nite_aura* was exhibited in NIME (New Interfaces for Musical Expression) conference in 2007, some participants played a guitar and sang inside of the environment. The sound created by the participant was nicely blended with the interactive sound processed by computer and created an active sound space. Many people around the installation entered after they heard the sound.

Another interesting characteristics from the participants' experience was that *nite_aura* invited people to emerging conversation. Participants crawled down to the piece often started a new conversation related to the art work. They talked about their childhood memory, past experience, and book stories. The space became a living narrative space.

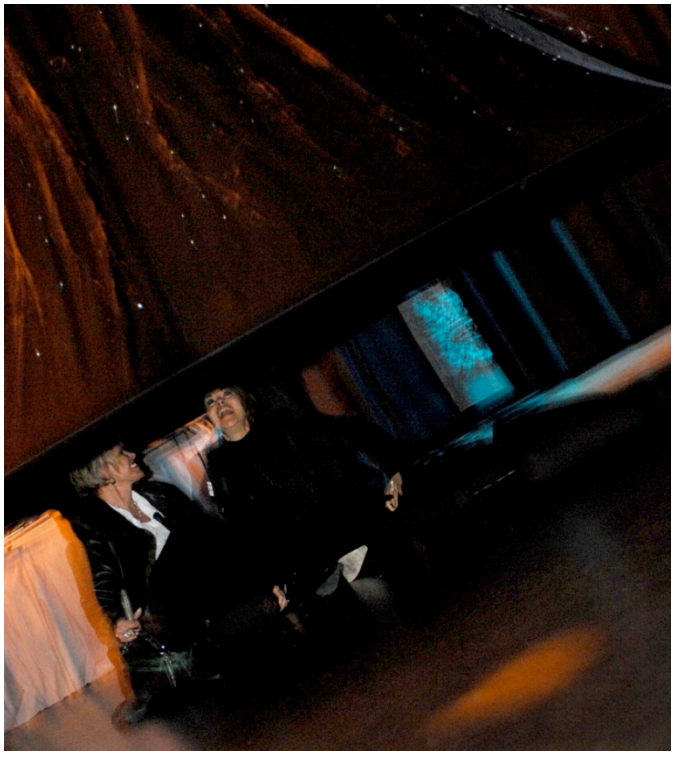


Figure 33. Participants in *nite_aura* in Surrey Art Gallery

4: METHODOLOGICAL BACKGROUND

"…we understand and become aware of our research activities as telling ourselves a story about ourselves…"

(Slater, 1992)

4.1 Research Paradigm Shift

Research has been dominated in the last hundred years or more by the scientific method also known as positivist or quantitative research. Its emphasis is on objectivity, measurement and validity (Campbell, 2005). However in the dominance of positivism has been challenged. An increase in qualitative research inquiry and a dissatisfaction with using scientific research methods in the humanities, social sciences and education have led the development of a variety of methodologies called 'post-positivist.' In these methodologies, the way knowledge is created and understood places value in research focusing on individual experiences, subjective qualities, and processes (Creswell, 2003).

Research into immersion follows a similar trend. Much of it focuses on scientifically verifiable ideas such as: "What makes immersive environments work?" or "How is it possible to build virtual environments such that people respond to differing forms of media and interaction techniques within them?" Most scientists explore factors that affect the immersive experience by using scientific research methods, as would be expected. For

example, various physiological responses were measured in much of Slater's studies. He and his collaborators created a virtual environment that illustrates a bar scenario. During the participant experience sessions, physiological data was measured, including electrocardiagram (ECG) and galvanic skin response (GSR). The heart rate, the heart rate variability, and the event-related heart rate changes were calculated from the acquired ECG data. In the study, the physiological data shows differences in different conditions: a training and an experimental phase. In addition, it varied depending on the participant's social anxiety level, as measured by a questionnaire completed in a prior session (Slater, et al., 2006). In other studies, a number of subjects were asked to fill out questionnaires about their experience in VR spaces and the results were analyzed statistically (Barfield & Furness, 1995; Slater, et al., 2006; Slater & Usoh, 1993, 1994). Some researchers studied the correlation between different types of data of the participant's experience using scientific triangulation methods.

However, since many scientific methods require focusing on a constrained condition and limiting the set of variables as much as possible, studies about immersion prove to be difficult, especially in the subjective realms of art research and practice.

4.2 Developed from Process

Similar to the shift in traditional research, art has been acknowledged as research among practitioners, theorists, and educators (Schön, 1983). In contrast to academic and scientific research emphasizing the generalizability and repeatability of knowledge, art research expresses a form of experience-based knowledge (Sullivan, 2005) and explores subjective qualities of experience.

In the terms of Frayling, there are three types of art as research:

First, there is research on the art, which he labels as "research into art and design." This category represents traditional theoretically oriented research such as art history, art education, and musicology (Elkins, 2009). There is a tendency to distinguish this theoretical research from artists' professional knowledge. In other words, the artist creates artworks

embodying their artistic questions, ideas, and intentions, whereas the theorists use words as the vehicle to convey their interpretations about art.

Second, there is research in the arts, which Frayling describes as "research through art." This category includes all artistic research that aims at exploring a certain practice or examining aesthetic experience through process. The value of art is not only about final artefacts. The importance of art practice has been emphasized through an experimental, laboratory-style environment, exploring novel forms of knowledge and experience (Elkins, 2009).

Third, Frayling describes the practice of "research for art." This notion refers to research that emphasizes producing a particular artwork. This includes concluding technical or material research in order to create art. In current higher education of art, this is often not considered to be academic research.

Similar to Frayling and other researchers (Sullivan, 2005), I believe that artists identify researchable problems discovered in practice, and respond or solve them through professional practice. Therefore, artists know their works and the questions around the works better than any other researchers. An artist is a researcher who has multifaceted roles: material experimenter, space designer, fabricator, critic, documenter and audience (Gray & Malins, 2008). In other words, it is ideal that artists take a lead role in the research of their works, rather than being separated from the research process. In that respect, artists' research activities seem to be appropriate for Baumgarten's classical definition of the aesthetic domain.

In general, art is an artist's unique and aesthetic expression, imposing particular and embodied knowledge. Even though art is considered as research, it is widely known that artistic research cannot easily be generalized into a well-defined methodology. Rather, it entails a strong belief that the methodology should be flexible, transparent, and transferable via communicate with others. According to Gary & Malins (2008), artistic research material may not be repeatable, but can be made accessible for communication and shared understanding. From these basic philosophical positions, it is clear that an artist's attitude to research should be eclectic, diverse, open and creative in the methodologies that are adopted and utilized. It is often characterized that artists develop research methods based on their artworks or processes. They are capable of tailoring different research methods to the

individual projects. This has involved the use of multiple media to integrate visual, tactile, kinaesthetic, experiential data into rich data.

The recent interdisciplinary research culture makes it possible to expand art research into collaborations with other disciplines. As long as artists hold an outward-looking attitude and an awareness of other research cultures and paradigms, dynamic and creative artistic research methods will provide unique perspectives different from traditional research. It will be beneficial to have research methods that are responsive and driven by the demands of practice (Gray & Malins, 2008).

4.3 Phenomenological Approach

As an artist and researcher, I have been looking for an appropriate research method that can help me to frame my research and to investigate the aesthetic properties of participant experience. I wanted a research method that allowed me to pursue a creative, artistic research strategy. After I studied different qualitative research methods and considered my cultural and philosophical background, the phenomenological research approach seemed to provide the best vision for my research.

Phenomenology is rooted in early 20th century European philosophy originating with G.W.F. Hegel and developed by the German philosophers Edmund Husserl and Martin Heidegger, and French phenomenologist Maurice Merleau-Ponty. Since the 1990's, phenomenology has been adopted by different scholars as an alternative way of exploring interdisciplinary knowledge undiscovered by scientific research methods. Phenomenology has opened the potential to research almost any phenomenon regarding to lived human experience (Campbell, 2005). It provides a thematic and reflective approach to the core qualities of human experience.

To investigate the sense of immersion created by my art works, along with the inextricable and varied experiences that the participants have and describe, I have selected a specific research method: Maurice Merleau-Ponty's existential phenomenology as followed by Francisco Varela and other phenomenologists. Phenomenology, in Merleau-Ponty's interpretation, is a philosophical view to a research. It has been considered an interpretive

study of human experience because phenomenology involves the tradition of "thick" description and the close analysis of lived experience to understand the meanings and qualities of human experience through embodied perception (R. Sokolowski, 2000). Its common aim is to examine and clarify human situations, events, and experience "as they spontaneously occur in the course of daily life" (Von Echartsberg, 1998, p.3). Merleau-Ponty's phenomenological method is valuable and meaningful for research concerning immersive experience precisely because it accounts for subjective first-person experience focusing on bodily experience in relation to the world. Through close investigation of human experience, phenomenological researchers seek to find the meaning and common qualities of the essence of an experience or event. In phenomenology, real knowledge is understood through embodied experience in space and time (Starks & Trinidad, 2007). We experience the same things differently based on individual experience of being embodied in time and space. This is different from the third-person access found in typical quantitative research methods, which focus on external behavioural or physiological studies.

In the realm of art research, there has not been much work dealing with research methods because artists' interests often lean more towards creating new works than investigating the aesthetic qualities and meanings of participant experience. However recent movements in interactive art indicate that some interactive artists put value on the qualities and meanings of participant's experience with their works as well as the process of artistic creation. Phenomenology, especially as contained in Merleau-Ponty's work, has been acknowledged as an appropriate research method by contemporary new media artists.

Joseph Nechvatal (1999) and Char Davies (2005) described that phenomenological research is necessary for Interactive Art research in their dissertations. However, Nechvatal focused on the philosophical implications on immersion and Davies concentrated on her artistic practices. They did not conduct phenomenological studies with their participants. Recently, there are three artists who have approached their research with phenomenological research methods. In 2007, Diane Gromala used phenomenological methods in her doctoral thesis, *Towards a Phenomenological Theory of the Visceral in the Interactive Arts,* focusing on descriptive analysis combined with empirical research methods (Gromala, 2005). Susan Kozel used first-person methodology in her book, *Closer: Performance, Technologies, Phenomenology*. She applied phenomenological methods to designing experiences in various

computational contexts: telematics, motion capture, responsive architectures, and wearable computing (Kozel, 2008). Interactive media artist, Thecla Schiphorst considers phenomenology as a research method in her research rooted in somatics. In her dissertation, *The Varieties of User Experience: Bridging Embodied Methodologies from Somatics and Performance to Human Computer Interaction*, she claims that recent interdisciplinary contributions to Human Computer Interaction (HCI) include the knowledge-rich domains of somatics and performance that carry long-standing traditions of embodied practice along with phenomenology, cognitive science, psychology and the arts. She explored phenomenological methods in her artistic explorations illustrating how artistically led phenomenological research can contribute to technology design within HCI (Schiphorst, 2008). These research precedents helped to build my initial methodological understanding of the use of phenomenological lenses and to integrate phenomenological research with my art practice.

4.4 Phenomenological Research Methods

Though I already explained that I adopted Merleau-Ponty's existential phenomenology as my methodological foundation, it is important to acknowledge that Merleau-Ponty's phenomenology itself is not a method. It is a philosophical attitude to conducting research. When it is employed as a research method, researchers need to pay careful attention to establishing a research procedure including framing research questions and selecting participants as well as collecting and analyzing phenomenological data (Starks & Trinidad, 2007).

Early phenomenologists often separate researchers from the context of research using a bracketing method. However recent artists/researchers using phenomenological research methods accept that the researchers' perspectives cannot be denied but instead must be examined as part of their understanding and analysis (Fraleigh & Hanstein, 1999). McNamara (1999) points out that researchers are a composite of their unique personal experiences as well as their historical and socio-cultural situations. Therefore I will take into account my artistic and cultural background as part of my PhD research. It accounts for my first-hand, creative experience which is continuously influenced by the experiences of participants and provides a better understanding of the aesthetics of immersive experience.

Phenomenology is not a single method. Phenomenological methods have been adopted and developed in many disciplines and are being actively explored in Cognitive Science and Human Science including Nursing. Because of the nature of phenomenology, there are multiple interpretations and modifications of phenomenological philosophy and phenomenological research methodology. However the focus is always to get descriptions about subjective experience from the first-person perspective "in their fullest breadth and depth" (Spiegelberg, 1965).

In phenomenological research, the researcher's role is very important. In order to access other's experience, it is critical for researchers to explore their own experience of the phenomenon, as well as collecting intensive and exhaustive descriptions from participants. Moreover, the relationship with their participants is very important. The Vancouver School identifies participants as co-researchers and stresses "reverence for the co-researcher as a fellow human being and his or her lived experience" (Halldorsdottir, 2000b, p.58). The aim of this strategy is to build a harmonious relationship between researcher and co-researchers. This relationship will allow them to access intersubjective meanings (Schwandt, 1994). This is reciprocal relationship, where the researcher's questions may cause the co-researcher to reflect upon his or her experience and through this reflection a deeper understanding of the phenomenon may result. Conversely, the researcher may build a deeper understanding of the experience while listening to the co-researcher. In this collaborative and reciprocal situation, the researcher and the co-research are able to convey this understanding to each other (Halldorsdottir, 2000b).

In the data collection phase phenomenological research, first-person descriptions can be collected using journaling. For artists, journaling is often done during the process of art creation and experiencing the project. The first-person method is considered an example of what Schön refers to as "reflection-in-action" (Gray & Malins, 2008, p.22). Artists' journaling styles can be various, such as writing, drawing and photographing. The journaling process should be done without editing or censoring whenever an artist makes some progress on the work. In writing the experience, care is taken to focus on descriptive language and avoid statements of judgment, analysis or assumption (Kozel, 2008).

Varela and Shear (2002) suggest building connections between first-person descriptions and third-person studies using a second-person method as a mediation. In *The*

View From Within: First-person Approaches to the Study of Consciousness, they explore the efficacy of first-person practice and holistic views of blending first, second and third person practices.

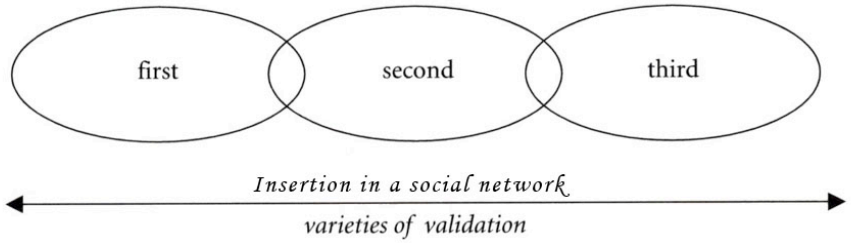


Figure 34. Validation Methods along the Continuum of a Social Network[37]

In this dissertation, I investigate participants' experiences from all perspectives: first, second and third person methods and triangulate them to find emerging meanings and qualities of the experience. The details of each method will be illustrated in Chapter 6.

In the analysis of phenomenological data, it is important that researchers immerse themselves in the data. This should be undertaken conscientiously with an open mind (Halldorsdottir, 2000b). Van Manen suggested that a final dimension of conducting research on the lived experience is "balancing the research context by considering parts and whole,….reaching equilibrium between the parts and the whole…." (Van Mane, 1990, p.33).

While scientific methodology requires a random sample as a validity measure and a large sample to ensure generalization, postpositivist research, including phenomenological methodologies requires neither (Green & Stinson, 1999). Phenomenological researchers are interested in investigating a specific context and may use particular small group samples. Kvale claims "the complexities of validating qualitative research need not be due to a weakness of qualitative methods, but, on the contrary, may rest upon their extraordinary power to reflect and conceptualize the nature of the phenomenon investigated, to capture the complexity of the social reality. The validation of qualitative research becomes intrinsically linked to the development of a theory of social reality" (Fraleigh & Hanstein, 1999, p.97). Some qualitative researchers reject the framework of validity that is commonly

[37] Varela, F. J., & Shear, J. (1999). First-Person Methodologies: What, Why, how? Journal of Consciousness Studies, 6(2-3), 1-14.

accepted in more quantitative research in the social sciences. Instead they suggest that qualitative researchers approach to validity by establishing that the results of qualitative research are credible or believable from the perspective of the participant in the research. Since from this perspective, the purpose of qualitative research is to describe or understand the phenomena of interest from the participant's eyes, the participants are the only ones who can legitimately judge the credibility of the results (M.K, 2006). Connecting views from continuous perspective will help ensure the validity and credibility of the results.

5: CREATING *LIGHT STRINGS*

5.1 Introduction

Based on my experience with preliminary projects and research, I created a new interactive immersive environment, entitled *Light Strings*[38]. I sought to explore a sense of immersion and embodied interaction through the body in close relation to mind and the world, resonating Merleau-Ponty's philosophy. The intent of *Light Strings*[39] was not creating a space that replicated a small scale of nature that suggested people to get immersed and relaxed. I intended to create a noble experience that allowed participants to become physically immersed while surrounded by a flexible and dynamic environment and to interact with embodied computer mediated virtual agents in the space. *Light Strings* provides a possible moment and a space that evokes immersive consciousness and creates meaningful experiences.

Even though the art installation itself conveys artistic ideas and values, the participants are the most important components of this project. In my opinion, interactive art cannot be completed without participants and it is hard to find the meanings of the work without considering the participant's experience. As I have been interested in creating immersive experience and exploring the qualities of experience with my artwork, I conducted a case study with *Light Strings* using phenomenological research methods. In this research, I investigate participants' experiences and study the aesthetic properties of their immersive experiences. Moreover, I examine how the artist's intention transfers to the participants' experience and how the artist and the participants construct a collaborative meaning around the artwork. This chapter describes the concept of *Light Strings* and the implementation process.

[38] This project is a collaboration project with Greg Corness, Diane Gromala, Thecla Schiphorst, funded by ITST, SSHRC from 2008 to 2010.

[39] Project website, http://immersion.iat.sfu.ca/?p=232

5.2 Concept

Light Strings shares artistic concepts and ideas with my previous projects, *Sky Reverie* and *nite_aura* as described in Chapter 3. As my practice-based research is built through an iterative process, experiential concepts, artistic techniques, and computational components have been developed through the previous projects.

5.2.1 Bodily Experience

The idea of considering the body as a main felt medium inspired by phenomenologists, Merleau-Ponty, Varela, and Johnson has been a strong motivation for me to create interactive environmental works. Treating "Body" as not separated from the being who experiences an interactive work was critical while I developed my ideas of immersion. In other words, I avoided disembodied immersion that focused on mental stimulation in virtual environments. In *Light Strings*, bodily and sensorial aspects of the immersive experience were emphasized as one of the key properties of immersion. The participant's body connects to the physical and virtual world through movement. Movement that occurs within an environment makes intimate connections and interactions with aspects of that environment. Movement keeps us in touch with our world in the most intimate way (Johnson, 2007). According to Noë (2005), what we perceive is determined by what we do.

In the preliminary projects, *Sky Reverie* and *nite_aura* there were some elements that provoked bodily movement. The participant's physical engagement with the environment was almost required in order to see the works. In *Sky Reverie*, participants were required to enter a chamber through an entrance within an inflatable structure. To get in they have to be touched. On the walls of the chamber, there were interactive constellations that shaped in response to a participant's shadow. In *nite_aura*, participants were required to crawl into the space unless they lifted the rim of the bottom structure. Once they entered, there were able to play with the interactive constellations by pulling the ropes and with the interactive sound system by making noise.

From both projects, I learned that this bodily interaction was somewhat disconnected from what participants usually do in the environments. *Sky Reverie* provided a cozy and soft space that most participants wanted to sit down and relax. To interact with visuals, participants had to break their immersive/relaxed state and stand up because of the

constraints of technology. Only one wall was responsive and the size of interactive part was about 6 ft by 4 ft. In *nite_aura*, my focus was on how to connect participants and the environment. *nite_aura* also created a small space that people could sit and lie down in. Most of participants liked the playful or meditative aspects of the piece. Participants were able to see interactive lights by pulling the ropes when they were sitting or lying down. They liked touching the fiber optics, but that interaction was not fully integrated with other qualities of the experience.

Based on the lessons I learned from these previous projects, I built an immersive environment that makes an immediate connection to the body. There is no direct sensory mapping for interaction. Any kind of bodily movement affects the environment and computational system, creating unique but varied qualities. To pursue this concept, I focused on the creation of a physically immersive environment.

5.2.2 Physically Immersive Space

To create immersive space, many different technologies have been examined. It is known that a space that expands our peripheral vision is critical to creating a sense of being immersed. Many researchers and artists use HMDs because they provide a 360 degree view and the screen is linked to the head movement. However, it still limits navigating a space to only head movements. Usually an HMD is wired to a main control system. Other immersive screens (domes, caves, etc.) often offer more free body movement and interaction with the environment. There is still a separation perceived between virtual world and the participant's body, however. Most immersive techniques focus on visual stimulation, providing limited bodily interaction.

In *Light Strings*, I tried to create a physically embracing space that is flexible and open, and provides participants with free movement in the space. Participants and multimedia agents co-exist and meet in *Light Strings* through touching and using their whole bodies. Full freedom of physical body movement, creating relations to the physical installation and a virtual world is a critical condition of *Light Strings.*

As mentioned, *Light Strings*'s space is an outcome of iterative experiments with my previous projects. In *Sky Reverie*, I experimented with LED lights and worked on inflatable structures to create an enveloping, encompassing but buoyant space where the audience can

feel warm, safe, relaxed, and immersed. The bubble structure looked very light and organic from the outside and invited participants inside via a light touch or hug. Inside of the bubble, I made a small chamber with same material. To keep inflating the room, fresh air was continuously blown in by a fan. Even though the room was small and fully enclosed by inflatable materials, the participant did not feel claustrophobic. Rather they felt like they were being exposed to the air as well as feeling wrapped and enveloped. The chamber worked as a personal and safe space. In addition, it was perceived as a big and open space that evokes conversations with other participants. In the process of creating *Sky Reverie*, I focused on building a cosy space that creates immersion with quiet and calm qualities. However it was revealed that it creates two very different qualities: meditative and playful.

In *nite_aura*, I intended to keep focusing on evoking those experiential qualities from the space. Moreover I concentrated on elemental qualities of light to create a compelling space. I chose fiber optics strands that create nice point lights. Multiple ends of the fiber optic strands create a surface of lights swaying with wind or touch. To hold a concave shape with thousands of fiber optic points, a bell shape was tailored using dark fabrics that block any light. The suspended bell structure with fiber optics looked like a night sky with constellations. This creates an organic surface of points of lights that surround participants inside of *nite_aura*. As I intended, *nite_aura* holds possible qualities of meditation and playfulness. Depending on how participants experience it, the space becomes an active, energetic playground or a personal, contemplative womb.

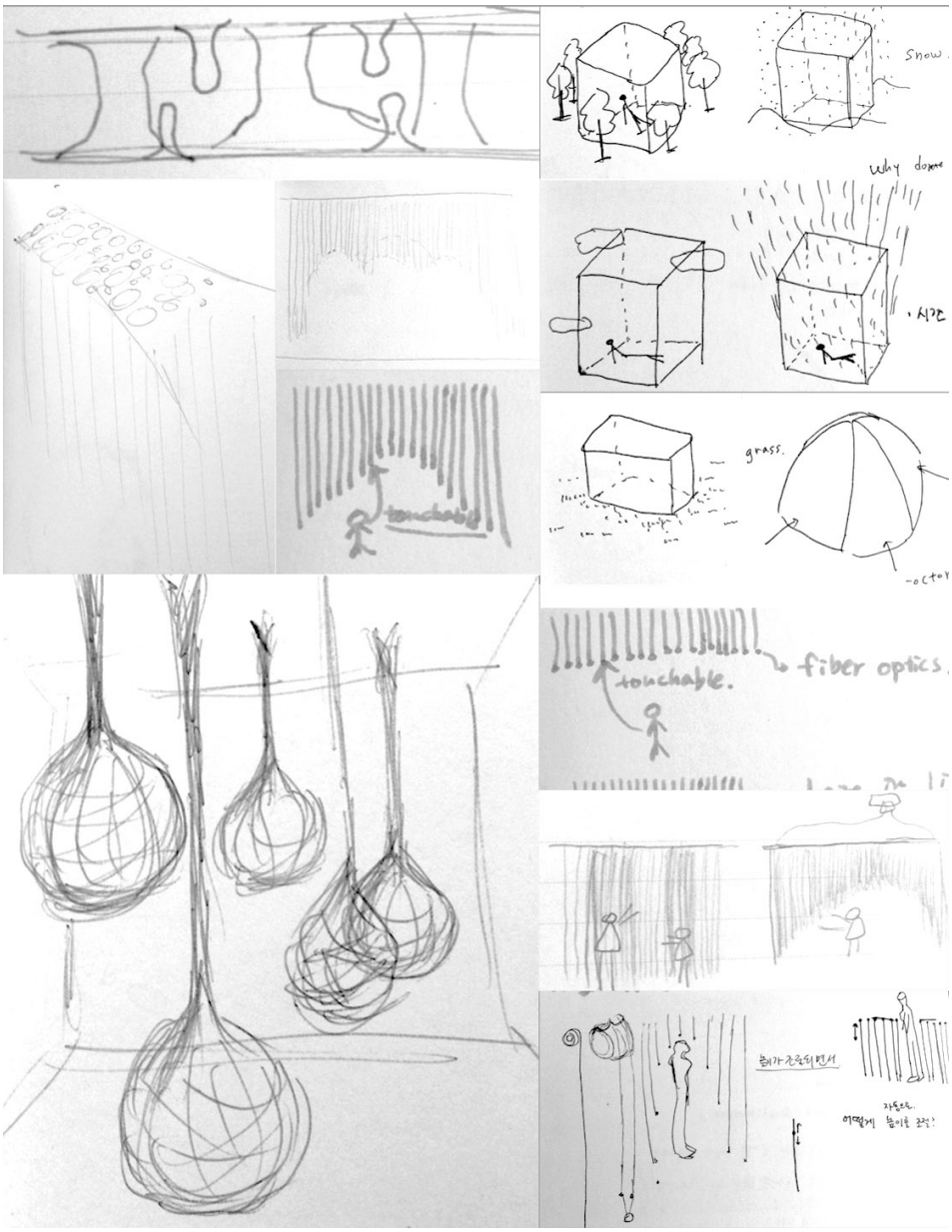


Figure 35. Ideation process for environment design

I have been eager to create imagination provoking / fantastic worlds. Figure 35 shows some of my idea sketches for *Light Strings*. These are based on my dreams and imaginings that I have had for a long time:

> *"I can see air (maybe shapes of small bubbles) around me and I push them, follow them, pile them up, sit on them, lay on them, break them, etc."*

"I want to grab a moment of rain. All raindrops are frozen and I reshape them, reorganize them and color them. I create my own world. I run, jump, walk, sleep. Then I feel lonely. Everything doesn't move. Can I make some friends of rain?"

"Personally I don't like rain. I don't like getting wet. However I love water. I don't know how to swim. I like being in the water except my head. I like sauna" (from my journal)

After the success of using fiber optics in *nite_aura*, I wanted to use a same material for *Light Strings*. It seems to have a great potential to create an ephemeral atmosphere as well as subtle luminous qualities. From *nite_aura*, I learned that if I use one or two fiber optic strings, they are perceived as an object or objects. However, if I use thousands of fiber optics and fill a space with them, they are not a single entity anymore. They create an environment with collective aesthetic qualities, capable of provoking bodily experience. Fiber optics is a material made out of pure glass (silica[40]) or plastic that has been used mostly for communication and illumination.

Since I create physically immersive environments that engage bodily experience, materials are very important for me as an artistic media. Physical materials are simple, direct, and apparent in and of themselves. Once they are combined with digital technology, materials are no longer simple. They become complex, integrated and interconnected and these new relationships create their own beauty. When they move, responding to the participant's motion in varying scales from wearables to environments, they can provoke a strong visceral feeling. The branching and joining of physical material and technology in my work echoes the symbiotic relationship between human and technology, exploring the idea of "hylozoism[41]" or life from material. In the process of art creation, fiber optics are not simply cold plastic strands to me. They live in the space the same as other computer generated interactive elements and participants as well as myself. This encourages active, self determined relationships within a work of art.

For *Light Strings*, my material/spatial exploration was focused on the length of fiber optics hung from the ceiling (Figure 36). Interestingly, different lengths create totally different perceptual spaces and evoke different physical actions. If they are around shoulder height, the participant tends to look up and stay below the fiber optics. When the fiber optics

[40] http://en.wikipedia.org/wiki/Optical_fiber

[41] Beesley, P., & Macy, C. (2007). Hylozoic soil: 1995/2007 : geotextile installations. Cambridge, Ont.: Riverside Architectural Press.

are placed around waist height, the space immediately turns into a water pool. People run and hit the fiber optics very similar to how they play in a water pool. This seems very engaging and playful. The last trial was to fill the space with very long fiber optics. The ends of fiber optics hang around people's ankles to knees. This was a bit less engaging than the second trial but it creates very interesting spatial qualities that I wanted to examine more closely. Without lights, I concentrated on the kinesthetic touch of the strands on my body in the space. It felt like rain. It sometimes produced static but no claustrophobic quality was experienced.

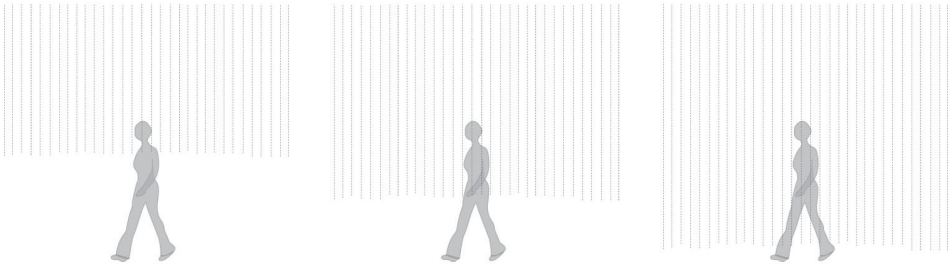


Figure 36. Illustrations for the fiber optics length tests

After these experiments with collaborators and invited participants, I decided to go with the long strand version. It was encompassing and the effect was very strong. After I created an environment with long fiber optic strings, a surface of light was revealed. The end points of the fiber optics create a topology. Because of the aesthetics of the environment, participants can interact inside of the space. While some participants interact within the system, other participants can observe their performance. Therefore *Light Strings* provide two perspectives for participants.

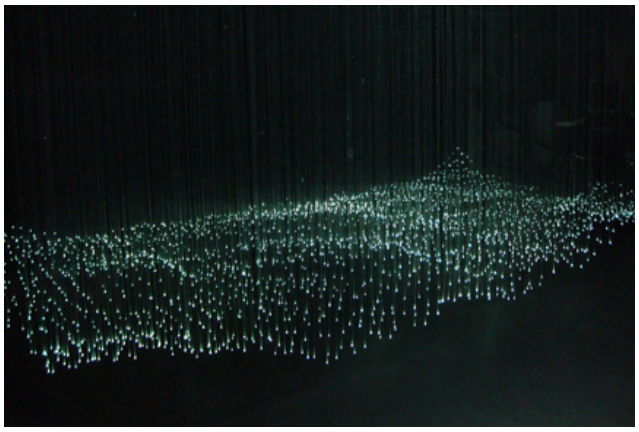


Figure 37. Topological light surface *Light Strings*

5.2.3 Intertwining with Nature

When I was growing up, Korean society demanded that every member conform to its standards, always pointing fingers at those who deviated from them and hardly embracing nor even acknowledging individual-uniqueness. I felt pressured to study assiduously and work around the clock so that I would not fall behind. At that time, it was inconceivable for me to even dare to surround myself with nature to refresh and rejuvenate. Perhaps I have unconsciously longed to be completely immersed in nature, breathing within it and relaxing in it. I suppose for that reason, my creative practice is drawn towards design that foster aesthetic experiences that allow one to find solace from hectic civilization and that are 'way findings' back to the experience of the self.

Even though I desired to create a space where people can feel relaxed and meditative, similar to being immersed in nature, I was not quite sure what kind of qualities of experience I would like to drawing from my artworks. My goals were a bit abstract until I started hiking. Hiking helped me to crystallize the experiential qualities for immersion. British Columbia in Canada is well known for beautiful nature. I started hiking and exploring mountains with my husband two years ago. Regardless of the difficulty levels of the trails, hiking consists of many interactions with nature such as touching leaves, putting hands in lakes, passing berry bushes, climbing rocks and crossing over creeks. All these experiences construct a holistic hiking experience integrating bodily exercise, sublime nature, and cathartic experience. These experiential qualities and ways of finding meanings from hiking in my experience really helped me to actualize my ideas of immersion as interactive art.

In *Light Strings*, I did not try to create an immersive space imitating the forest or ocean to enhance participants' immersive experience. Rather I focused on the experience and the relationship between the participant and nature. Instead of designing a space as a whole, I intended to design each element along with its behavior and interactions with other elements and the participant. Once the environment was fabricated, I concentrated on keeping a harmonious flow through the work.

5.2.4 Embodying Virtuality

In my art practice for immersive spaces, I avoided realism by not trying to represent the physical world but rather to provide "minimal cues" that enable users to construct their own experience. Such abstract, minimal cues echo the physical via unique visual, audio, and behavioral content that references the world without realistically imitating it. In my immersive space, interactive components as minimal cues were designed using subjective expectations taken from the embodied experience of the artist and observation from participants.

These behaviors are sufficient for inspiring the perception of a media agent as an entity in the physical space. This work considers the dynamic interplay between consistency of a media-agent's behavior and a behavioral schema from the physical world. This determined a baseline for the expected behavior of the media agent on the part of the participant. The expected behavior of an agent could be understood as occupying a space on a continuum that runs from *known behaviors* to *imaginative behaviors.* Known behaviors describe behaviors that adhere to the participants' prior experience, while imaginative behaviors describe those behaviors beyond the everyday, embodied experience or expectation of the participant.

nite-aura inspired an interest in the dynamic relation between behaviors that the system performs in direct response to the participants' interaction and those performed of the system's own programmed "volition" (AI). This dynamic creates another axis that runs from *performative behaviors* to *triggered/responsive behaviors*. These two axes in interaction combine to create a plane for categorizing the various behaviors programmed into the system (Figure 38) and an initial point to create the specific aesthetics of interaction.

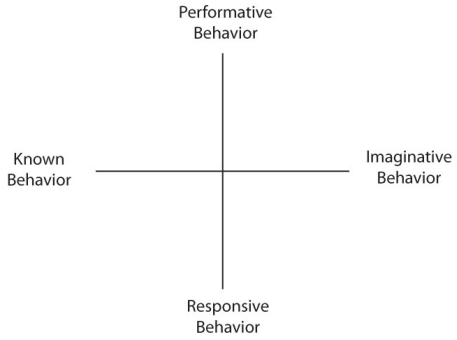


Figure 38. Embodied design scheme for virtual agents

5.3 Implementation of *Light Strings*

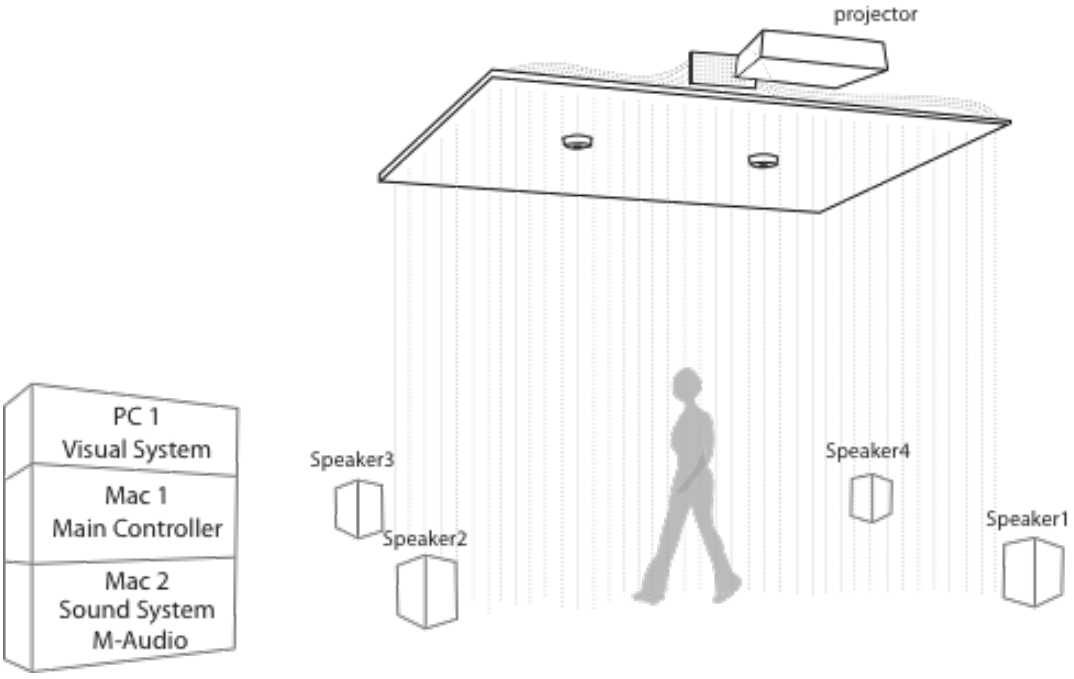


Figure 39. Hardware Installation of *Light Strings*

5.3.1 Fabrication of Immersive Environment

The physical space of *Light Strings* consists of over 2500 strands of fiber optics hung from the ceiling. The wooden structure holds 55 pieces of foam boards and each form board hold 48 fiber optic strings. All the fiber optics from the 55 pieces of foam board were bundled and created a small grid of fiber optics for projection (Figure 40). I used custom produced, straightened fiber optics. Each end of the fiber optic strand was directly mapped to a point in the projection grid.

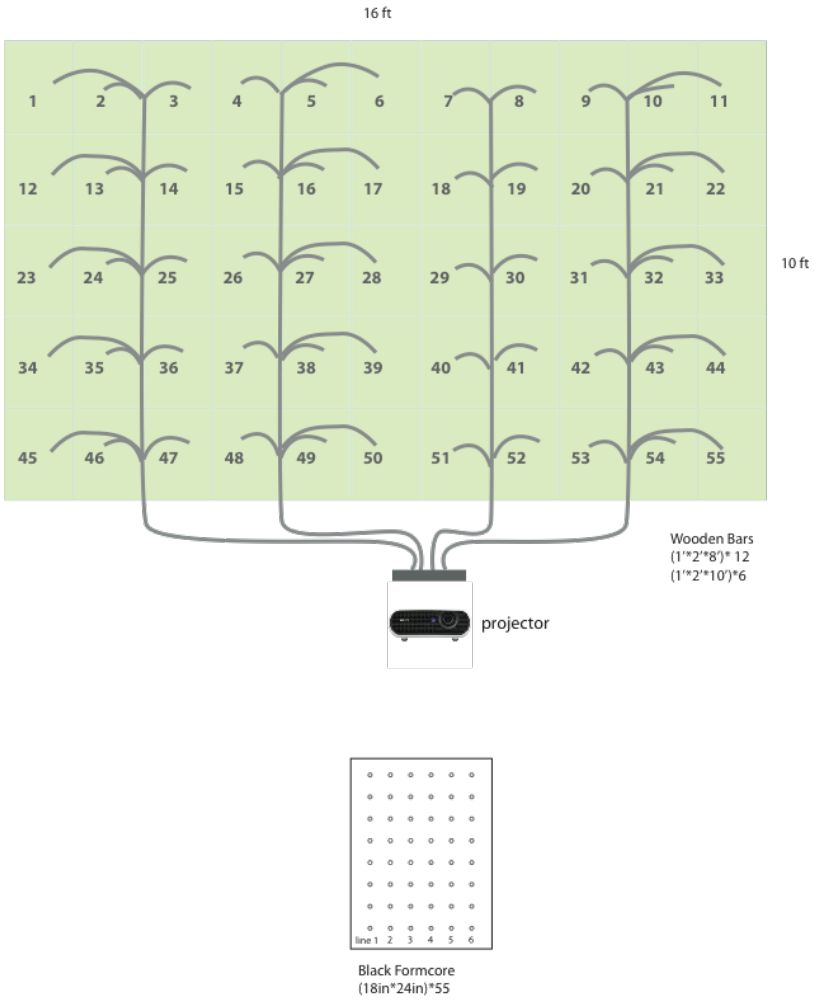


Figure 40. Grid design for hanging fiber optics

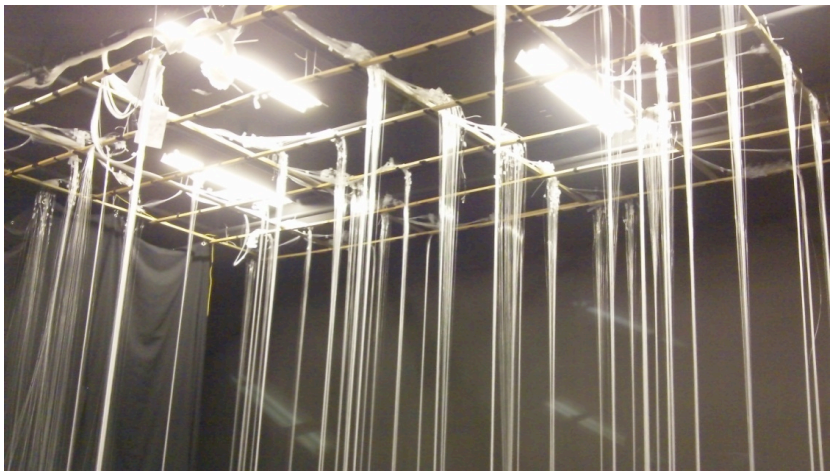


Figure 41. Ceiling grid for hanging fiber optics

5.3.2 Immersive Experience Design

The interactive system design began with observations of participant experience. First of all, I tried the environment by myself with my collaborators. This exploration provided an ability to understand the range of movement possible in the space. Then, I invited a participant and observed their movement in the space without any interactive elements. I was able to classify their movements into four categories: ambient, exploration, play, and meditation.

- Ambient mode: no audience in the space.
- Exploration mode: slow walking
- Play mode: very active, fast movement
- Meditation mode: very slow or static movement

Based on this categorization, my sound designer and I started design behaviors for virtual agents (visual and sound) responding to participant behavior by referencing the modes of movements. In addition, the agents' own behaviors were also designed. Similar to other living beings' behaviors, they come together, fight, and ignore each other sometimes.

5.3.3 Interactive System Design

The setup of *Light Strings* is a combination of three groups of equipment: a motion tracking system, a visual system, a sound system as well as a fiber optic structure. The motion tracking system consists of a computer (Macintosh), two video converters and two infrared (IR) cameras hung on the ceiling grid. The computer continuously tracks participant's movement in the space, and analyzes the movement and sends the movement data to the visual and sound systems. The visual system consists of a computer (PC) and a projector that projects visual data on the grid of fiber optics bundles. The sound system has a computer (Macintosh), the audio interface and four speakers. M-Audio, an audio interface, spatializes the sound processed through the four speakers. Each system is illustrated in detail in the diagrams below.

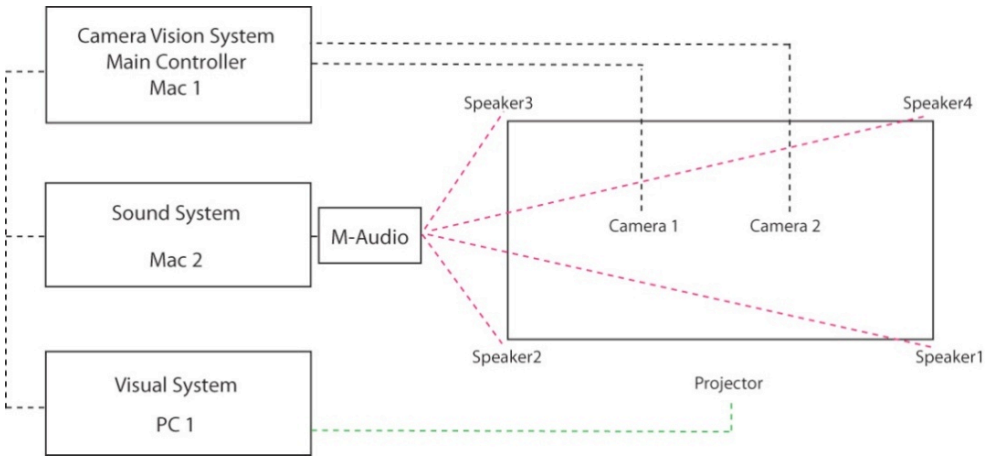


Figure 42. System Diagram of *Light Strings*

5.3.3.1 Motion Tracking System

Two firewire IR cameras detect the participants' motion in the installation. The light emitted by the fiber optics has a low level of infrared spectrum. This allows the use of IR cameras for tracking the movements of visitors in the space.

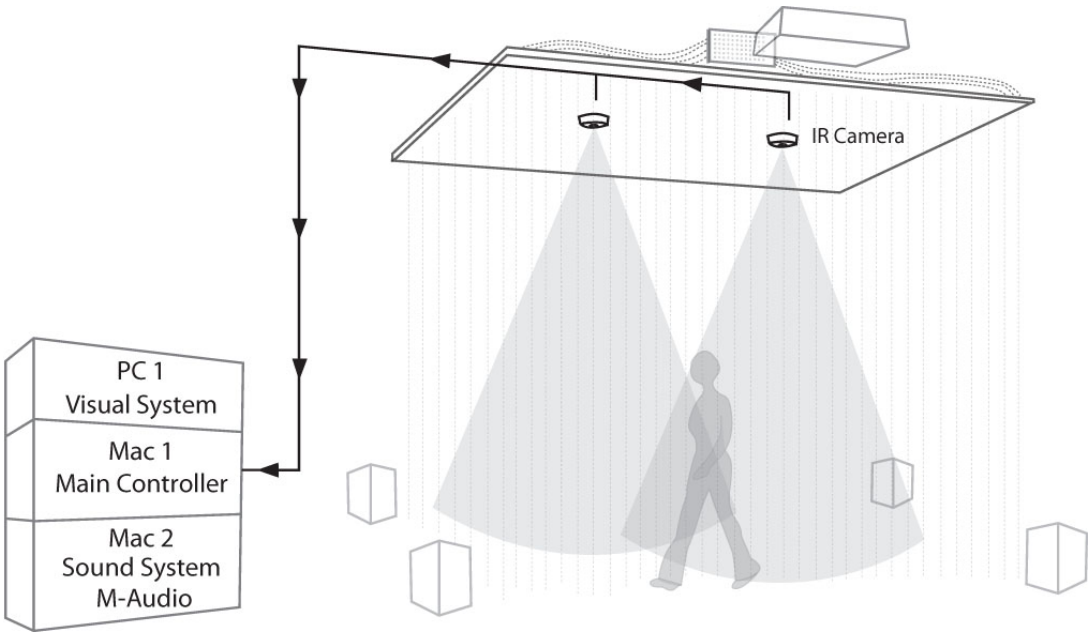


Figure 43. Data flow in the Motion Tracking System

Figure 44. Screen captured for camera vision

Video images from two IR cameras were stitched together (Figure 44) and the custom created application provided variables to produce interactive virtual agents. The visual and sound system received these values over the network and generated the interactive multimedia (Table 1).

Table 1. Variables for movement

Variables	Descriptions
Movement	Amount of blob's movement (center change)
Motion	Frame difference (size of movement)
Number of Blobs	Number of participants (detects only one blob this time)
X position	X value of the center point of a blob
Y position	Y value of the center point of a blob
Mode	0 - ambient mode 1 - exploration mode 2 - play mode 3 - meditation mode

5.3.3.2 Visual System

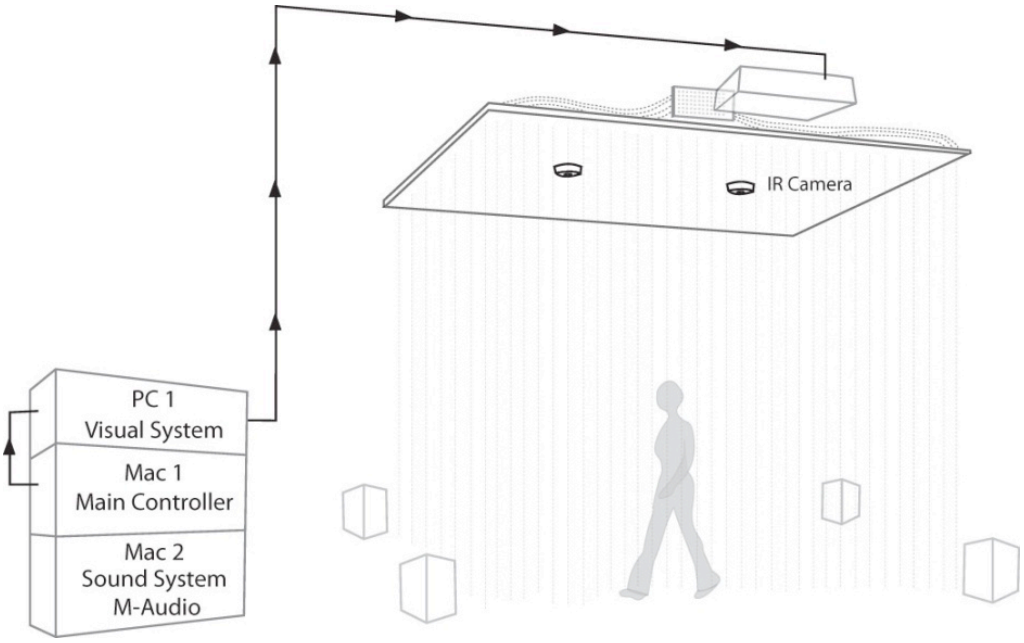


Figure 45. Data flow in the Visual system

The visual system consisted of a PC and a projector. The graphical aspect of visual agents was implemented using Processing. In the graphic environment, 8 to 10 visual agents are created and they move around depending on their characteristics and behaviors assigned to them initially. There are two kinds of visual agents: active and inactive. Two different colors represent their characteristics. The pink ones behave actively and the blue ones are inactive (Figure 46). Their initial characteristics (color, size, movement, speed) may be changed in response to the participant's behavior. All visual agents have circular shapes. Their sizes are randomly assigned between 80 to 100 pixels in diameter. The initial active agents (pink) are floating around in the space. They move faster than inactive agents (blue). They are curious and friendly beings and they explore the environment very dynamically. When they hit each other, they bounce off each other. The inactive agents are slow and less friendly beings. They tend to gather in one area. They are not interested in other beings in the same space. They don't care about the pink ones or the participant (grey circle in Figure 46).

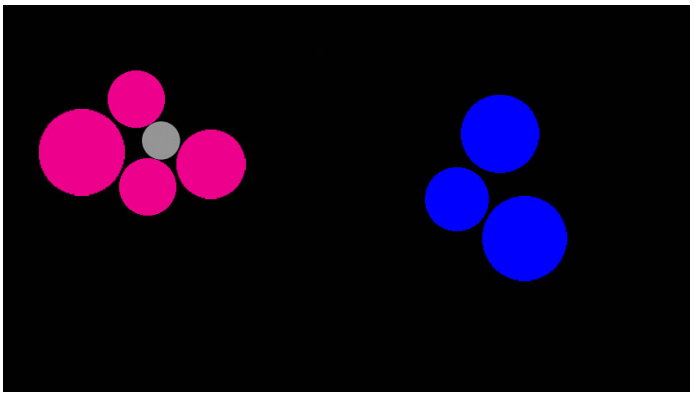


Figure 46. Graphic application for visual system

Table 2. Summary of Agents' behaviors

	Ambient	Exploration	Play	Meditation
Active Agents	Color: pink Movement: fast and active Behavior: actively bounce off	Color: slowly change to yellow according to their activity Movement: same Behavior: follow the participant	Movement: same Behavior: avoid the participant	Color: yellow Movement: very slow Behavior: gather around the participant
Inactive Agents	Color: blue Movement: slow and inactive Behavior: slowly bounce off	Color: same Movement: same Behavior: they don't follow the participant.	Movement: faster Behavior: they expand their body because of agitation from the participant and occupy the space	Color: yellow Movement: very slow Behavior: they don't care about the participant and gather themselves

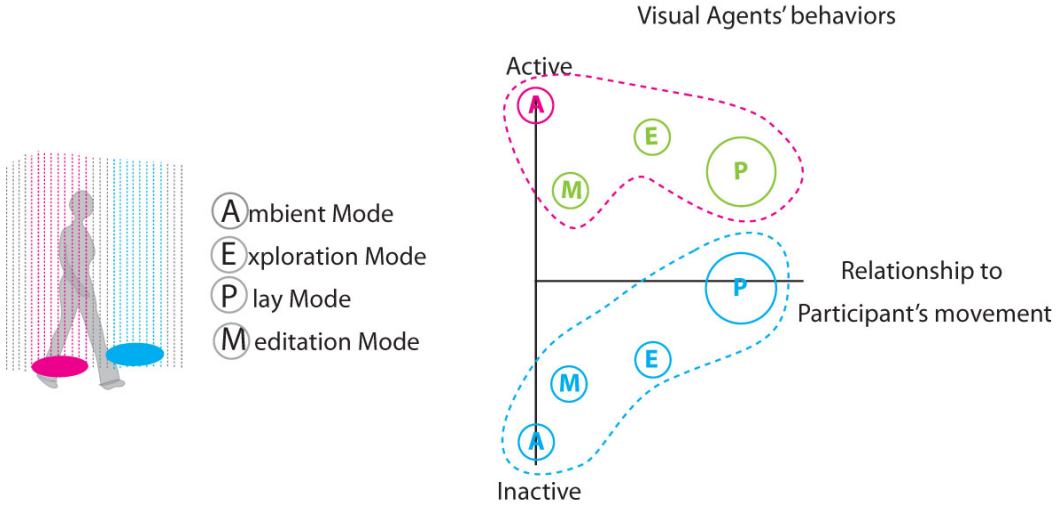


Figure 47. Diagram of the visual agents' behaviors

The images of the agents rendered by the system are projected on to the ends of a bundle of fiber optics. The fiber optic strands that fill up the installation space create a tactile light space allowing the light animation to move in the fiber optics hanging around the space. The behavioral movements of the agents create the illusion that they are alive.

5.3.3.3 Sound System

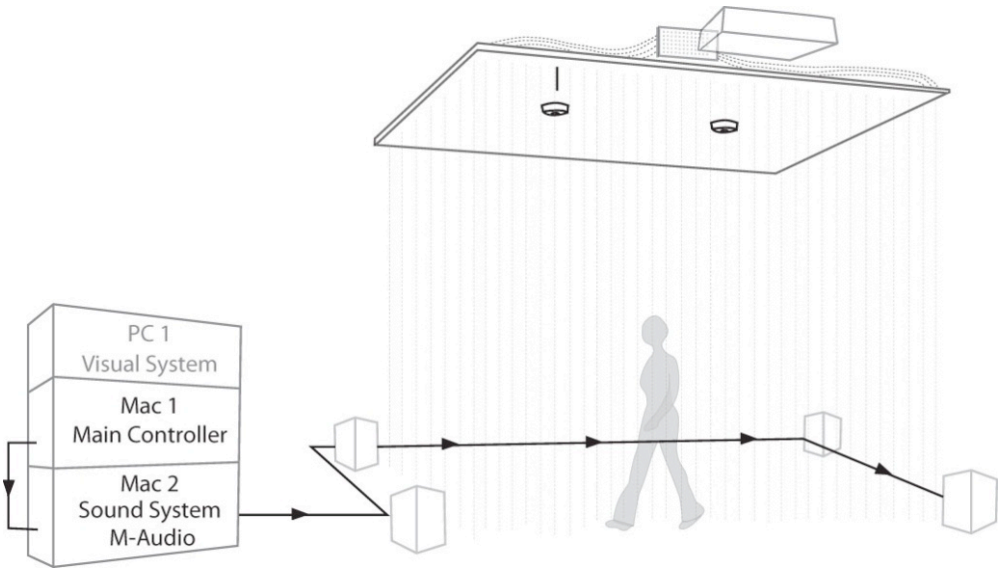


Figure 48. Data flow of sound system

The sound system works along with the visual system to create an immersive environment. Our goal was to create natural but elemental sounds that respond to the participant's movement. They work as environmental sound agents similar to air in that they move around regardless of human existence and people can feel them through the movement of their bodies. The environment contains initial sound elements from white noise in Max/MSP/Jitter[42], a visual programming language for music and multimedia. They are activated when the participant's movement is detected in the space and come and go while interacting with the participant.

[42] http://cycling74.com/

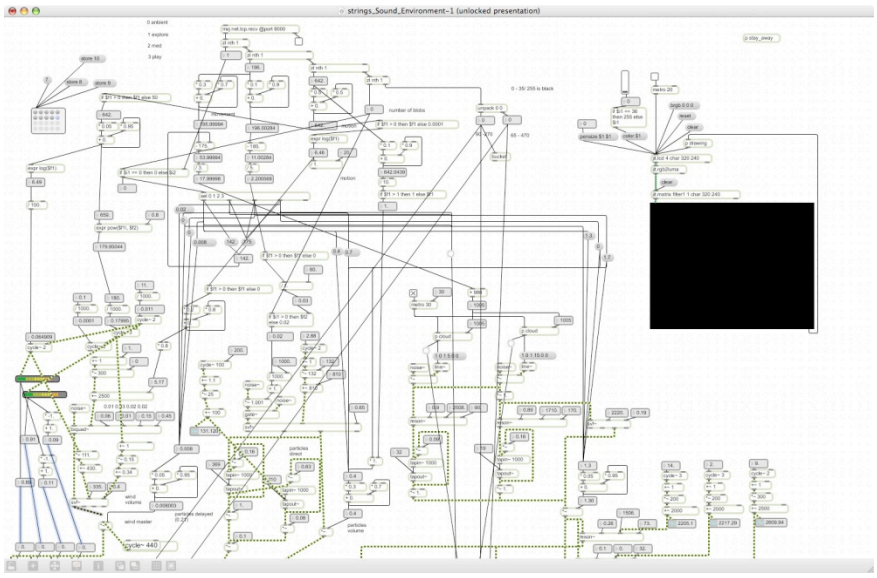


Figure 49. Max/Jitter screen of the sound system

The main motion capture system sends the participant's movement data to Max/MSP/Jitter through the Ethernet connection and the Max patch processes these data depending on values of movement. The received data contains 6 kinds of values: movement, motion, number of blobs, x position, y position, and mode. After this processing, the interactive sounds are spatialized through 4 channel speakers. The sound designer, Greg Corness and I created three initial natural sounds: wind, rain, and chirps. Even though they sounded like wind, rain, and bird chirps, we didn't name them as wind, rain, and bird chirps. The sounds were perceived and interpreted freely by participants. Some people heard seashore sounds, fire sounds, and clicking sounds. Some others perceived storms, water dripping, and cricket sounds. Each sound was controlled and the possibilities of being played were changed by the 6 movement values received (See Table 1).

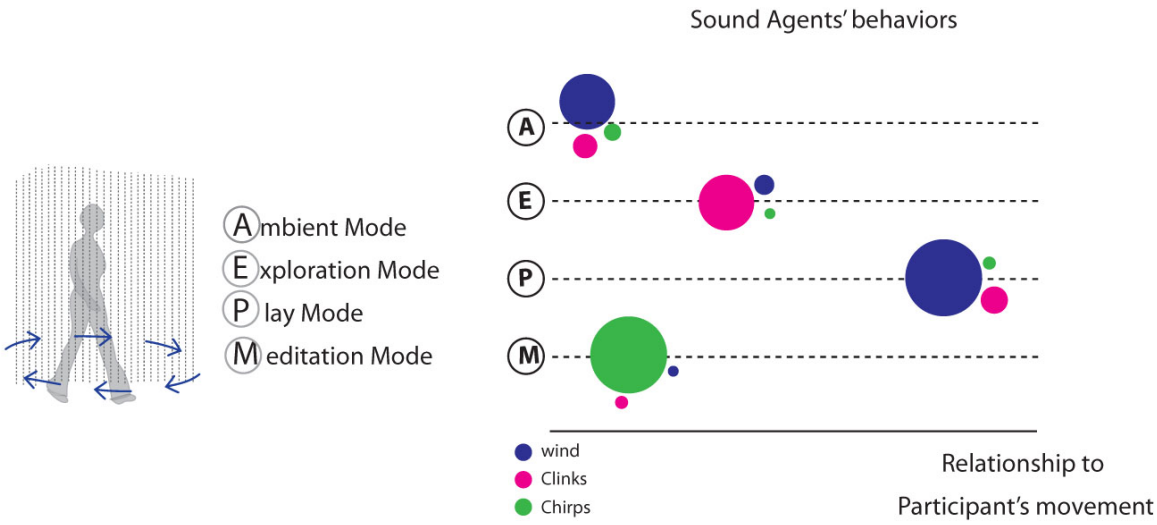


Figure 50. Diagram of sound agents' behaviors in *Light Strings*

5.3.4 Computer Codes

For the computer codes of *Light Strings*, refer to Appendix A.

6: EXPERIENCING *LIGHT STRINGS*

This chapter describes the planning and execution of my participant study regarding the nature of immersive experience and how it is experienced in *Light Strings*. In the study, I focused on getting participants' experience from their first-person perspectives. To support the subjective first-person data, other data collection methods such as interviewing and video recording were also used.

6.1 Introduction

As discussed earlier, "immersive experience" has been a popular research subject in various disciplines. However there are not many in-depth studies focusing on the aesthetics of participants' subjective experience in immersive environments. In particular, there is almost no such study regarding physically immersive environments in an Interactive Art context[43]. I conducted an in-depth study of the qualities and properties of immersion and how they are structured with participants in *Light Strings*.

As discussed in Chapter 4, phenomenological research methods are appropriate to study subjective qualities of human experience. Therefore I adopted phenomenological methods that have been used in Psychology, Human Science, Nursing and other disciplines and built them up based on my art practice and research background. To pursue validity, triangulation of different methods (First-person, Second-person, and Third-person methods) was conducted.

I used *Light Strings* as a case study to look at participants' qualities of aesthetics of immersive experience. The overall process can be summarized as 1) gathering a full set of naïve descriptions from participants who had experienced *Light Strings*; 2) analyzing the descriptions in order to grasp common elements that make the experience what it is; and 3)

[43] Some of the reasons they are not visible are that they may be written in a different languages or that immersion was considered in slightly different ways. Other reasons are that artists in prior times did not have a habit of publishing their work in academic journals.

describing or giving a clear, accurate and articulate account of the phenomenon so that it can be understood by others (Polkinghorne, 1989).

6.2 Participant Study Design

6.2.1 Relationship with the Artist's Experience

Creating immersive environments is part of my art practice, but as a research practice, I am curious about how my participant experiences my artworks. I wanted to know whether and how the qualities that I focused on during art creation process are passed to participants. Therefore the participant study cannot be conducted separately from the original art creation and cannot be done by other researchers. The art creation process, final artwork and participant experience are interwoven and should be considered as a circle of study (Figure 51).

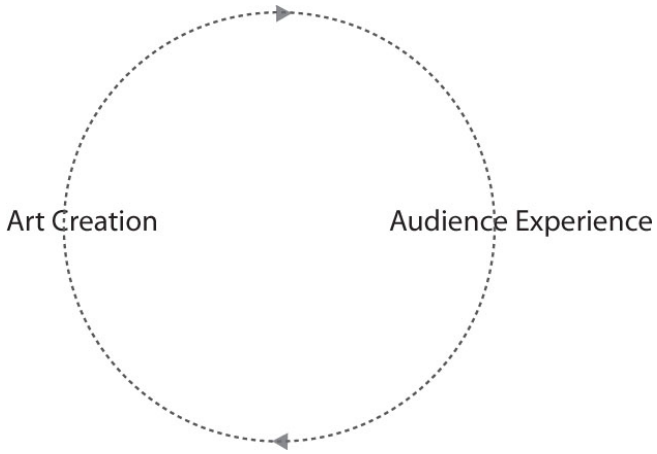


Figure 51. Relationship between art creation and participant experience

As I described previously, I adopted phenomenological research methods to undertake this study of my artwork. However I had to modify these methods based on my artistic research enquiry because there is no standard method for interactive artists like me. My first-person, embodied questions developed through an artistic ideation, experiment, and creation process helped to frame my participant studies (Figure 52).

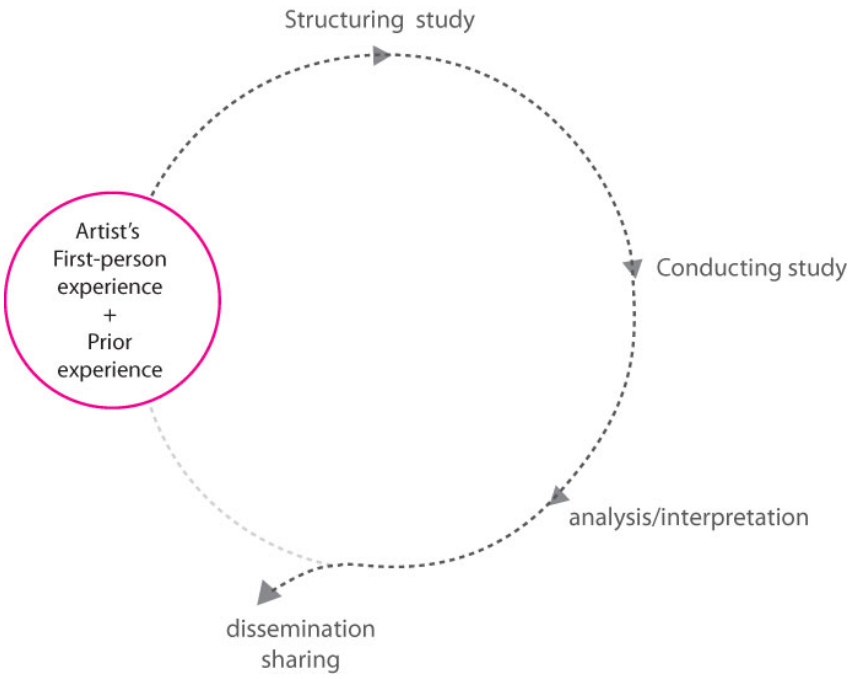


Figure 52. Overview of the methodological process of research design

While I was creating *Light Strings*, I experienced it a great deal by myself and with my collaborators. I observed myself interacting very differently with *Light Strings* depending on the multimedia contents, i.e. the light and sound. That experience framed the initial inquiry that structured my participant study. Based on that experience, I planed and conducted my participant study and analyzed the results. During my study process, I worked with the participants very closely. The participants' experiences helped me understand my work by relating to their experience (Figure 53).

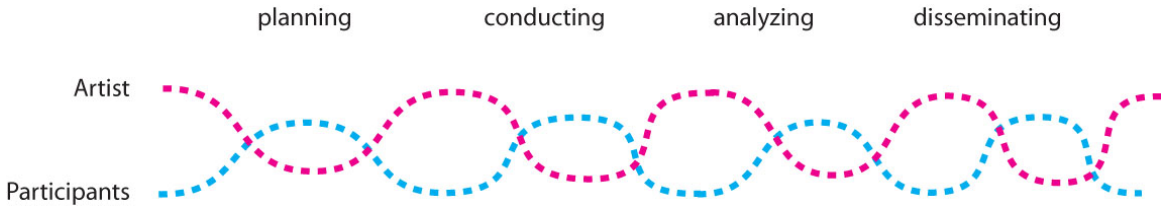


Figure 53. Artist and Participants' relationship

6.2.2 Participants

16 participants were recruited through an open email call that was available to the general public. They were given ample opportunity to accept or decline. Participants were informed of the procedure verbally and through a written document describing the procedure and any risks, including the ability to quit or leave the study at any time. There were no expected risks outside of what people might experience in day to day physical activity. They signed consent forms to participate voluntarily. Personally identifiable information such as first and last name was never be used to reference the participant at any point, and their names were not used in association with any of the collected data. Participating in this study took about an hour and half to two hours and participant received $20 compensation for participating in the study.

Even though there was an open call for recruiting participants, the participants who applied for this study were all undergraduate students and graduate students from SIAT (School of Interactive Arts and Technology) in Simon Fraser University. They were asked to pay attention to their sensory experience and felt experience. Because of the nature of the school, they were not technologically naïve and many of them were capable of understanding *Light Strings* in a technological context. I recognized that this may relate in some bias. However previous exhibits of the piece appeared to elicit similar responses. I will be more careful about how I choose participants in future research.

6.2.3 Study Condition

The study environment consisted of the installation and interview space. The interview space was set up besides *Light Strings* (Figure 54) so that participants were able to write about and describe their experience while looking at the artwork, after their experience. This helped them to remember their experience and re-experience it in their minds.

Figure 54. Study Setting

The participants had a chance to experience *Light Strings* three times with different conditions (*Both*, *Visual*, and *Sound*). The physical environment was the same for all three conditions. In the *Both* session *Light Strings* had visual elements and sound elements. In the Visual session, the sound elements were taken away and the participants only experienced responsive light patterns in the environment. In the Sound session, there were no visual images, only a soundscape filled with fiber optic strings.

Early test runs showed that the participants' experiences were affected by the order they experienced the three sessions. Therefore I used four different orders of the three sessions to structure the study (Table 3). Basically, in half of the orders, the participants experienced the *Both* session first and in the other half, they experienced to experience the *Both* session last. For each order, four participants were randomly assigned (Table 4).

Table 3. Four different orders of participants studies

	Session 1	Session 2	Session 3	Duration
4people	*Both*	*Visual*	*Sound*	1:30-2h
4people	*Both*	*Sound*	*Visual*	1:30-2h
4people	*Visual*	*Sound*	*Both*	1:30-2h
4people	*Sound*	*Visual*	*Both*	1:30-2h

Table 4. Sessions randomly assigned to the participants[44]

	Session 1	Session 2	Session 3
Participant 1	*Visual*	*Sound*	*Both*
Participant 2	*Both*	*Visual*	*Sound*
Participant 3	*Both*	*Sound*	*Visual*
Participant 4	*Visual*	*Sound*	*Both*
Participant 5	*Both*	*Sound*	*Visual*
Participant 6	*Sound*	*Visual*	*Both*
Participant 7	*Both*	*Visual*	*Sound*
Participant 8	*Visual*	*Sound*	*Both*
Participant 9	*Both*	*Sound*	*Visual*
Participant 11	*Visual*	*Sound*	*Both*
Participant 12	*Sound*	*Visual*	*Both*
Participant 14	*Sound*	*Visual*	*Both*
Participant 15	*Both*	*Visual*	*Sound*
Participant 16	*Both*	*Sound*	*Visual*
Participant 17	*Sound*	*Visual*	*Both*
Participant 18	*Both*	*Visual*	*Sound*

6.2.4 Procedure

Once the participants came to experience the artwork, they were informed of the study procedure verbally and through a written document describing the procedure and any risks, including the ability to quit or leave the procedure at any time. Participants in the

[44] The data from Participant 10 and Participant 13 were not included for analysis because the sessions did not run smoothly.

study were asked to experience *Light Strings*, three times for as long as they want to stay. Since this study examines the aesthetics of immersive experience, I wanted to provide enough time for participants to experience *Light Strings* while focusing on different sensory experiences: *Both*, *Visual*, and *Sound*. Participants were asked to imagine that the installation space was a gallery space and they were experiencing an art installation. This initial mental setting helped for them to focus on the aesthetic qualities of their immersive experience in *Light Strings*. They were free to do anything and there were no time limitations on how long they stayed in the installation. Participants experienced *Light Strings* aesthetically via the artworks' kinaesthetic tactile quality as well as visual and auditory qualities.

While the participants were experiencing *Light Strings*, their movement inside of the installation was video captured. *Light Strings* was already capturing the participant's movement from above using two IR cameras to analyze movement in the space in order to create responsive virtual agents that the participants can interact with. Therefore, I was able to record the camera capture screen using another video camera. This video data was digitized and processed to investigate how the participants moved and behaved in the installation. I did not extract the video images from the motion analysis process because recording a video at the same time as analyzing it uses too much of computer's processing ability and made the entire system unstable.

After each session of experience, the light level of the room was adjusted for the next activity and the participant was guided to a writing station (Figure 54). Participants were provided a single card with three open-ended questions: "What did you experience?", " How did you experience?", "How did you feel?" (Appendix B) They were asked to write down their experiences quickly and fearlessly when answering the questions. The quick writing process without analytical thinking helps to extract their subjective experience effectively (Kozel, 2008; Schiphorst, 2008). The participants were instructed: "think back and describe your subjective experience of the artwork as much detail as possible." They were assured of the confidentiality of the information. They could write, note or draw their experiences in a hand written "journaling" form. This would give the participants the opportunity to take their time and to reflect on their experiences and to reconstruct the event in more detail on their own, without interference.

As soon as the writing session ended, participants were involved in an interview procedure. The participants were told that the interviews would be treated confidentially. The research instruments for the interview was an open-ended method. The interviewing technique is based on a protocol developed by Petitmengin and Varela (2006). This protocol focuses on the researcher facilitating the participant in articulating a description of their experience, creating a phenomenological description. Each interview was digitally video-recorded. Video files were marked only with the session number and the participant number. Transcriptions of the interview were used for the analysis of the data. The participants experienced three sessions of the installation experience and wrote three times and interviewed three times (Figure 55).

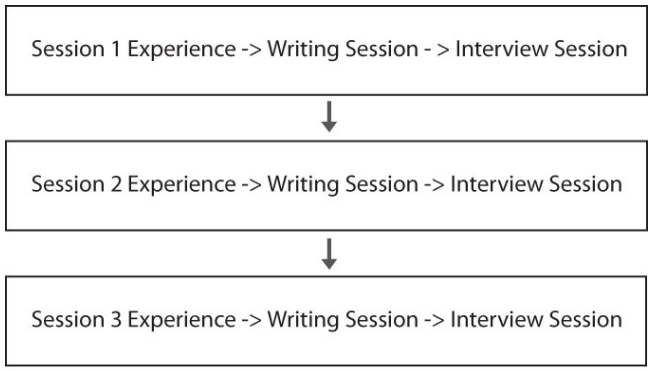


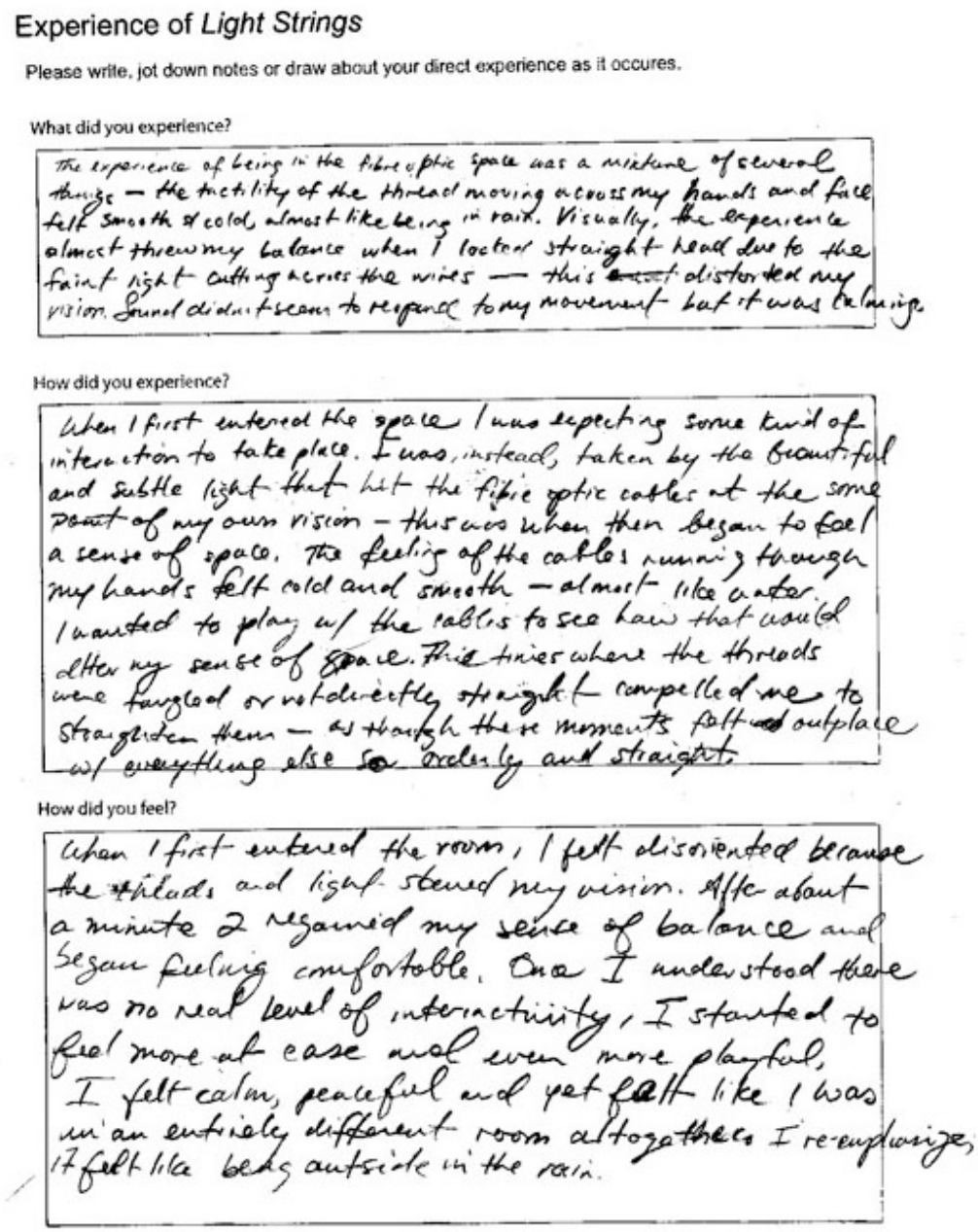
Figure 55. Study Process

6.3 Data Collection

Data collected from each step was transcribed to analyze and triangulate later.

6.3.1 Participant's First-Person Data

16 participants provided written descriptions of their experience by responding to three questions: "What did you experience?", "How did you experience?", "How did you feel?" These responses were collected and transcribed. The participants wrote their experience in a free style. Some of them had little drawings to illustrate their experience (Figure 56).



Experience of *Light Strings*

Please write, jot down notes or draw about your direct experience as it occures.

What did you experience?

The experience of being in the fibre optic space was a mixture of several things — the tactility of the thread moving across my hands and face felt smooth & cold, almost like being in rain. Visually, the experience almost threw my balance when I looked straight head due to the faint light cutting across the wires — this ~~must~~ distorted my vision. Sound didn't seem to respond to my movement but it was calming.

How did you experience?

When I first entered the space I was expecting some kind of interaction to take place. I was, instead, taken by the beautiful and subtle light that hit the fibre optic cables at the same point of my own vision — this was when I began to feel a sense of space. The feeling of the cables running through my hands felt cold and smooth — almost like water. I wanted to play w/ the cables to see how that would alter my sense of space. This times where the threads were tangled or not directly straight compelled me to straighten them — as though these moments felt out place w/ everything else so orderly and straight.

How did you feel?

When I first entered the room, I felt disoriented because the threads and light stirred my vision. After about a minute I regained my sense of balance and began feeling comfortable. Once I understood there was no real level of interactivity, I started to feel more at ease and even more playful. I felt calm, peaceful and yet ~~felt~~ like I was in an entirely different room altogether. I re-emphasize, it felt like being outside in the rain.

Figure 56. Example of written response

6.3.2 Participant's Second-Person Data

Second-person data (of the participants experience) was collected using an interview technique adopted from Petitmengin and Varela (2006). In conducting the interviews, I asked questions using *How*. This wording focuses the participant on describing the

experience. Questions of *Why* were avoided because they tend to elicit analytical comments rather then experiential descriptions from the participants. In the interview process, my role was to ensure the participant was kept focused on describing their experience and was not lead by me. The open interview protocol allows the researcher to form questions by re-phrasing statements made by the participant. This approach reduces the effect of the researcher influencing the participant (Petitmengin, 2006).

Through the interview process, participants were able to re-visit and re-experience the installation and provided their experiential descriptions in detail. Under a guidance of the interviewer, the participants examined different parts or layers of their experience and anything about the phenomenon that appeared to their consciousness: a person, a feeling, an experience, an event, an idea, a perception, a memory, or relationships to research. Two 4th year undergraduate students were hired for transcribing the interview data. They were trained to transcribe for this research. The finished transcription was over 250 pages long with a single line spacing. All the data was put in a popular qualitative research tool, *Atlas.ti* for analysis. The software *Atlas.ti* was used in this research as a database tool but could have been replaced with any other similar software.

6.3.3 Participant's Third-Person Data

All the participants' bodily movements in the environment were video recorded and digitized. The average time of the participant's experience in each session was 8minutes and 42seconds. The total video length for the 16 participants' experience was 7hours, 21minutes, and 35seconds.

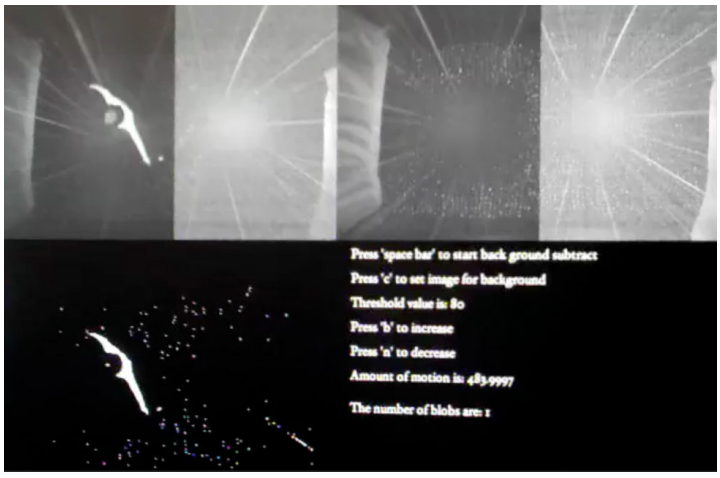


Figure 57. Original video data

The original video files recorded from the screen of the *Light Strings*'s system include a few steps of the analysis process used to create responsive elements. To analyze only their movement, I cropped the image of the upper left screen (Figure 57) and created a separate video file from the original ones. A Java application, *Processing*, allowed me to create animated visualizations of each participant's movement, gesture, body size, and speed using the modified video files. Figure 58 is a sample screen shot of the Processing results. On the screen, a pink line represents a trajectory of the participant in *Light Strings*. The pink line around the "A" area is brighter and wider than other areas. This means that this participant stayed longer or walked very slowly in the "A" area and their body posture was wider: they may have opened the arms widely or laid down on the floor. The circular line around the "B" area represents that the participant walked around without any arm movements.

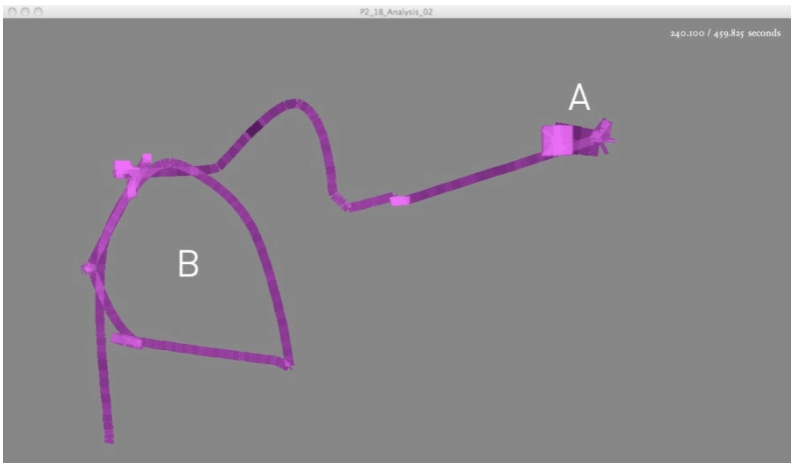


Figure 58. Sample screen shot of visualization of a participant's movement data

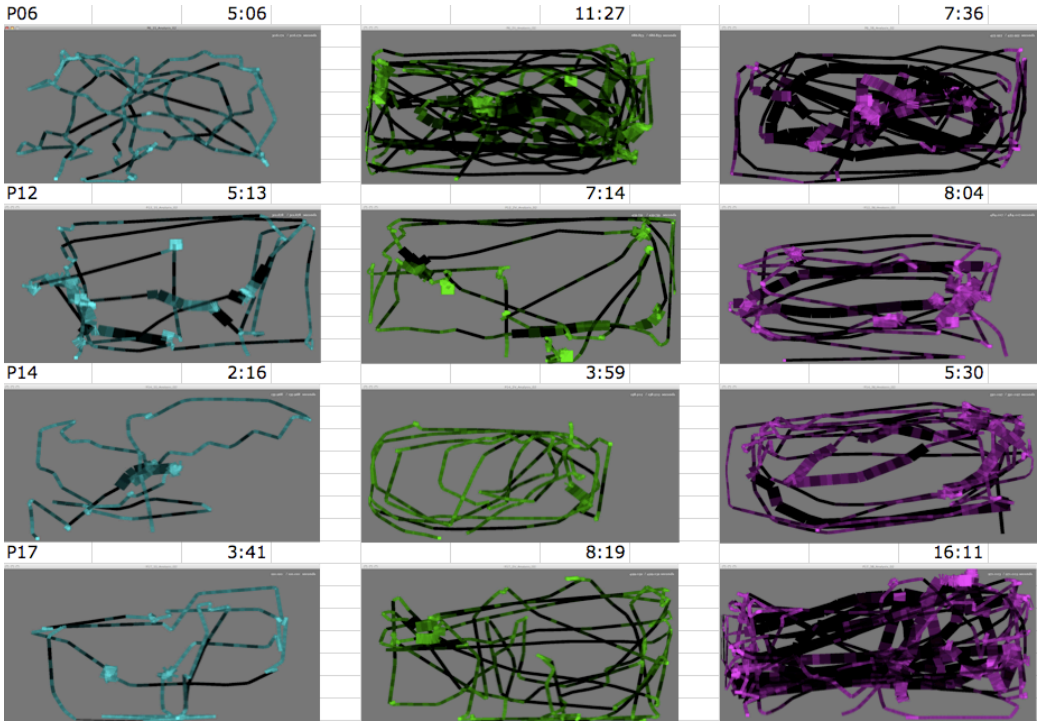


Figure 59. Visualization of the participants' movements in the *Sound-Visual-Both* order

The video data was not put in Atlas.ti and coded for analysis but visualization patterns of all the participants' movements were produced. Figure 59 shows the visualizations of 4 participants who experienced *Light Strings* in the order of *Sound*, *Visual*, and *Both*. The video data showed that the participants spent much less time in the *Sound* sessions regardless of the orders: 90% of the participants spend the shortest time in the *Sound* sessions. In addition, it was appeared that the participants moved more and longer through the sessions. The visualizations for all orders are in Appendix B. This process allows me to triangulate the data between several sources improving the validity of the findings.

6.4 Data Analysis

There is no uniform phenomenological method of analysis that is imposed indiscriminately in every case. The method of analysis used in this study was based on Halldórsdóttir's *The Vancouver school of doing phenomenology* (2000b) and a combination of Petitmengin's (2006) and Varela et al.'s (2002) methods. The data analysis was started while I

was collecting data from the study. There was a temporal overlapping of these research processes similar to the way Halldórsdóttir (2000b) and Lofland and Lofland (1995) describe. This means that the processes of data collection and data analysis occurred simultaneously. In my research, my role was an artist and a researcher. I created the art project, designed the research, conducted the study and analyzed all on my own making it difficult to distinguish each phase of research distinctively.

Although I hired two undergraduate students for transcribing the interview data, I transcribed all the written responses and a portion of the interview data by myself. In addition, I watched the recorded interview videos over and over. I read and re-read the transcribed dialogue to get a sense of the participants' experience as a whole. Multiple readings of the transcript helped me to remind me of the interview situation and immerse myself in the data. This step took a long time. However, this is considered to be an extremely important step by other phenomenological researchers (Halldorsdottir, 2000b; Van Manen, 1990) and should not be underestimated.

Next, I focused on "identifying key statements" (Halldorsdottir, 2000b, p.63) from the descriptions, making such statements bold. This helped me to get an overview of the flow of the experience and highlight unique characteristics of the experience. After this process, I worked on "themes" arising from the data and coded these themes in *Atlas.ti*. This process is similar to Colaizzi's (1978) step of "formulating meanings" (p.59). In the end, all the different themes were grouped for each participant and used to construct a model of qualities of the participant's immersive experience. This allowed the individual models and general model to be developed concurrently while being compared for validity.

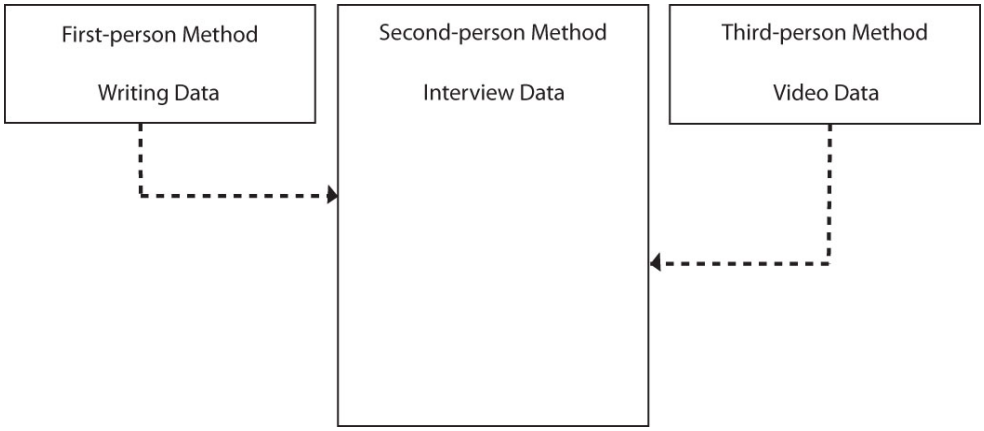


Figure 60. Triangulation process of the research

Although all the elements from the different data sources were compared in order to enhance validity of the research, the main data analysis was conducted using the interview data (Figure 60). After a preliminary analysis of each data source, I found that the participants' writing primed their interview data. When you interview them. They are more ready at hand because they were actually physically writing used the words they were able to describe. Writing could well have helped because they could be able to articulate that detail. Therefore I focused on the interview data for analysis triangulating with the writing data and video data. Based on the analysis, I constructed a combined model of immersive experience which can be used to develop a further understanding of the aesthetics of immersive experience. In addition, my method can inform the practice of other interactive artists/researchers.

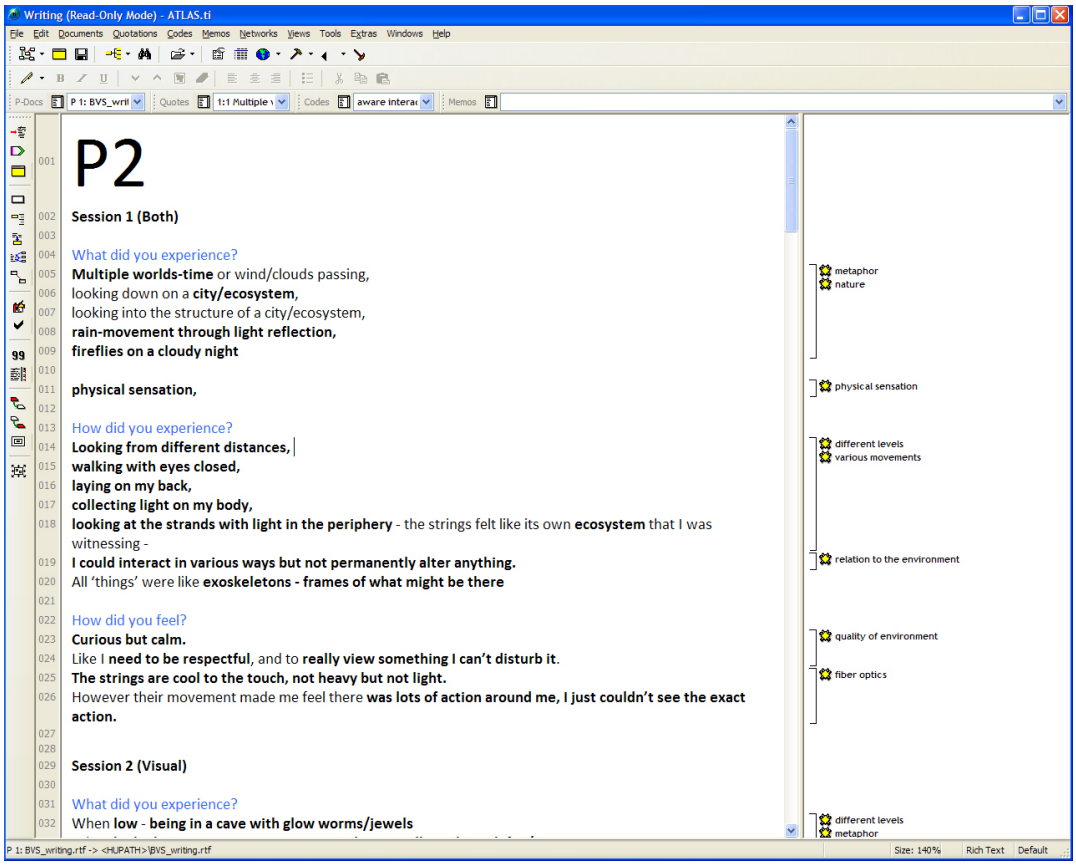


Figure 61. Interview data coded in *Atlas.ti*

7: ANALYZING THE AESTHETICS OF IMMERSIVE EXPERIENCE

7.1 Introduction

This chapter analyzes the results of the case study described in Chapter 6 with the goal of answering one of my research questions: what are the aesthetics of immersion in the realm of Interactive Art? The focus of the research was to investigate the qualities of participants' immersive experience in physically immersive and interactive environments and explore to find meanings created by the experience. During the case study, it became apparent that the participants' experiences in *Light Strings* were immersive. Unlike other researchers' understanding of immersion[45], I focus on bodily experience engaged with culture, society, environment, and history. My work connects deeply with the body-based approach of Merleau-Ponty and Varela, which emphasizes a phenomenological understanding of body and relations with mind and the world. I acknowledge that mind and body are not separated norms. Every aspect of our experience is grounded in our bodily engagement within the environment. Therefore my analysis concentrates on building an experiential structure based on immersive consciousness considering temporal aspects (Figure 62).

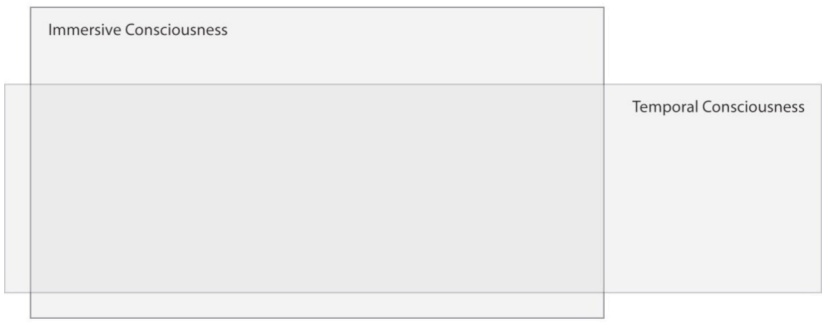


Figure 62. Experience structure of Immersive Experience

[45] In immersion research, many VR artists and researchers focus on a mental state where a participant's physical body is diminished in the environment concentrating on visual illusion. (See Chapter 2)

7.2 Immersive Consciousness

The notion of Immersive Consciousness that is built through my analysis is framed by Bodily Consciousness, Spatial Consciousness and Contextual Consciousness (Figure 63). I describe each of these elements in detail below. I have found that by using this model I am able to recognize similarities in sensorial and felt experience and processes across participants. This helps to understand the participant's immersive experience and to create interactive immersive environments. In a general sense, consciousness refers to any activities or aspects of the mind. However, in my dissertation, I define consciousness as embodied akin to the way it is defined by contemporary cognitive scientists (Noë, 2005; Prinz, 2008; Varela & Shear, 2002). Our consciousness can be affected by the existence of body or somatic or enactive processes. Therefore, Immersive Consciousness illustrates embodied consciousness as experienced through the body and explains how participants perceive an immersive space and make meanings out of it.

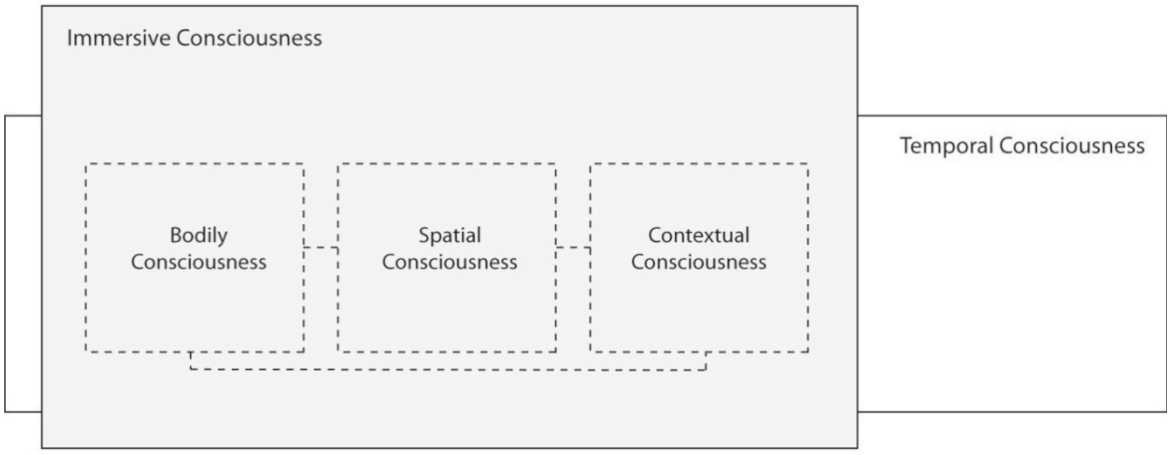


Figure 63. Structure of Immersive Consciousness

7.3 Bodily Consciousness

Body Consciousness focuses on the sensory experience of the participants in *Light Strings*. We learn and understand the world through our bodies. This is not just about a body rather a body in the space and in relationship to the installation. It is always connected to the world we live. Therefore investigating participants' sensory experiences allows me to examine the origin of immersive experience and frame immersive consciousness in terms of

embodiment. Since *Light Strings* is a physically immersive installation, the participants experienced and described various sensory experiences including exteroceptive senses (sight, hearing, and touch) and interoceptive senses (proprioception, kinesthetics, and vestibular sense). I have separated their experiential descriptions about sensory experience from others identifying them as statements of sensorial experience without rational and analytical thinking. The bodily consciousness includes mostly sensory experience focusing on what is seen, heard, touched, felt and some emotional valence from the sensory experience. Due to the aesthetic characteristics of *Light Strings*, multiple senses were stimulated and helped to create sense of immersion. Sensual richness helped create a deeper sense of immersion. It is also important to acknowledge that bodily consciousness is closely connected to spatial and contextual consciousness.

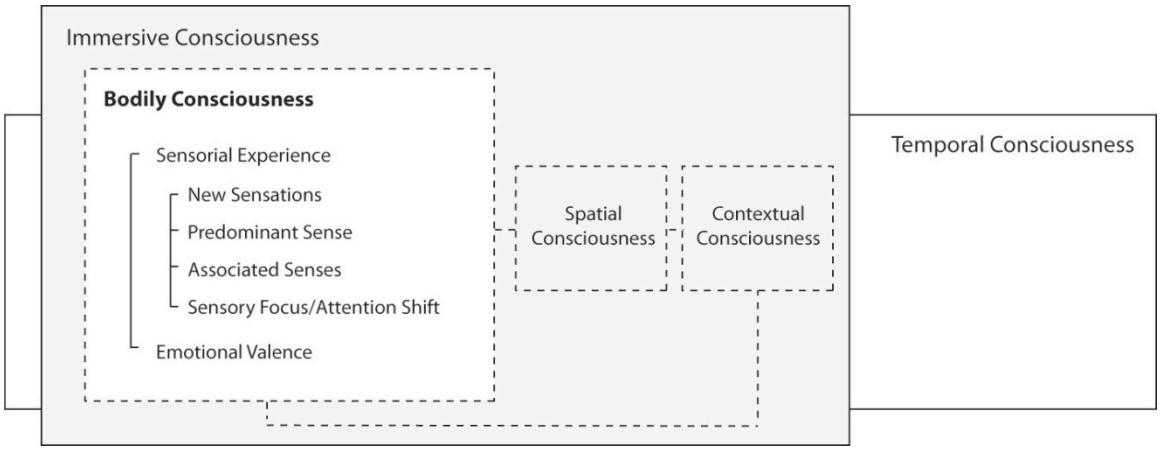


Figure 64. Bodily Consciousness

7.3.1 Sensorial Experience

7.3.1.1 New Sensations

Awe

Many participants described the experience in *Light Strings* as extremely new and said they never had a similar experience before (P1, P3, P4, P6, P8). This was connected a feeling of being overwhelmed in the sense that their experience was sensorially very stimulating (P1, P2, P6, P16, P18). From outside of *Light Strings*, the installation looks like thousands of lights floating in the air, and the lights appear very delicate. When participants walked in the installation, they reported that the visual and tactile sensation were saturated

and created a sense of awe (P11, P16, P18). This experience was mostly revealed in the sessions with lights, i.e. the *Both* session and *Visual* session.

> "it was a kind of glee that I experienced. It was new, I never seen it, it was the 'gee, whiz, wow' factor so it was very playful I felt um…uh…"[46] (P3 in the *Visual* session)

> "Never had this experience in my life. Very unique" (P8 in the *Both* session)

> "It was really hard to think of other things during that. I was sensorially overwhelmed by how cool that was." (P16 in the *Visual* session)

Disrupted sensory habituation

One of the basic general findings is that participants remember their body movement and somatic touch very clearly. In our daily life, we need to move our arms and legs to walk, but we often do not feel or recognize how we move them unless we hit something accidently or we encounter resistance, such as when moving water. Johnson and other psychologist call this "background disappearance" (Johnson, 2007). According to Merleau-Ponty, for most people, the senses of vision and touch are often unified and create "habituated background" (Merleau-Ponty, 1992). Such a habituated background of bodily experience becomes disrupted in cases of sudden blindness or cases where surgery restores sights. Unusual sensation disrupts habituated perception, just as cases of sensory loss or restoration causes dehabituation of perception (Paterson, 2007). Merleau-Ponty stated that this phenomenon can "reawaken perception" (Merleau-Ponty, 1992). When I got a Lasik[47] eye surgery, for example, I experienced a similar phenomenon. Suddenly my body needed to learn or modify my body knowledge with restored eyes. Even though I was able to see without contact lenses, my movement was slow because I needed to be sure that I was ok during this month-long period of re-coordination or re-habituation

In *Light Strings*, the habituated perception of not being aware of any tactile feeling when we walk normally became disrupted. *Light Strings* is filled with fiber optic strings at a distance of three inches from each other. Therefore, any movement in the environment causes the fiber optic strands to touch the body. Descriptions from participants revealed

[46] Unless otherwise indicated, all the descriptions came from interview data.

[47] (laser-assisted in situ keratomileusis) a type of refractive surgery for correcting myopia, hyperopia, and astigmatism

feelings about new sensations that they did not experience in a daily life (15 participants/16 participants).

> "Visually new, tactilely new experience" (P6 in the *Both* session)
>
> "It was like experiencing air" (P7 in the *Both* session)

Other sensory experiences that will be described below are also very closely related to the tactile feeling that breaks sensory habituation and re-awakes other senses. In *Light Strings*, tactility was a main sense that is always integrated with other senses.

7.3.1.2 Predominant Sense

From this reawakened sensory experience, many sensory descriptions were collected. The descriptions focused on heightened individual senses. Sometimes senses were associated together and the participants experienced what might be described as a form of synesthesia, that is a recombination of their senses.

Visual sense

Visual experience includes any experience related to visual perception in *Light Strings*. We are visually dependant. We see objects with our eyes. People pay more attention to visual information and tend to ignore or pay less attention to other senses. Visuality is privileged both culturally and biologically in terms of the amount of brain mass dedicated to vision (Livingstone, 2002). In *Light Strings*, visual elements were prominent. In general, the participants' responses about the visuals were very positive. Participants concentrated on the fiber optic lights and often forgot about other senses particularly in the sessions with lights (*Both* and *Visual* sessions).

> "It was also very interesting and very intriguing…still I was very captivated I guess by the lights so I was very much focusing on it instead of trying to listen to some other things." (P5 in the *Visual* session)
>
> "I really love it! It's a very special but it gives some sort of magical feeling….it was super pretty to have these lights on my body so I laid down and I saw all these lights around me and they also touched body so I was really integrated in the installation." (P4 in the *Visual* session)
>
> "I guess the lights give you immediate feedback maybe that's partly what's so appealing about them." (P9 in the *Visual* session)

> "I was more interested in the light because it's a more unique experience." (P8 in the *Both* session)

Participants commented that the fiber optic lights had hypnotizing and mesmerizing qualities (P1, P3, P5, P16). Some of the participants were just sitting on the floor and staring at the lights. They often forget about everything else.

> "I like watching the washing machine go. It's just like going round and round and round. I could've stared at it for a long time. Like I could do this with the lights." (P3 in the *Visual* session)

I also observed that participants were absolutely fascinated with the patterns of light that they created.

> "…going round and round and round…I could have ..it's just mesmerizing. It's like watching a screen it's like watching river you could watch the sea for hours and never get tired of it. It's the same thing, it's dynamic, it's moving. " (P3 in the *Visual* session)

> "I was using my body to create specific visual things out of it." (P16 in the *Visual* session)

Lights in *Light Strings* often create visual illusions that seem organic. Some participants saw natural elements like hills, mountains and creeks (P5), a city (P12), little dandelion seeds (p18); others connected the images to more realistic objects, such as a bead curtain, chairs, and boxes (P2, P15).

> "The fog part is intriguing now. I remember I tried to find out is it real fog so like use the smoke effect but no, there's no smoking! And then I can feel it's a little kind of blurry, almost like a roundish foggish looking, it's like a little aurora or something under each fiber so I feel like dotted but they're like this dot and if you look at it the entire thing, it feels like fog going on. But if I keep staring at it for a little bit long, then they sort of disappear." (P18 in the *Visual* session)

> "It almost looks like a landscape with the way its, um…the various lengths of the fiber. So it was very interesting sort of just looking at it at first with the lights moving around and seeing the contours of this landscape." (P8 in the *Visual* session)

These illusive images affected the participants' actions. They tried to sit on the chair and climb up the mountain (P11, P15, P16).

> "It certainly seems like this island of light that you could step into or walk into and they would crossover each other and um... it's sort of this playful thing. I spent a while just walking back and forth." (P16 in the *Both* session)

> "I kept expecting about that I'd have to start climbing hills because it looked like, the lights made up shapes on the ground."(P11 in *Visual* session)

There were a lot of metaphoric descriptions about the visual experience. They experience was sometimes described as a single image and some other times as a combined image. These metaphors helped to construct spatial consciousness and serve to rehabituate or stabilize normalcy again. More metaphoric images will be introduced in the section of spatial consciousness (See also 7.4).

One of properties of light is to help to grow and animate life. It generates energy. In *Light Strings*, people often attribute life to the glowing lights and light animation patterns. This appeared to help participants to construct meanings out of the experience and relationships with the environment (See also 7.5.3).

> "It feels like a mystical world and it's playing with you, as such as you're playing with it. So it feels like it's got a personality all on its own…it's like a game..." (P6 in the *Visual* session)

> "I thought it felt like…they're playing with me. they're tricksters but at the same time, it's keeping me company like a friend. Really weird but maybe but that's the kind of personality it was evoking to me. it wasn't a volatile or aggressive one, it was just…"what's up?"" (P6 in the *Visual* session)

> "…the green lights, those felt like they were a character…the nature of the two different lights gave them their own personality of their own. And the blue lights really felt like the space itself and when they came alive, when I started to [hands swiftly open wide]…then they themselves became something else and then the green lights were gone haha so." (P6 in the *Visual* session)

> "…its own presence or like it was its own presence in the space. And the lights were kind of alive even" (P12 in the *Visual* session)

In the *Both* session (visual + sound), participants focused on the visual elements so much, they often did not hear the sound for a long time. Moreover, when the sound was taken away in *Visual* sessions followed by *Both* sessions, participants often did not realize that there was no sound.

> "Well in the beginning I didn't hear any..I didn't give attention to it." (P5 in the *Both* session)

The *Visual* session was a visually focused sensory experience rather than a cognitive experience or an emotional experience. Therefore many participants chose as their favorite sessions the sessions with lights: *Both* (P5, P8, P11, P12, P16), or *Visual* (P4, P6). P3 had hard time to choose only one favorite session because he liked both sessions with lights.

> "…it's the difference between um…being with your husband, lover, your wife, you're out seeing a play and having a good time or being together in bed playing with each other's hair…which is better? You tell me. That's what the first and third sections were like for me. Haha" (P3 in *Visual* session)

Sonic sense

The sound of *Light Strings* was perceived as sensually very strong by the participants. The participants heard "wind or wooshing noise", "water dropping sound", "rain", and "clicking sound" (P2, P4, P7, P9) and they felt lots of changes happening in the environment. The spatialized sound was moving through the *Light Strings*. The sounds that the participants described were more realistic, environmental, and atmospheric and helped to create a sense of immersion.

> "… the wind one I guess it gave me the right feeling like the feeling of openness it was also very natural sound." (P12 in the *Sound* session)

> "It was sort of very ambient. It was sort of um…well I think it was…maybe I'm reading too much into it but it seemed like it was. I don't know, with the dark and the wind it seemed like it was …seeming very fairly desolate. But I'm not sure that it was. Kind of hard to describe, it kind of reminded me of um…being on a beach somewhere or not necessarily a beach but if you've ever been on sort of cliffs above a beach. You kind of get the rumble of the ocean."(P8 in the *Sound* session)

The participants often make connection easily between their body movements and the sound even though the sound response was not simple enough to understand the cause and effect. However, they found playfulness in the environment when interacting with sound.

> "I think maybe my playfulness was enhanced by the sound. I think the sound." (P3 in the *Sound* session)

> "It's a big percussive instrument." (P8 in the *Sound* session)

> "I even tried to make the sound myself because when I moved the sound it sounds like wind. And then I accidentally noticed that when I move through the fiber I heard the clicking of the fiber, that sound sounds like a raindrop. After I found that, I started playing with it. I intentionally touched the fiber and make the sound louder and match with the winds sound coming from the speakers and it feels like a rainstorm." (P18 in the *Sound* session)

> "Initially I feel like the sound is intensified with my movement, so if I move violently then the sound of the wind, that's what I feel, the sound of the wind become almost like a storm. So when I speed up I can hear the sound louder and tenser. It's really interesting and then I feel like a little god, I'm changing the weather of this landscape." (P18 in the *Both* session)

The interactivity described in the participant's comments above may not be pure play but it suggests an integrated inquisitiveness of the mental and physical body. The participants tried to figure out how they could create sound using their body. Through the process of figuring this out, they were more engaged and found fun in their activity and identified with the sound outcome.

> "This one was very playful, very exploratory…I spent a lot more time figuring out… in this case, I tried to play it like a percussion instrument but I had to figure out what the instrument was and what can I do with this. It's still playful because it's still me having fun and trying to figure it out."(P8 in the *Sound* session)

The interactivity embedded into the system encouraged the participants to play with physical fiber optic strands.

> "The sound of the fiber optics when they swish and when I move through them, they sound like a rainmaker, beans falling on top of each other or like grass rustling through the wind." (P3 in the *Both* session)

> "I could play with the string or with the fiber and have it make a sound, very specifically as I'm moving through it…Like I started actually treating the whole space like a percussion instrument or tried to." (P8 in the *Visual* session)

In *Sound* sessions, many (P1, P2, P3, P4, P7, P9, P14, P15, P16) participants thought that something was taken away and they perceived this as loss and a more negative valence of affect. Participants' reporting about the sound was weighted towards the negative, calling

it: very creepy (P2), empty space (P1, P3, P7, P15), and scary space (P7, P14, P17, P18) whereas sessions with lights were more positive: unique, beautify, fun, happy, joyful experience (P1, P3, P5, P6, P7, P8, P9, P11, P12, P14, P16, P17, P18). This might be related to a simple "fear of the dark." Human like to be able to see when faced with unknown environments. The sound experience was described as seeming tired, incomplete, trapped, not comfortable, and cold (P1, P2, P3, P5, P6, P7, P8, P9, P11, P16, P18). Therefore, the participants didn't find a connection to the artwork easily and they didn't care about the system as much (P1, P3, P7, P14, P15, P17, P18). In addition, the participants felt the fiber optics more on their bodies (P2, P3, P6. P8, P11, P14, P18).

> "cos in the first one, somehow I didn't realize it was actually touching my face and this time I really felt it. Maybe because I was like not looking anywhere so they were really touching my forehead and cheeks." (P5 in the *Sound* session)

> "The overall experience was quite unpleasant. Like I didn't really felt safe or welcome. So I felt like it was an undiscovered area with which no other people or where going. I didn't know where to go or what to do…It's like I was walking around the Lord of the Rings movie with the ring on my neck." (P4 in the *Sound* session)

> "this really made me feel like "okay I really want to get out of it." So I didn't feel the instinct of exploring so much and with standing still I was hoping the sounds would go away or turn off. So I tried to stand as still as possible so the strings would not move anymore."(P1 in the *Sound* session)

Because of the texture of the sound in the environment, some participants' experiences were much colder and less playful particularly in the Sound sessions after light sessions (*Both* and *Visual* sessions).

> "I felt like I could hardly wait to get out of here." (P9 in the *Sound* session)

> "…it was almost the sense of foreboding."(P16 in the *Sound* session)

> "It (*Sound* session) lost somehow some of its beauty and some of its peace, warmness." (P4 in the *Both* session)

> **"**I kept feeling like I was in a haunted house and everywhere I turn I would see a little movement and hear something and never quite catch it. And um..and it kind of felt like something was following me all the time and u and it never felt like cold or warm but like the temperature felt fine but I could never could really get to a place where I could calmly observer the environment like I was too having had heebie jeebies kind of the whole time."(P2 in the *Sound* session)

However when a sound session was first, the participants find it is more or less playful, relaxing, meditative as explained earlier.

> "I felt calm, I felt…just a sort of state of meditation almost…I felt relaxed and just at peace. Just at peace and playful."(P6 in the *Sound* session)

> "that I felt more linked to the sound in the space." (P12 in the *Sound* session)

> "I started to explore with the strings, they were kind of like the safety net and at the same time…the control too." (P14 in the *Sound* session)

In the *Sound* session, the participants provided more narrative descriptions to describe their experience. Sound helped to set an imaginative context (P2, P18).

> "you don't actually want to go through them but you're totally encased but you know the wind is going and it's..the storms about to happen or um….yea and that maybe even that you know there is stuff on the..you know what leaves on the ground on whatever but they're not, you're just really feeling like you're kind of stuck and can't get out before the storm breaks a little bit." (P2 in the *Sound* session)

Tactile / Kinesthetic Tactile sense

The *Light Strings*'s space was always tactile, touchable not only by hands but through the whole body skin. It has a quality of breaking habituated background senses and evoking unique experiences as compared to watching something on a screen. There are many engaging material properties of the space. In the participants' descriptions, this was very strongly perceived and evoked a feeling of magic qualities. In *Light Strings*, participants actively touched the fiber optics but at the same time, they were being touched by the strings.

> **"**It was different from the air you don't feel anything in the air. I was in an environment that wasn't really solid but I could feel something and I could see something but I was also free to move. It was different, like you can see the air but it's also you can freely do whatever you want but…also feeling something." (P7 in the *Both* session)

> "There was this touch experience of being touched by the tendrils." (P16 in the *Both* session)

> "The textures of the fiber glass which was um…it's a weird texture. On the one hand everything is um..malleable. like the installation is a whole and you can kind of mold it and there's also a kind of resistance to it like I can't draw everything in, no eventually some things fall away and I just kind of let go,

> it's just kinda like I can't do that oh that's okay. And you know there's the fiber glass is kind of…there's a hardness to it ..." (P3 in the *Both* session)

The participants immediately felt fiber optics on their body as soon as they entered. Through tactile perception, they constructed the understanding of their surroundings by expanding their peripheral vision.

> "They felt quite uhm... I don't know what the word is, sort of like transparent (waves hands as if swimming with a frog stroke) like I could go through them without feeling blocked or guided in any specific way. Sort of like feeling in a forest or underwater, or where you're surrounded by stuff, but it's not closing you in." (P1 in the *Visual* session)

Tactile experience often connects to affect. Touching fiber optics induces a positive or negative valence. In *Light Strings*, when it was positive, they felt the physical weight of fiber optics as very light and cool to touch. However when it worked as a negative valence, they felt that they were in a cobweb and someone was pulling them.

> "I enjoyed it because it felt very playful I guess 'cos the lights themselves felt like their own presence." (P12 in the *Visual* session)

> "I would feel them getting caught in my hair and pulling that way. And I was sort of moving quickly through it, I found that, several would bunch up around my neck and my arm and they would sort of slide off and pulling off. There were always cooling and smooth to the touch. It's not at all warm" (P8 in the *Visual* session)

> "… it felt like I was…um…touching a lover's hair or something like that. When I was…'cos I closed my eyes for a few minutes so it's almost like I'm caressing somebody's hair." (P11 in the *Sound* session)

> "They felt a lot like cobwebs. I noticed more this time than others that they would really get caught in my hair sometimes and a couple of times they got me around the throat and that was really you know I think it happened in the other ones but here it really stood out and something was really trying to grab you." (P2 in the *Sound* session)

Sometimes, the fiber optics strings forced people to move and explore the space. Fiber optic strings sculpted by the participants' movements encourage them to move more to create different shapes or fix the strings.

> "Almost like you walk through an intense forest. You feel like you need to make your way." (P18 in the *Both* session)

> "I tried to push away a lot of the strings and create a hole or a space around me and the effect of that looking down at all the lights was really neat because you can see the darkness all around you and the glow of the lights off in different directions and that looked really cool." (P1 in the *Visual* session)

The participants' experiences often show that when people get used to it, they tend to forget the fact that they were surrounded by fiber optic strings. In the beginning of their experience, their touches were very gentle and careful. In the later sessions however, they cared less about the strings and began creating bigger movements.

> "I was kind of afraid to grab the strings too badly so that made me interact with it carefully which made it also a more new experience and not just go in there and walk and run around but very gently and careful." (P4 in the *Visual* session)

> "…the very beginning it was wrangling me it wasn't unpleasant but it made me feel very careful but I kind of lost that during the experiment because I kind of feel like it was kind of really solid and it doesn't really matter if you can't easily unwrap it if it turns around. It makes me more feel free to move however I want." (P4 in the *Both* session)

Tactile sense affords a very rich experience because of direct contact to the skin. Through touching fiber optics, the participants found a stronger relationship with the environment.

> "It's not an insecure feeling but the string's kind of cold, I can sense the temperature and this time, when you walk passed the string, I can feel there's some lighting moving up from... cause when your hand touch the string, it feel like there's some lighting moving up to the body. I feel like I can become another person. I could be an alien or something with the light moving." (P15 in the *Visual* session)

7.3.1.3 Associated Senses

Many of the participants said that they noticed two sensations at the same time. Senses worked together. In particular, the *Both* session showed a combination of sensory elements that really came together effectively. The associated sensations helped the participants to get engaged and immersed in the environment and created emotional and imaginative experiences. When the participants noticed two or more sensations at the same time, they often constructed associations and found meanings.

> "It's kind of in my mind that started unifying the phenomenon. I unified and I found, so the landscape changed cold now, so it's kind of like winter and the color becomes blue. I feel like it's snow, like the sound intensifies. When I'm in that mode, then I start to kind of feel a wholesome experience…I felt that would be a unified experience. (P18 in the *Both* session)

Always with tactile

The tactile modality functioned primarily to integrate with the other senses. When other senses (visual or sonic) are prominent, the tactile sense intensifies those senses. In addition, the physicality and materiality of the fiber optics extended and enhanced the perceived quality of dynamicism.

According to Merleau-Ponty, vision and touch are often unified through the lived body. There are active correlations between the data of vision and that of touch (Paterson, 2007). In *Light Strings*, the visual was always tactile because the space was full of tactile elements. Even though participants might not have noticed direct tactility, there is a notion of metaphoric and magic qualities of the feeling.

> "I think that for some reason I had a hard time trying to focus on both the lights like the visual and the sound at the same time but it was quite easy to focus on the physical sensation and the sound at the same time or the physical and the light…kind of either one." (P2 in the *Both* session)

> "It would start to feel like rain and they were kinda cool to touch and the way that the light is bouncing off of them is more like water." (P2 in the *Both* session)

> "As I was moving through the fiber optics I just felt again that tactility but also the visual beauty of the lights combining together and moving away. And so that really had my focus for a really long time." (P6 in the *Visual* session)

Many participants described the *Sound* session as feeling more whole body experience for them because they did not really see anything except the fibers optics. Therefore, their attention was on the sounds and the feeling of the threads on their bodies. Sound works as an intensifier of tactile sense, so there is a reciprocal intensifying effect.

> "I see the fiber sticks more than before [when] I only see dots right mostly the bottom. I didn't pay attention to the tip. And now I paid more attention to the stick. I grabbed them. I had that little moment. I grabbed it and I was looking at it." (P18 in the *Sound* session)

> "I felt like...outside but this time I was caught in the rain or something. the fiber optic cables were almost like rain falling on my face especially with the sound effects adding to that experience, but I also felt more uncomfortable like I could really feel them against my face this time." (P11 in the *Sound* session)

> "…on the sensation against my face and forehead felt stronger this time." (P11 in the *Sound* session)

> **"**...it seem to reinforce it. especially when the wind effect came up, it really felt like I was walking against the wind and the fiber optic cables…I thought it was rain." (P11 in the *Sound* session)

The strong negative feeling in the *Sound* sessions created by the touch of fiber optics often triggered visceral feelings.

> "I felt the weight of the strings on me more…I was less inclined to dance and more inclined to fight in this version of it, for whatever reason. I didn't really want to do dance moves." (P16 in the *Sound* session)

> "I was much more aware of the pressure from all sides of the different points of contact and less aware of the playfulness of the surface as a result." (P16 in the *Sound* session)

> "…here it really stood out and something was really trying to grab you." (P2 in the *Sound* session)

When the tactile sense grew familiar for the participants (they habituated to it), it became a background sense. In this case, the participants became aware of the sensorial association of visual and sound elements.

> "I felt like they did bring something to the experience because then, you know, lights you can focus on something and sound is always around you so it um…it did bring back also these memories of being in the grass or in nature with the wind around so this I think helped a lot because only with the lights I don't think I would've felt the same." (P5 in the *Both* session)

The carpet on the floor of *Light Strings* created a soft and safe feeling. It worked as an indicator of the installation in a dark space (P16). The participants understood that when they were on the carpet, they were in the environment.

> "I could feel the softness of the carpet on my feet. And I was thinking that was like walking on grass or something." (P11 in the *Visual* session)

"It was confusing for my feet but not like not necessarily in a bad way either it was just different."(P12 in *Visual* session)

Connection to somatic sense

The participants' bodies stored the feeling of the tactility of the fiber optics and their sensation of it was persistent. When I was conducting interviews, some of the participants illustrated that they still had the feeling that the fiber optics were still on their necks and shoulders. This is a similar feeling to skiing for a long time, where the legs still experience they are on the snow with boots. In addition, the participants became more aware their body condition: coldness, warmness, and hunger.

"…the third time around it felt a little colder inside I guess. Um…I think maybe that was maybe because of the sound that made it feel like that. Um..because I didn't get that feeling of coldness during the second one." (P12 in the *Both* session)

"I became aware of the fact that I have a cold." (P3 in the *Both* session)

"It feels like walking under water or something. Feel like some kind of water or wave.…I feel like something behind because I feel like something's on the back, things like that." (P15 in the *Both* session)

7.3.1.4 Sensory Focus/Attention Shifts

I found that as participants started to associate and notice connections between their senses, they shifted their attention and sensory focus. This attention shift made it apparent that people could not focus on many distinctive things at the same time. One sensation is always stronger than the other. This sensory-dominance informs how they came to understand of the environment and how they felt immersion in the environment.

"Yeah, I didn't notice any sound or uhm... smell or taste, obviously. I think I was pretty focused on the space." (P1 in the *Visual* session)

Their attention transformed their experience. This illustrates some of the unique qualities of *Light Strings*. In many cases, shifting your attention is not going to transform your experience that much. In *Light Strings*, the participants shifted their attention intentionally and unintentionally. Intentional shifts of attention were undertaken to discover the functions of the elements of the installation. After they discovered the functions or

interactions, they tried to focus on some of the other elements. In some instances, participants described blocking out a certain sense such as hearing or seeing in order to not be distracted from a sensation that was providing more pleasure.

Light Strings also provided an opportunity to shift attention forcefully (13 participants/16 participants). Because the environment has multiple dynamic elements, it utilized triggering to change participants' focuses. This made the participants discover different aspects of the environment.

> "I think I kept trying to figure out what the sensation was of everything at but…everyone just can't focus on everything at once right? It was interesting because it was always kind of like oscillating between light and sound, and then, light and tactile, then, sound and tactile, and then um…yea cause I think when I was focusing on the tactile and was trying not to look at the light directly, I became more aware of the sound again …" (P2 in the *Both* session)

> "I guess you know, when I started looking at the lights and getting lower as I'm looking at them. I think I kind of….I kind of shifted focus away from what I was hearing I didn't notice it as much. But when walking through and not looking at the floor and trying to keep my gaze up , especially that little 'plunk' noises, kind of started to sound like something gathering and falling Um…which I think kinda helped the feeling of rain or of um…more just like something is falling." (P2 in the *Both* session)

> "I have both moments, some moments is unified. Some moments it might be split." (P18 in the *Both* session)

> "Predominately, one sense would kind of be in my attention first like the texture of the floor. And then that texture would prompt me to act, like lay down. From there I would notice other things. Then I would notice, I would notice the sound, the pattern of the light, the colors of the lights and once all of those had been put together, I would experience an image. Like an image of a map, the image of the universe in its infancy."(P3 in the *Both* session)

7.3.2 Emotional Valence

The *Light Strings* experience evoked strong feelings. The participants' experiences were described with emotional valence[48]: both positive and negative. The descriptions of the participant's emotional valence revealed that their valence was mainly affected by sensorial

[48] "Valence" is a term used to characterize and categorize specific emotions.

experience in the space. The participants also described that they were able to notice their feeling through their bodily reactions.

7.3.2.1 Positive Valence

The participants' emotional experiences combined elements of diverse positive valence: relaxing, joyful, playful, and creative.

Relaxing / Joyful

A relaxing and comfortable feeling was most often reported from the participants. The environment made participants calm, peaceful and relaxed (P4). They were able to feel those positive emotions because their body responded innately in that way. They felt a smile on their face and some buoyancy in their chest (P16). They could not control it. These reflexive reactions reveal that the relationship between emotion and sensory experience is very critical.

> "The second one (*Visual* session) felt really closed in and yeah like comfortable and intimate." (P12 in the *Both* session)

> "…in this environment, I felt relaxing whenever I was free to do whatever I want…I think even in the middle I felt more relaxing." (P7 in the *Visual* session)

> "There's something that make you feel release from your stress, something. I feel something on my body but it's not that much." (P15 in the *Both* session)

> "I didn't have a strong creative impulse as I did earlier…uh..my mind was um..more blank with yea I just kind of allowed to zen out." (P3 in the *Visual* session)

> "There was a sense sort of jumped into this experience and it immediately splashed out and rippled out all around me and it was this real sort of this sense of happiness actually. I was expecting melancholy or sort of meditativeness or peacefulness and instead it was absolutely happy and joyful. It was just really neat because I'm pretty jaded about new media art and these experiences so it's rare that I have one of those experiences where I'm just like sort of authentically enjoying it." (P16 in the *Both* session)

> "I think a lot of people associate light with safety, and being okay."(P6 in the *Visual* session)

Playful

Light Strings was repeatedly described as being playful. Mostly in *Both* and *Visual* sessions, participants found playful aspects while touching the fiber optics and seeing the light patterns. This is different from art appreciation in general, such as viewing artworks from a distance. Participants physically play with the installation and feel happy and engaged with it. They even felt connected to the system (P3).

> "I guess on the inside like happy. Made me feel kind of happy and playful to be in there." (P9 in the *Both* session)

> "It (*Both* session) was just playful throughout. There's so many different attributes to this space than there was the first one. And that's why I think it was immediately, playful and engaging." (P6 in the *Visual* session)

> "It looks like that lights want to interact with me."(P12 in the *Visual* session)

> "The first session (visual), was playful. Where it's just fun to be in a space and experience it. It's fun to see how the lights move and see what happens when you run in a circle really fast." (P8 in the *Sound* session)

> **"**Oh it's playful in the *Both* session when I'm doing that and also when I'm walking through or waltzing or dancing through and that's being playful too because that has an effect." (P11 in the *Both* session)

> "I had this childlike experience of them. It was a nostalgic experience, really." (P16 in the *Visual* session)

> "…it did feel like I was going more back into childhood." (P5 in the *Visual* session)

Creative

The playfulness of the installation evoked the participants' creativity while they were creating light patterns as well as spatial sound using their body. Some participants described a "flow" state in creating patterns (See also 7.4.3) but most of them expressed pure aesthetics of creation from their movement (P7, P16).

> "I really enjoyed that I felt 'cos being creative and experimental at the same time and it was creating beauty and it was really nice."(P11 in the *Both* session)

> "The third experience (*Visual* session) was being a pure experience of that, "these are fiber optics. Fiber optics are neat, they're awesome, they're fun to play with, look at all the awesome things you can do." (P16 in the *Visual* session)

"The lighting that appears. And um…so I thought it's like a mirror but something that is like …like I'm causing it appears but it appears after I do something. so I wanted to move creative in my movements so I wanted to be more free so that I can see different lighting yeah." (P7 in the *Visual* session)

"What I was trying was to create inky pools of blackness by pushing the lights away." (P11 in the *Both* session)

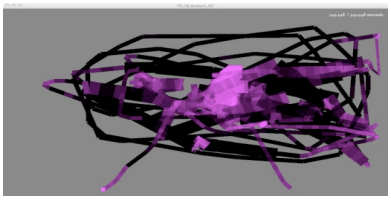
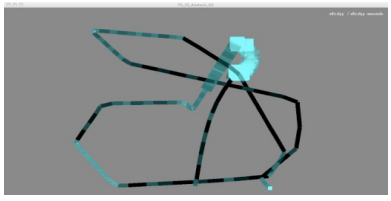
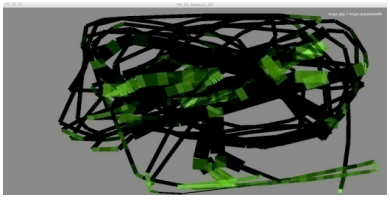
7.3.2.2 Negative Valence

Some of artistic components' of *Light Strings* created emotions with a negative valence. In terms of sounds, the participants perceived an unwelcoming and scary feeling (14 participants/16 participants). The combination of the sound and fiber optics fostered negative valence and affected the qualities of their experience.

"It made me feel more like I wanted to get out of there. It was like uh a spider web but with a different texture. Something like that made me feel like trapped." (P9 in the *Sound* session)

When participants had negative feelings in the installation, their experience sessions were much shorter (15 participants) than other sessions. Table 5 shows P3's trajectory, speed and movement. P3 reported the *Sound* session was cold, lonely and did not want to stay longer. This participant left the *Sound* session in 4minutes and 48 seconds. This is about half as long as the *Both* session and shorter than one third of the *Visual* session.

Table 5. P3 Movement Data

P3		
Both Session (9:10)	*Sound* Session (4:48)	*Visual* Session (17:27)
		

7.4 Spatial Consciousness

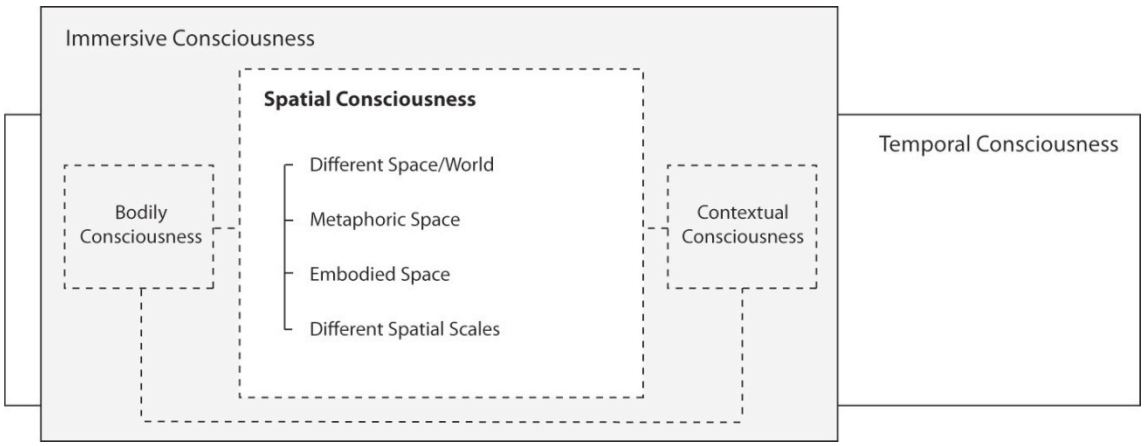


Figure 65. Spatial Consciousness

Many participants described *Light Strings* as a space not an object. This is important that they perceived it not just by seeing with their eyes but via embodied seeing through the whole body. *Light Strings* provided an opportunity to expand their conscious experience through the space. In this section, I will illustrate how spatial consciousness developed through bodily experience. Participants' spatial consciousness can be characterized by an emphasis on the sensation of a different world, metaphoric space, embodied space, and vast or proximal scales (Figure 65).

7.4.1 Different Space/World

In the installation, many participants experienced a different space/world, very different from outside. Moreover the participants' experiences in each session were very different depending on the computer generated visuals and sound. At a basic level, the space was physically always the same, only the media changed. In general, where it was visual-centric, the space was perceived as warm, enclosed, meditative space (P1, P2, P3, P9, P6, P16, P18). Many participants described these different worlds using metaphors from their memory, movies, and books. This will be covered in the metaphoric space section (See 7.4.2).

> "When I walked into the space, it's kind of like walking into the sea or on water." (P15 in the *Both* session)

"I feel like I'm in Narnia, a little bit. Like there's a lot of different worlds happening and, …depending on a lot of different factors, you know what level you're at [levels hand high and low], where you are in the space [cradles hand back and forth in air], what you're choosing to pay attention to more at the moment and where you're looking…all totally change that world a bit." (P12 in the *Both* session)

"I feel like I'm in a different space; some kind of entering into another dimension or something – a space that you can explore, but at the same time, you feel like you're floating. You feel the curve and things like that." (P15 in the *Both* session)

"because of the height difference of the strings it really occurred to me like a landscape so I was walking around in this new world." (P4 in the *Visual* session)

"…the darkness and isolation was very strong. So it felt like uh…it did feel like I was in a different space already just kind of when cross that threshold…It felt like this alien environment kind of to me." (P12 in the *Sound* session)

"Cos as I say the moving through the fiber optic cables almost feels like using the swimming motion so it's like you're swimming but at the same time the feel of them on your face it's like you're going through a thick undergrowth so it's on dry land going through a forest and at the same time you're swimming under the ocean." (P11 in the *Visual* session)

7.4.2 Metaphoric Spaces

After experiencing *Light Strings*, many participants told me that it is difficult to describe their experience in words. In the process of perceiving the space, the participants attempted to relate their bodily feeling to their previous knowledge or experience using metaphors (all 16 participants). Qualities of physical sensation evoked metaphors. The prevalence of metaphors means that as the participants were paying attention to their physical sensations, their imagination generated metaphors for the experience. The richness of poetic description really came from the interplay of their experience with the media of the system. This shows the success of the piece in terms of immersion.

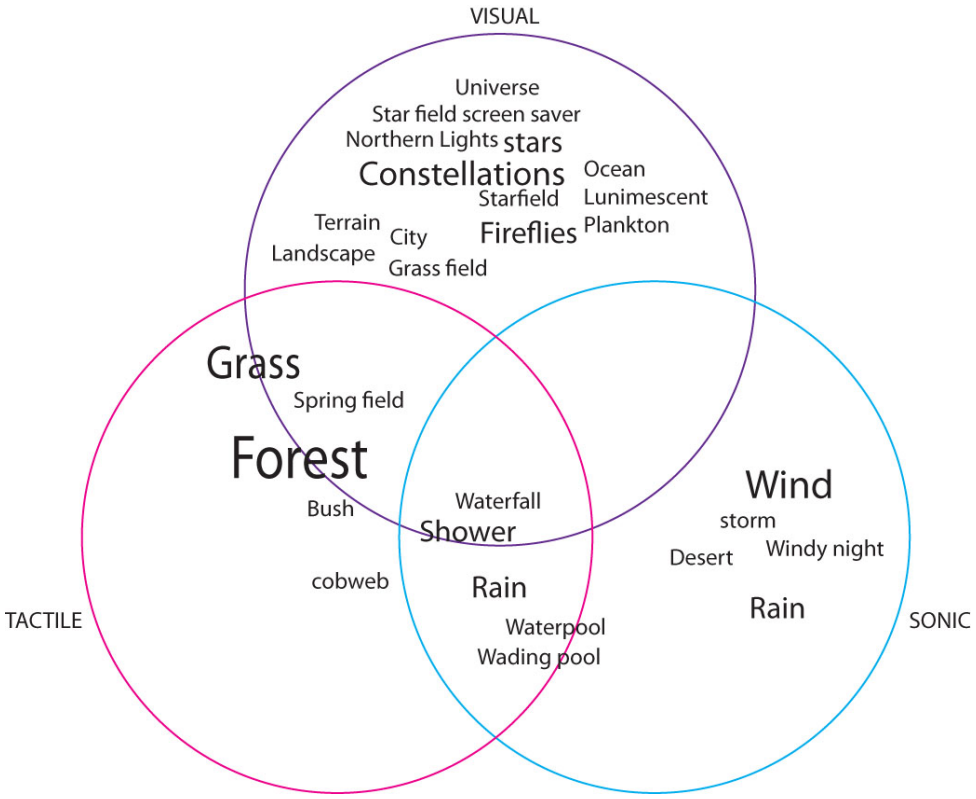


Figure 66. Metaphoric Spaces

Figure 66 is a visualization of word frequency in the descriptions of the participants' experience drawn from the written responses and interview data. All the metaphoric words for the space were collected and categorized by sensory modality. Some metaphors directly represent visual, sonic and tactile space such as fireflies and northern lights for visual space, wind and storm for sonic space, and bushes for tactile space. However, there were metaphors representing associated sensory spaces such as grass field for visual and tactile association. Different aspects of the sensory experience helped to build imaginative metaphoric spaces.

7.4.2.1 Visual Metaphors

Participants used visual metaphors to construct their own space. In this section, I will examine some of the visual metaphors used to describe the space. Due to the luminous characteristics of the installation, many metaphors directly connected to the experience of the fiber optic lights. Stars and constellations were the most common metaphors. Almost all

participants used metaphors related to stars, such as northern lights (P9), constellations, a star field (P8), the star field Windows screen saver (P8), and the universe (P3, P4). Some participants mentioned imagining luminescent sea creatures (P1, P3) in the deep ocean. This made him/her feel immersed in the ocean. Similarly fire-flies were often used revealed as a visual metaphor.

> "…they remind me so much of fireflies and when you're a kid you would used to want to catch those things or want to see how they reacted to you you know so it reminded me a lot of them." (P12 in the *Visual* session)

Another popular visual metaphor was "landscape, city, and topology." This was because of the surface created by the end tips of fiber optic strings. They had different lengths and were perceived as terrain as a whole.

> "I felt like it was as landscape moved by nature." (P5 in the *Visual* session)

> "I could see the terrain. It was almost like looking at a terrain of um...it was like looking at the topographic map of some imaginary country in some imaginary world…um…and I could almost like um…I could almost imagined these little villages and tiny houses, yea, on the terrain." (P3 in the *Both* session)

These visual metaphors help participants to construct their space, conjuring a magical, dream like feeling.

7.4.2.2 Visual + Tactile Metaphors

When the participants moved in *Light Strings*, they often associated visual experiences with the tactile experience. It is also known that visual and tactile senses are combined and work together in many cases (Merleau-Ponty, 1992). In *Light Strings*, participants noted that tactility enhanced qualities of imaginative visual metaphors as well as added mobility. Metaphors of grass, a spring field (p18), forest (P15), and countryside (P11) were used to illustrate how they perceived the space. The metaphors were not static images. The participants remembered movement and the bodily feeling of the metaphoric spaces.

> "I started thinking of how grass moves and the wind… I started trying to mimic, this sounds goofy when I say it, but I was trying mimic the wind in the space." (P8 in the *Visual* session)

> "it felt like when I was a child running in the grass field and seeing like grass moving or when the wind is moving also." (P5 in the *Both* session)

7.4.2.3 Sonic Metaphors

In the descriptions of the participants' experience, metaphors to describe the sonic space were very visceral and had predominantly negative valences: lonely, cold, dead, wet, etc. Water dropping sounds[49] evoked feeling of being in the water (P5) or outside in a rainy day (P7). Another metaphor frequently used by the participants was of a desolate space. This space concerned loneliness, coldness, and death. The participants imagined that they were standing in a desert at night (P1, P2) or outside in the future where everything is dead or disappeared (P2). They felt more like being in a movie or story.

> "… sound maybe just brought me back to some of the experiences in the past or some experience with the scene that you read from a novel or you watched from a movie." (P18 in the *Sound* session)

This kind of negative quality of the spatial sense influenced participants' movement in the installation. Most participants didn't move a lot. They often stayed in the middle of the space and reported that they became aware of their body temperature. They felt cold in the sonic space.

> "I feel totally 'creeped' out and that I feel like that if I'm standing still I can't see what's behind me and I felt like I needed to be more aware around all directions…" (P2 in the *Sound* session)

> "It was very different. It was a much colder experience… I could feel the coldness of the fiber optic tendrils very clearly on my neck and ears wherever it contacted my skin as I walked through it" (P16 in the *Sound* session)

7.4.2.4 Sound + Tactile Metaphors

It was apparent that the participants felt the physical fiber optics more prominently in the *Sound* sessions. When they were moving through the fiber optic strings, tactile feeling was merged with sonic experience. When the tactile sense came to the foreground and the

[49] The artist didn't produce a specific sound like a water dropping sound. This was described by participants.

sound became faint, the participants produced more positive metaphors about the space. The space was described as a waterpool, evoking the feeling of being immersed in the water.

> "I'd still think it like drops so it did feel like in the water. Maybe this was also because I could feel the threads everywhere so that, you know, when we have air everywhere but we don't really realize it because we're always in it but when you get in water, you feel like 'okay I'm surrounded by something." (P5 in the *Sound* session)

> "I imagined it's like walking through a continuous waterfall, in a sense. There are definitely moments where I got visuals, very cinematic visuals of beautiful people walking through waterfalls and having water bouncing off their bodies and cascading down." (P16 in the *Both* session)

> "…swimming through the space, parting the curtains of the tendrils to wade into it deeper." (P16 in the *Both* session)

When people focused on the sound more, the tactile sense became habituated and this amplified the negative qualities of the sonic space.

> "They felt a lot like cobwebs. Like they would um…I noticed more this time than others that they would really get caught in my hair sometimes and a couple of times they got me around the throat." (P2 in the *Sound* session)

> "I was there was um…kind of walking through a plants or like lots of blackberry bushes where you know you've got a very narrow corridor." (P2 in the *Sound* session)

7.4.2.5 Tactile Metaphors

Even though tactile senses tend to link with other senses, there were obvious characteristics of tactility in *Light Strings*. The tactile metaphors that the participants used were mostly natural. The fiber optics environment became forest, a grass field, bush, waterpool, and shower. These metaphoric spaces are very immersive and require whole body movements.

> "I also felt like when you're in the shower or if in the rain and they have negative ions and it improves your mood? It kind of made me have that same kind of feeling like being in the shower and having a little bit of an uplifted feeling like that." (P9 in the *Visual* session)

Another environmental aspect of *Light Strings* was the carpet on the floor. Because the participants were asked to take off their shoes in the installation, they were able to

perceive the floor very well. Generally the carpet provided a soft and welcoming feeling because of the cushiony fabric. This sometimes helped to construct a natural spatial sense because it felt like *walking on the moss* (P11).

> "It felt like….run around in the fields with and through the tall grass or something and there'd often be moss underneath your feet and it felt very nice. A little bit springy 'cos you know moss is usually very thick." (P11 in the *Visual* session)

7.4.3 Embodied Space

Space is often defined by constituent and their behaviours: how inhabitants make a connection to environmental behaviors and how they frame it constitutes their space. If we look at *Light Strings* in terms of experiential qualities, it can be interpreted as a playful and meditative space. The most obvious qualities that the participants felt from the space were playfulness and meditativeness. These were characterized by the participants as extremely embodied. In the descriptions of the participants' experience, two different spaces (playful and meditative spaces) were being appeared depending on interaction with the environment.

7.4.3.1 Playful Space

There were several components that the participants found compelling. Physical play with the fiber optics was one of them. The participants gathered them up and touched them to make light patterns or cover their body with lights (P3). Some participants reported that they could play hours in *Light Strings* (P3, P11, P16).

> "I was much more comfortable just letting them drape over me and watching the lights fly by as I walk through it... I got a very distinct feeling of how the moving through this collection of tendrils would be how you'd move through a bamboo forest on a very different scale and then I got a distinct visual of sparks and fireflies with it. So yeah, that was my initial response to it." (P16 in the *Visual* session)

> "It was the opportunity to really play with different interactions of the light and different uses of the light. And so I spent a while gathering up as many of the tendrils as I could and releasing them and watching them spread out. I spent a while sort of crouched down, moving backward watching the light sort of sweep past my eyes. I did a lot of arms spread walking across the

space because it's my favorite thing to do in there now." (P16 in the *Visual* session)

"It felt very playful, kind of organic experience. It was very flexible and fluid and promoted my curiosity and sort of seemed to engage back because it was responsive and I really liked that. I just felt very open to it and sort of calm and curious at the same time. Fairly quite emotions, as opposed to excitement or something more energetic. It felt quite relaxed." (P1 in the *Visual* session)

They also made sound from the material. Sweeping and releasing stings with big open arms created nice wind sounds as well as some entanglements. These physical sounds as well as the interactive sound components enhanced the playfulness and energy of the piece (P16).

"It was really encouraging me to move around more and want to do more stuff like that just because it felt like there was more happening in the space because of that." (P12 in *Both* session)

7.4.3.2 Meditative Space

The space often became a relaxing and meditative space. Many participants sat and laid down on the floor. They stared at the lights. It was obvious that the installation created a mesmerizing quality that made many people feel calm and relaxed. The fiber optic strings would slightly sway in the air and the projected lights created a subtle but continuous light shifting. According to participants, it was similar to watching fireflies flying around. They attributed life-like characteristics to the fiber optic computer-generated light patterns.

"Very small like um..at one point I just started collecting one string with another string and looking at it and then another string..it's like watching insects. As opposed to running around in a forest trying to climb trees. That's kind of the experience, it's more quiet, more gentle, more detail. And less um..intrusive. yea. It was almost like…So for example I'm watching an insect or like.it's less intrusive than climbing a tree. And in this case, it's like watching this individual strings was less intrusive in than me running around the space which I did in the end." (P3 in the *Visual* session)

Meditation is a practice which involves cultivating a feeling or internal state awareness. There are so many different styles of meditation practice and some of them

require long-term professional practice. Without any training, *Light Strings* provoked meditative qualities through the experience of an immersive artwork. Since meditation techniques have been used in clinical settings as a method of stress and pain reduction (Everly & Lating, 2002; Wilkinson, 2000), future research between interactive immersive art and meditation seems possible.

7.4.4 Different Spatial Scales

The most interesting phenomenon of the immersive experience observed was that the participants perceived the space at widely different scales. *Light Strings* was perceived as two environments (vast and proximal) at the same time. The idea of multiple worlds means that the participants were able to connect to the physical sensation of vastness at the same time as noticing intimate poetic extrapolations. The specific amount of space in the installation was really contained. The participants were contained within the space but their subjective responses expanded beyond it. However, the space was often sensed and perceived as differently sized in a positive sense, evoking a feeling of wonder.

7.4.4.1 Proximal Space

Subjectively, *Light Stings* became a very small space by creating qualities of cocooning, or a wrapped, comfortable, safe experience in a positive sense and entrapped in a negative sense (10 participants / 16 participants).

> "Here, um..i felt causative, I felt like I was wrapped in sensation with the felt of the floor, by the dancing light you know. It was more you know immersive I don't know but it felt like it was more of a cocoon." (P3 in the *Visual* session)

> "It's very comforting and subtle wrapping of…accompaniment, for a lack of a better word…" (P6 in the *Visual* session)

> "I spent a lot of time on the ground and um…it started to feel like I was in a cave with either glow worms everywhere they were hanging by silk or um..or it was like treasure mountain there's jewels everywhere." (P2 in *Visual* session)

> "I am in the protected shell." (P15 in the *Visual* session)

The proximal reports arose mostly from *Visual* sessions. In *Both* sessions, people's experience oscillated between a small and big space. When people felt the space was small, sound sensation was ignored and visual sensation was saturated. To create a small and warm space, light was a critical component.

> "So comparatively the first one (*Both* session) really felt like I was entering into an ecosystem that was surviving on its own and I was just observing and temporarily affecting things. Whereas the second one (*Visual*) kind of felt like I was either moving into a very small space or was um..very far away from anything and even though I could still affect it slightly it wasn't quite as much." (P2 in the *Visual* session)

7.4.4.2 Vast Space

The participants also reported images of big space: the universe, landscapes, the ocean, etc (15 participants/16 participants). Their experience of a big space represents loneliness, freedom, and wonder. This idea expands perceptual awareness and breaks personal limitations. One example of a big space was an ecosystem. An ecosystem is a biological environment consisting of all the organisms living and interacting in a particular area. This idea of a larger space includes connection to a greater world.

A big space was mostly experienced in sessions with sound components. In these session, the perception of the space was vast and created emotional feelings of loneliness as well as freedom. Negative valence in *Sound* sessions amplified the spatial consciousness of vastness.

> "I couldn't see where they ended; there was less of a sense of the space - the bounded space. It felt a little bit more limitless, but that was intimidating. It wasn't this finite, contained space. It was this open space."(P16 in the *Sound* session)

> "It added more I guess like the first time (*Sound* session) around it made it feel larger or made the space feel vaster than it seems on the outside so I was going through it." (P12 in the *Both* session)

> "it just felt kind of vaster for me 'cos it would…it was strange 'cos it would give me this image in my mind that I was outside or kind of in this open space" (P12 in the *Both* session)

> "…the inner imagery I kind of had in my head of being outside or in some open natural space, like that was really clear in the third one." (P15 in the *Sound* session)

"I didn't know how much of there was around me. it felt more endless." (P14 in the *Sound* session)

When the participants felt the space a large, some of them tended to move less. They were overwhelmed by the space and felt lonely and scary. However some other people were encouraged to move around more to explore the vastness.

7.5 Contextual Consciousness

This section describes how the participants learnt about the space and built meanings from their experiences. Contextual consciousness consists of phases of initiation, active interaction and construction of meanings and relationships (Figure 67).

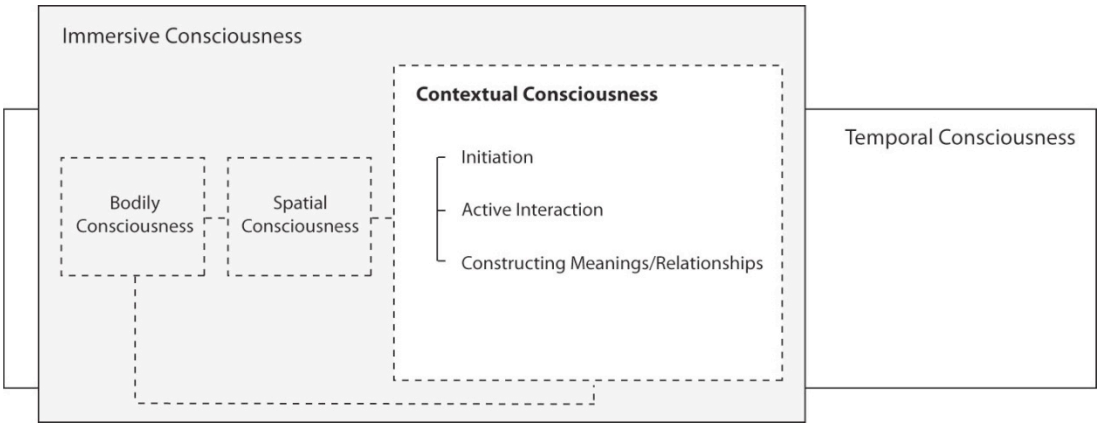


Figure 67. Contextual Consciousness

7.5.1 Initiation

7.5.1.1 Safety Check

When participants came to the study, I guided them to the installation and they started their experience from the outside of the installation. Even though they were told that they could enter and do whatever they wanted inside of the environment, some participants hesitated to touch and walk in *Light Strings*. I observed that the participants waved their fingers passively to see if they could enter. This action implies a "safety check" to start

something. The participants tried to ascertain that the environment would be ok for them to enter and that they would not be harmed in the environment. This phase of *checking safety* is reciprocal and builds an initial basis of belief in the environment.

> "At first they felt really delicate and so I didn't want to break anything. Uhmm but they seem to be fine with different kinds of movement." (P1 in the *Visual* session)

7.5.1.2 Passive Waiting

I observed that when the participants entered the environment, they often had a tendency to stand still and look around patiently. Their movement was very subtle and limited. They perceived that the environment was quiet but it looked like something would be happening soon (P3). The environment thus appeared to evoke curiosity and wonder but participants also described *Light Strings* as having a calmness and groundedness in it.

> "Like almost before the big bang when things were waiting for something to happen. There's a kind of waitingness, this suspension in time um…like um…I'm also reminded of this scene C.W. Lewis, 'The Lion, The Witch & The Wardrobe', one of the Narnia series, um..when the children are transported into the world of Narnia before it was created and there was nothing. There was only just kind of stars waiting. And that's what it reminds me of, the birth of the universe." (P3 in the *Both* session)

7.5.1.3 Initial trial

During the passive waiting phase, participants built assumptions about the environment and interactions: what they would be able to do within the environment and what would be going to happen. The initial trial phase consists of a short iterative loop of trials (assume/try/discover). When participants come to an art installation, particularly interactive art, they have some expectations about the piece based on their personal knowledge and cultural and technical background. Participants try simple things based on their initial assumptions and compare the outcomes to their assumptions. Many participants in this phase moved across the space for a short time and stopped to see or hear environmental responses. The participants still kept their passive attitude towards the environment. They tried different things based on curiosities about the affordances in *Light*

Strings. For example, P7 tried to press an illusive button created by points of lights and P9 climbed up an illusive mountain to see what might happen.

Some participants referred to this phase as a beginning stage of the meditation process. Participants made their bodies get used to the environment. It was a calming down process.

> "I think for the first few minutes when I'm trying to get used to the environment it almost like the meditation. Like when you go to a yoga class and then you have the first few minutes, the teacher will quiet you down. You breathe and when you feel warmed up, you start doing things. " (P18 in the *Both* session)

In this phase, participants constructed their initial knowledge about the environment through quick interactions.

> I think it's similar here, and then try to see if this place is dangerous or is it friendly. So start moving slowly and try to create patterns and see if there's any [that] will surprise me in a bad way, not in a good way, right? Just start from baby steps." (P16 in the *Both* session)

> "I just quickly did a little bit of moving around to see if it's different from last time and then I noticed the difference. And then I did a little bit of exploration just to see if there were new patterns but I couldn't concentrate anymore." (P17 in the *Visual* session)

7.5.1.4 Framing action scheme

While participants were figuring out the environment, they tended to frame their action scheme based on the interactions they discovered. They set degrees of actions and types of movements. This would be done based on embodied knowledge from *Light Strings*.

> "I think it's just while I'm in there during my first few minutes kind of meditation. I just formed the scheme, I'm gonna go from slow to fast and to see what happens. I can't relate it to my previous experiences." (P18 in the *Both* session)

> "After that first few minutes I feel like I want to see what energy is in the space. I started moving around and see I don't know, I feel like it's almost like a game to me." (P18 in the *Both* session)

Usually the initiation phase in the first session took longer than later sessions. In the second session of two continuous light sessions (*Both* and *Visual* sessions), the participants did not even need an initiation phase. Figure 68 shows P2's movement data for first three minutes of the experience. The first row shows movements in the *Both* session (first session) and the second row's movements are from the *Visual* session (second session). As described, P2's initiation phase seems shorter in the second session. P2 moved through the entire space from the beginning of the second session whereas she explored only the left part of the space in the first session.

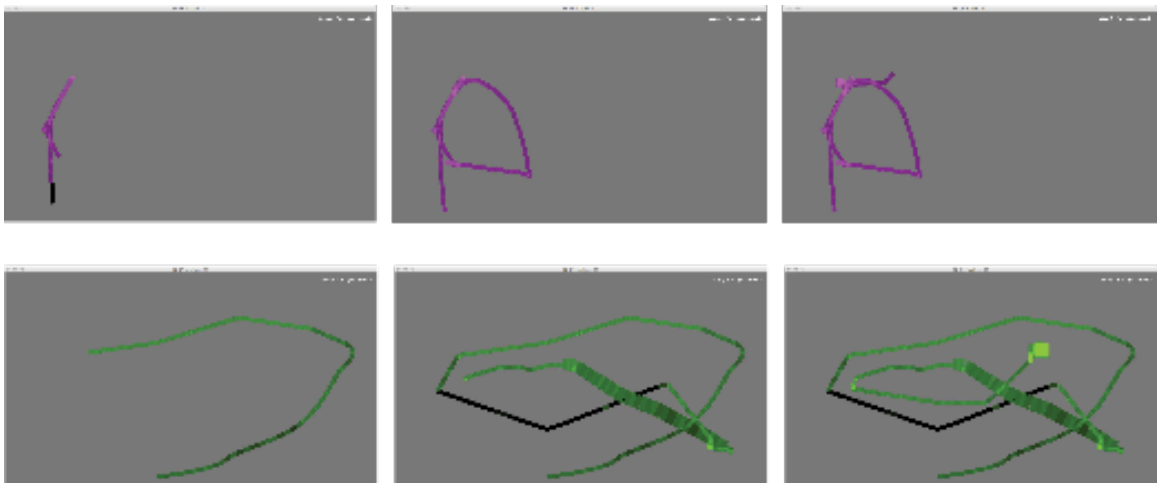


Figure 68. P2's movement data

Even though participants acknowledged that the environment was same, their prior experience with the environment inspired them to try new things actively. However when the participants had a *Sound* session after a *Visual* session (or *Both* session) or a *Visual* session after a *Sound* session, the initiation phase lasted longer than the other cases.

7.5.2 Active Interaction

Based on the experience of the initiation phase, participants tried specific things in various degrees. In the active interaction phase, participants constructed their understandings of the environment through physical interaction.

7.5.2.1 Bodily Navigation

Light Strings has physical components that encourage bodily movement in the space. There are also unexpected aspects which forcefully make participants move inside it. Participants navigate through the space actively or inactively interacting with both aspects. In the study, it was found that participants moved in the space based on the action scheme that they had built in the initiation phase. Through bodily navigation, participants' bodies became mediums that store sensory stories and build experience related to immersion. The continuous flow of navigating the space made the participant feel immersed.

> "It's here and there, it's not even. So I'm like "oh what is this?" it's really the feeling of the weather and I become really immersed in that moment I just feel like "what is it now? What is the weather now?" that part is intriguing. It's like intertwined." (P18 in the *Both* session)

Walking/Running

It was observed that most participants were moving across the space by walking or running. Walking or running can be considered techniques of discovering the space and they provided an opportunity to feel the fiber optics strongly throughout the entire body. Since there were physical or structural challenges in *Light Strings*, their movement was also challenged. While they were walking or running, participants focused on the changes of the fiber optics and sounds in response to their movement. Apparently, if the participants moved fast, it was hard to see the light patterns. Therefore there was an emerging negotiation moment that they decide to move or not, to see the result of interaction. The participants' movement and the spatial sound were easily integrated and perceived. However the visual patterns required more careful access. To see light patterns while moving, the participants needed to adjust their degrees of movement in the limited space.

> **"**I tried to …while standing upright tried to walk both quickly and slowly and just stay still. And umm…it's actually really interesting 'cos I feel that being still feels very strong because everything is moving but you and you don't quite notice that movement as much when you're moving, as usual…and moving slowly was, you know, tended to feel a little bit more meditative, moving quickly was actually quite interesting…" (P6 in the *Both* session)

> "I started noticing that if I walked in a circle that I would gather all the strings on me as I'd go but then I could actually see them fall back behind me. So I was playing a lot with walking even quickly for the beginning of a

> circle and then slowing down kind of looking behind and stopping at a point and slowing and then changing the speed." (P2 in the *Both* session)

Participants often combined arms movements with walking and running: walking with arms put together in front to open the fiber optics, similar to sweeping tall grass and walking with arms open widely. Some of them walked with their eyes closed. To walk with your eyes closed in a space, it requires that you feel safe because you are not going to walk with your eyes closed if you feel worried or nervous or you don't know what's there. This helped block the visual sensation and more forcefully focus on sound or tactile feeling.

> "This time, I tried to close my eyes because I want to feel the string with my body and walk through the space with my eyes closed." (P15 in the *Visual* session)

Different Viewpoints

Light Strings offers vertical navigation as well as horizontal exploration because it is a 3D space that gives different perspectives from different levels. This was most obvious with the lights. The participants described different images they saw from different heights (8 participants / 16 participants). When they were standing, the lights were illuminating around the ankles or knees. They became an observer flying over a landscape or universe. They felt a bit detached from what was happening. This did not mean that they were separated from the piece but that they experience a different level of immersion in the space. This perspective was often combined with a horizontal walking view. The participants often walked and stopped repeatedly to explore their illusive landscape or universe.

> "it was some kind of landscape I felt. And um…yeah it I know that the light is coming through the thread but still they seemed that they had their own lives" (P5 in the *Both* session)

At a sitting level, participants were physically closer to the lights. Some lights were around their waistline and some were around the upper side of arm level. Participants connected that experience to being in water or surrounded by constellations. They also referred to a flock of fireflies. At this level, participants found the felt distance to be much more intimate. They could touch individual lights and make waves in the fiber optic lights around them. This experiential state was easily connected to meditative states. Participants

felt the environment was very immersive not because they were sitting in the light field but because they were able to interact with light very closely.

> "I was also just sitting and playing [hands rest at table and one moves across other] with like gathering strings with a foot and watching the kinda trickle back um…[pauses] mmm….which was another thing that just felt like water because you know it's kind of like a tangible water that could gather over here and falls back down and goes into a little waterfall but hmm…" (P2 in the *Both* session)

Another level of experience occurred on the floor. Participants laid back and looked up from the floor. From this perspective, participants felt very close to the lights, like being in a cave with glow worms or jewels (P2). Some participants described feeling enclosed and safe when they were lying down underneath the surface of the lights, keeping a certain distance from them. If, however, the fiber optics were too close to their eyes and invaded their personal space, participants felt a bit uncomfortable about the unusual touches all around their body by the fiber optic tips.

> "The other thing that was interesting was if I was laying back and looking up that if I was under the higher contours nothing would be touching my face but would most likely will still touch you know, I would go into an area with lower contours where it would still be touching my arms and legs. And it was actually really interesting because I felt like I was in a scuba suit or something because just my head is in a bubble." (P2 in the *Visual* session)

When some participants (P1, P2, P3, P4, P5, P9, P12, P15) sat and laid down, they felt a lot closer to the sound. This must be because surround speakers were installed at the floor level.

When I observed the participants' movement video data, all the participants explored across the horizontal space very actively. However, vertical navigation across the three different levels was done by only half of the participants. It was revealed that navigating vertically opened another layer of experiencing *Light Strings*.

Actively not Moving

I also observed that the participants did not move in the space from time to time. They intentionally stopped and stayed in one spot. It appeared in the passive waiting phase

a little bit but this was distinctive. However, sometimes, during active interaction, they intentionally froze their body to measure the responses from the environment, mostly the interactive system. In the *Sound* session, it was easier for participants to hear the wind-like sound responding to their body movements when they stopped. Since the sound system in *Light Strings* consists of several layers of different sound elements, some sounds were not produced by normal walking movement. When they stayed completely still, they were finally able to hear bird chirps flying around them. Sometimes participants changed their postures but kept staying still. This brought participants to a meditative state and they felt immersed.

> "…just trying to compare it again to what it felt like when I was being still as opposed to moving" (P12 in the *Sound* session)

7.5.3 Constructing Meaning/Relationship

Participants described that their experience in *Light Strings* as being was constructed through a constant meaning making process. The space was sufficiently unique to re-awake many senses. Throughout the physical and conscious challenges in *Light Strings*, participants tried to make sense of it first. They often connected their experience to their memory, with *Light Strings* reminding specific experience from the past.

> "I've experienced reminds me so much of my... trips when I've done snorkelling or scuba diving in such a nice way because you feel surrounded by something and it's also the effect of this with you're surrounded by medium of fiber optics but then you've got a surface below you that's different from what your feet are telling you so it has a feeling of 3 dimensionality and surrounding space, more so than I expected." (P1 in the *Visual* session)

When a participant's initial understanding had been built up through bodily, spatial and contextual experience, their relationship to the environment became more active and intimate. As the participants became engaged and immersed, interesting behaviors indicating new relationships were observed. Participants perceived the installation components as alive or having an animistic attitude. In addition, they would sometimes fix tangled fiber optics after they experienced the piece, engaging in care-taking behaviors.

7.5.3.1 Animistic attitude

In some sessions, the relationship between the participant and the environment became very intimate. Their descriptions showed that the relationship was similar to a relationship with friends or pets (6 participants / 16 participants). It was revealed that the patterns of projected lights through the fiber optics helped to create animistic awareness. When the fiber optics moved, they were perceived as having personality, based on their movement with participants and without participants. Obviously, the sound did not create that kind of strong feeling. Although some participants reported that they heard bird chirps, they did not seem to find intimate relationship or to be encouraged to interact with the sound.

> "…it was like meeting a new person." (P3 in the *Visual* session)

> "…it's (blue light) almost like the person wasn't listening to me." (P7 in the *Visual* session)

> "…logically it's not really alive but that's how it felt to me. Part of a living thing that extends beyond your physical reach." (P9 in the *Visual* session)

> "…they seem to be they had a personality, these little lights, like they were little agents moving around. So I decided to go lower a bit to look at them more closely and then I moved them and somehow they didn't move the way I expected them to move. 'cause I was moving my hand on them and then I think because I was moving it so low they were moving the same way they did when I moved them half of the thread. So it was curious and interesting…"(P5 in the *Both* session)

> "…they're playing with me. they're tricksters but at the same time, it's keeping me company like a friend. Really weird but maybe but that's the kind of personality it was evoking to me. it wasn't a volatile or aggressive one, it was just…what's up?" (P6 in the *Visual* session)

Some participants illustrated their animistic attitude from a different perspective. They felt that they were not really part of the environment. They were able to change some part of the installation but they did not have full control over it, and they could not change it permanently. When a participant did something within the space, the environment altered for a moment but it always went back to its original state. This stability was perceived as an animistic character of *Light Strings*. It did not mean separation from the environment but rather a higher connection to the environment.

"…guess I'd describe it as a contrast of a different world where you have a different atmosphere, you have a different…strange landscape that you're navigating but you can see into it a little bit into it but you never really become a part of it and you can affect things for a short period of time but everything returns to the way it was after you leave." (P2 in the *Both* session)

7.5.3.2 Care-taking attitude

The participants touched the fiber optics mostly very gently. The materials of the environment induced an ethical relation toward the space. The space has a quality that evokes respect. It was also observed that some participants tried to fix the fibers, straightening them again after they tried physical movement in the space (15 participants / 16 participants). This behavior is like gardening, involving care taking, respecting, and connecting to the environment. That means people actively care about the environment and make a connection to the environment. It is possible to speculate that knowledge of their affect in the space means there was a reciprocal relationship, where the space affected them and they in turn want ed to affect and take care of the space. What they got from the space was meaningful for them, and they would try to take care of and return something to the space.

"…I wanted them to come back again. I feel like I needed them to be…I just felt like there should be…yeah…they should come back because I don't like this hole I wanted everything be smooth…everywhere. I just ..don't want my body makes a hole." (P7 in the *Visual* session)

"…sometimes when I moved I could see that they would gather together because the threads were mixed together. I just went back there and umm..untangled them ? haha. 'cos I was like "no this has to be right!" (P5 in the *Both* session)

"I found myself often, not wanting to disturb it. So if I went through an area and found that I had tangled it up, I would comb it out to try to return it to its neutral state." (P16 in the *Both* session)

"I fixed it a bit to make sure." (P3 in the *Visual* session)

"I felt compelled at some points to go back to fix the cables, well there's disorder. Haha. So that was interesting and then sometimes they would…like the fiber would play with you." (P6 in the *Visual* session)

In the *Sound* session, participants were a lot less concerned about fixing the fiber optics. This may be speculated that because they couldn't see where they were tangled up. It seems that there was less of sense of a collaboration between participants and the system, that it seemed less welcoming.

7.6 Temporal Consciousness

It was observed that the immersive consciousness constructed based on the experience of bodily, spatial and contextual consciousness changed through time in *Light Strings*. Because of the design of the study where the participants experience the installation multiple times with different multimedia components, each experience became very different. Therefore, it is critical to examine how temporal consciousness affects the building a holistic immersive experience. Temporal consciousness was investigated based on an analysis of units of the experience (Figure 69). My focus was on how the experience changed through the three sessions and within each session. I also examined how the ordering of the sessions influenced how participants constructed the meanings of the immersive experience.

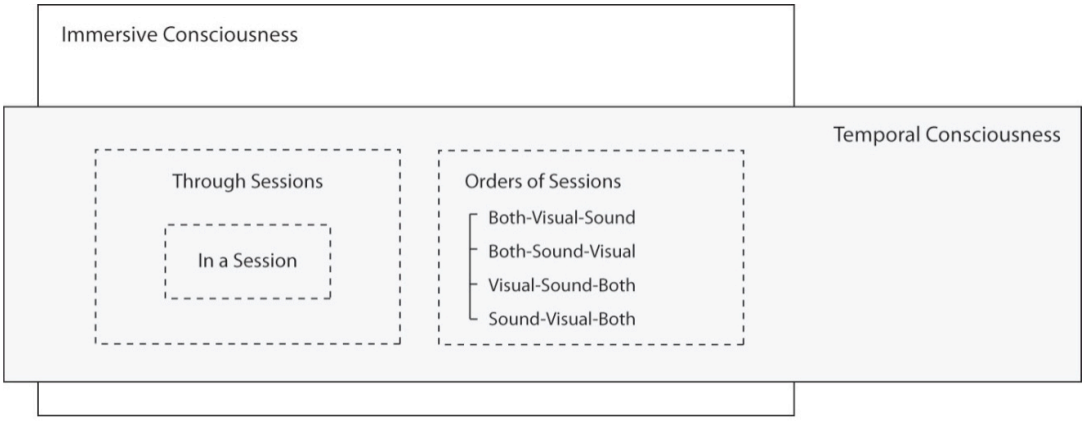


Figure 69. Temporal Experience Unit

In this dissertation, I have not included multiple experiences over a longer term than an hour. This would require a more rigorous research design. When I exhibited a prototype of *Light Strings* at the open house at Simon Fraser University, some children revisited the installation many times with their parents and friends. Their experience seemed to carry

similar qualities through multiple visits. Since no such research in this area exists in terms of immersion, this is a compelling research topic for future work.

7.6.1 In a Session

The three sessions that the participants experienced for the study stimulated different sensory modalities. It turned out that experience of each session was very different depending on the modality of the session. However, the participants' experience showed similar temporal structures in each session. The analysis here illustrates the general process that each individual went through in perceiving the environment, connecting to the environment and experiencing immersion. This structure illustrates the dynamic and explorative components of the experience. The structure below is iterative.

1. Physical newness (new situation)
2. New sensation (touched by the entire body)
3. Assume/ try / discover (includes unintentionally discover)
4. Making sense, making meaning
5. Attention shift

A constant shifting of attention leads to a construction of a new immersive experience. The participants' movements also presented different qualities of movement in each session. Figure 78 shows P4's movement data captured every minute. In the first frame, P4 entered the space very slowly without any arm movement (the thinner line represents no arm movements) and made brighter spots by staying around the middle of the space. This can be annotated as passive waiting or initial trial phases. In the third frame, P3 started moving more and occupying a bigger space. In the fourth to sixth frames, P3 made bigger and brighter spots around the center. This means P3 made their body bigger by sitting or laying down and did not move. This may represent the active interaction phase. Starting with the seventh frame, P3 explored the space more quickly and widely.

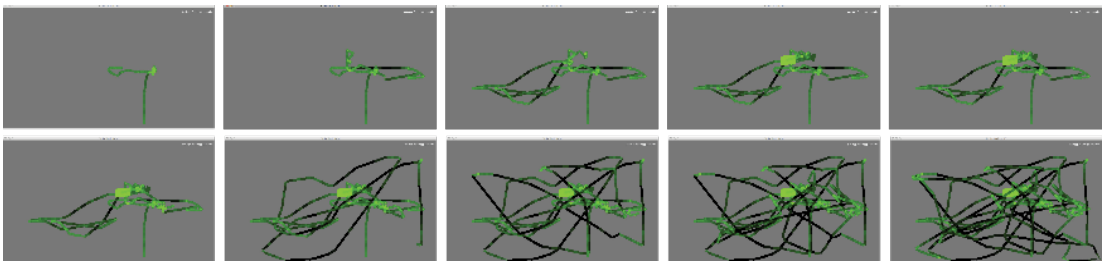


Figure 70. P4's movement data in the *Visual* (first) session

In terms of time, the average experience time of the participant experience for each session was 7 minutes and 42 seconds and for three sessions, they stayed around 25 minutes overall. There were tendencies to stay longer in the *Both* and *Visual* sessions and significantly shorter in *Sound* session (Table 6). This makes sense because of their descriptions of discomfort or eerie qualities of their experiences from the *Sound* sessions.

Table 6. Durations of the participants' experience

	Both	***Visual***	***Sound***	**Shortest Session**
P2	7:40	10:38	4:17	*Sound*
P7	14:28	16:48	10:06	*Sound*
P15	3:21	4:22	2:04	*Sound*
P18	9:05	5:03	4:29	*Sound*
	Both	*Sound*	*Visual*	
P3	9:10	4:48	17:27	*Sound*
P5	4:23	7:28	7:17	*Both*
P9	9:21	8:15	13:20	*Sound*
P16	8:56	8:16	11:16	*Sound*
	Visual	*Sound*	*Both*	
P1	6:21	9:45	10:03	*Visual*
P4	10:08	4:03	7:44	*Sound*
P8	8:05	9:06	7:42	*Both*
P11	2:10	2:02	3:15	*Sound*
	Sound	*Visual*	*Both*	
P6	5:06	11:27	7:36	*Sound*
P12	5:13	7:14	8:04	*Sound*
P14	2:16	3:59	5:30	*Sound*
P17	3:41	8:19	16:11	*Sound*

There were distinctive characteristics in terms of time for the last sessions. People tended to stay longer because they knew that was the last chance to experience the system (P3, P9, P16, P1, P11, P12, P14, P17). The *Sound* sessions created a more temporal sense and participants' experiences regarding the sound were described with temporal settings, such as night, future, past, etc. However in visual sessions, the temporal sense was comparatively weaker.

7.6.2 Through Sessions

Experiencing *Light Strings* multiple times created a flow of experience as a whole. Experience from early sessions helped to frame the initial understanding of following sessions. Participants assumed the roles of themselves and the system based on their experience from previous sessions. They tried the same things and new things to compare with the responses from other sessions.

> "So I'm not as analytical as last time. So this time I'm like "who cares?" you know. I'm just gonna walk around and see what happens and then I noticed…" (P18 in the *Visual* session, second session)

> **"**it felt like the sense of time is very different. 'cos the first one really felt like you could see everything's ..it felt like things were moving quite quickly and the clouds are moving past fast and and um…but you're present and attentive to everything in the moment and are being able to witness these things happening current ..it felt very present…Um..the second one (*Sound* session) felt a little bit more distance of…you couldn't actually see the actual stuff happening anymore …" (P2 in the *Sound* session, last session)

> "I can't discount the previous experience because I felt already familiar with the space um…it's kind of jumped in where I left of and kind of went through the same movements, tried to see if it would be different and I didn't find it to be that different." (P6 in the *Both* session, last session)

Through this process, the participants were able to build new meanings and relationships every session. They also often crated narratives from their experiences. This was closely related to the orders of sessions.

7.6.3 Ordering of Sessions

As described in Chapter 6, there were four different orders: *Both-Visual-Sound, Both-Sound-Visual, Visual-Sound-Both,* and *Sound-Visual-Both.* The ordering of sessions with

different sensory components is a new challenge in immersive experience research. In the study, it was revealed that the ordering makes participants' experiences very different in each session. In addition, the ordering of different sensory modalities in an immersive environment was critical to constructing various felt spaces.

> "it really became the idea that the first place was like and you're standing on top of the hill and you're watching all of the working farms actually and doing something now and then…and then..trying to look at it from outer space where you can't hear or actually see the action but you can see that it's there still …where as the third one is more you've come back to that and everything's dried up and there's nothing there anymore but you're back on the ground . you can hear the wind but uh…yea so I guess it really did ..the structure really did build the experience." (P2 in the *Sound* session)

> "where as with the lights, everything it made me think of was …positive and beautiful things that I've experienced like the phosphorus and stuff in Avatar or you know the sea life when I snorkel. Yeah, it couldn't be more different. I think the biggest thing that I was surprised by was that the strings felt so different. Like during the lights, I felt them but I really wasn't aware of them. I was focused on the lights and the effects and it felt friendly, it felt like water and I didn't notice them building up. Whereas this it felt like sort of I was tangled in them and they had weight and more pressure. They weren't moving as freely. Totally different experience, even though the physical space was the same." (P1 in the *Sound* session)

7.6.3.1 Ordering creates pseudo-narrative quality

When participants had multi-sensory experiences, they tended to describe their experiences using narrative stories. Their stories were closely related to immersion in terms of sensory experience. As an artist, I did not try to send any specific messages or stories to the participants. However, it was great to hear the different stories generated by the participants through their experience. Table 7 shows P1's narrative flow. His story is from his memory, past experience, movies, and a game. It is very descriptive and metaphoric.

Table 7. Narratives from P1

P1	Narratives
Visual	• "I saw little swarm of plankton or fish or something, **being surrounded by sea life**." • "It also reminded me of the **Pandora scenes in Avatar** cause there's all the phosphorus and life in the CG." • "I could go through them without feeling blocked or guided in any specific way. Sort of like **feeling in a forest or underwater**, or where you're surrounded by stuff, but it's not closing you in."
Sound	• "I reminded that...in the movie **Lord of The Rings** when they're in the cave with all the spider webs." • "in the game, **Half Life**, there are alien enemies that attach themselves to the roof and they look like a barnacle or something like just a little. They look like a long, it's like a tongue, but it's just like a thin, long thing that trickles to the floor and if you, if you get near it or touch it accidentally, it pulls you up and eats you!"
Both	• "I was picturing myself when I was sitting in a specific place where I grew up at night alone at side, with a **snow storm** and I could picture the environment and the sound from the moon reflection on the snow."

P2's narrative in Table 8 is also very descriptive. She uses metaphors from a movie, a book and nature. Using metaphors, she builds her experience. Because of the last session, her story was scary in the end.

Table 8. Narratives from P2

P2	Narratives
Both	• "I feel like I'm in **Narnia**, a little bit. Like there's a lot of different worlds happening." • "…at night when the **clouds are passing** going quickly across the moon and you kinda notice it on the ground more than by looking up the sky…" • "...from standing still that was when it felt the most like either you were **watching a city** with all the little bits shifting or there were just **fireflies** everywhere…"
Visual	• "I was in a cave with either **glow worms** everywhere they were hanging by silk or…**treasure mountain** there's jewels everywhere." • "…it felt like a **galaxy** or like there's a milky way over here kind of thing." • "…if I was laying back and looking up,…I would go into an area with lower contours where it would still be touching my arms and legs. And it was actually really interesting because I felt like I was in a **scuba suit** or something because just **my head is in a bubble**."
Sound	• **"**I'm trying to remember this **'murakami' book** - it's kind of all about getting lost in this dream world and not being able to tell the difference between reality and not reality but the guy keeps going like spending days at the bottom of a well kind of to kind of like to experience this non-reality and act in it and anyways it's kind of creepy" • "it's a very **windy night outside** and I'm in a very creepy house and I feel like I'm hearing the trees creak outside."

When the participants were describing their experience, most used metaphors to illustrate their experience. *Light Strings* worked as a vehicle for experience and reflection. Therefore, participants were able to build flows of their experience driving *Light Strings* as they wanted. This made *Light Strings* compelling unlike other interactive media where there more often is a specific kind of purpose, goal, or story to be told.

7.6.3.2 Ordering creates emotional valance

It was also revealed that ordering of sessions affected the participants' emotional flow. Table 9 shows the participants responses referring to emotional states in *Both-Visual-Sound, Both-Sound-Visual,* and *Visual-Sound-Both* sessions. When participants had a sensually richer experience before a *Sound* session, the *Sound* session was perceived as lacking or missing something. This induced negative valence and influenced the other sessions' experiences. P7 reported that he was excited, happy, and relaxed in the *Both* and *Visual* session but he did not enjoy the *Sound* session and he did not feel creative. In the *Visual* session after the *Sound* session, P16's response to the lights was very strong. He was so

happy about getting back the lights back. P1's last session experience, a *Both* session was affected a lot by the sound experience. The experience of sound made the *Both* session cold, unfamiliar, and strange. There were distinctive differences in the qualities of experience across the orderings: a notion of coldness, a notion of not welcome, and a notion of darkness.

Table 9. Emotional responses in *Both-Visual-Sound, Both-Sound-Visual,* and *Visual-Sound-Both* sessions

P7	Emotional responses
Both	Exciting, enjoyable, fun, joyful, happy, curious, alone, scary,
Visual	Curious, creative, relaxing, free, enjoyable
Sound	Not enjoyable, not creative
P16	
Both	Playful, energetic, peaceful, joyful, happy, fun,
Sound	Cold, less playful, less welcoming, interesting, lonely
Visual	Fascinated, playful, comfortable, nostalgic, pure
P1	
Visual	Pleasant, beautiful, calming, curious, peaceful, soothing, happy, positive, playful, organic, flexible, warm
Sound	Tenser, not relaxed, unwelcoming, unfriendly, dangerous, menacing, negative, uneasy, alien
Both	Cold, quiet, vulnerability, curious, unfamiliar, strange

In all cases, when I started with both (visual and sound) elements, and then took the visuals away, no matter what the order of the taking away, it affected the participants experience in a induce negative valence. Thus we have learned that to invoke loneliness and affective perturbation (something uncomfortable happens) and maintain immersive qualities, we can start with higher, richer level of sensory input and then slowly reduce the sensory perception.

However, when a *Sound* session was the first session (*Sound-Visual-Both*), the participants primarily paid attention to the newness of the system. Therefore, their responses were not as negative as in the other orders (Table 10). This may be because the participants did not have any comparable experience to the sound experience. In the second session, they became more positive and redefined the sound experience later as a bit negative.

Table 10. Emotional responses in *Sound-Visual-Both* sessions

P6	Emotional *responses*
Sound	Disorienting, dark, fantastic, curious, playful, calm, meditative, beautiful, cold, engaging, unfamiliar
Visual	Compelling, engaged, mystical, playful, comforting, interesting, safe, welcoming, beautiful, joy, happiness
Both	More engaged, happiness, meditation, playful, calm, peaceful

7.7 Summarizing the Aesthetics of Immersive Experience

The focus of this study was to investigate the aesthetics of immersive experience: how it is experienced and what qualities and meanings emerge from the experience. In doing this research, my focus was to study embodied immersive consciousness with a temporal sense.

The immersive experience described by the participants in *Light Strings* was quite different from the experience in other immersive environments. The participants were able to feel immersed while they were experiencing the piece sensorially and imaginatively. The retellings of the experience were very descriptive and qualitative.

Light Strings also offered body-based, exploratory play with physical and virtual elements of the installation, as well as evoking a meditative quality. From my analysis focusing on the bodily sensory experience, spatial consciousness and contextual consciousness in time, I was able to develop an experience model based on the descriptions of participants' experiences and observation.

In this study, I have shown that a sense of immersion can be pursued without HMD and CAVE systems. In each session of *Light Strings*, the participants were immersed even though their experiences were very different across the sessions. *Light Strings* is a dynamic and organic environment that evokes visual, sonic, and tactile senses. The descriptions of participants' bodily experiences were very rich and poetic. Senses work individually and in association with each other. There were predominant senses: visual, sound and tactile. When associated, the tactile sense took a main role and connected to the other senses. The emotional valence from the sensory experience really evoked a sense of immersion.

In *Light Strings*, many of the senses were re-awakened because of the unusual fiber optic environment. The body immediately became aware of unhabituated senses and this triggered a sensory attention shift intentionally or unintentionally. Because of this shifting focus, the participants were able to experience different layers of the installation.

The participants perceived *Light Strings* as a different world as soon as they entered. This is been an important element for creating the conditions of an immersive environment. The idea of a different world makes connections between physical sensations and poetic extrapolations. The participants actually suggested that the space itself is quite transformative in terms of the ability to enable them to feel like they are in a different world. Almost all of the participants used metaphors to describe the space because they had never had this kind of experience and there were no words to describe it. I did not ask specifically about metaphors, but rather had very open-ended questions. This indicates that the richness of poetic descriptions really came from their experience of the system and shows success in the piece in terms of immersion.

The most distinctive characteristics of immersive consciousness in *Light Strings* were that the participants experienced different spatial scales of the environment. In the *Sound* session, people tended to perceive the space as vast like a universe, landscape, ecosystem, etc. In this big space, their feelings oscillated between lonely and free. However, in the sessions with lights, the space became vast and proximal in turn. Regardless of the size of the felt space, they felt warm and safe in the sessions with lights.

The immersive experience was affected by the participants' contextual consciousness in the space. Through the iterative loop of initiation, active interaction, and making meaning phases, the participants created relationships with the *Light Strings* installation. They often found animistic qualities in the fiber optic lights and fixed the tangled strands to show respect for the environment.

Temporal aspects were also important to examine with respect to the experience of immersion. The ordering of different sensory contents made the space feel still immersive but resulted in different narratives of the immersive qualities. The narrative relationship of the perceiver and the space shifted the attentional focus and helped to construct the immersive experience in a single session and through multi sessions.

Overall, the participants strongly experienced immersion in *Light Strings*. They experienced both physical (sensorial) and mental immersion or engagement. To create immersion in *Light Strings*, fiber optics acted to de-habituate or re-awaken background senses. The responsive multimedia components within the fiber optic environment accelerated mental engagement and the experience of flow.

8: ARTIST/PARTICIPANTS RELATIONSHIP

8.1 Introduction

In this chapter, I examine how my art creation process was iterative, looking at how audience participation influenced my process and how participants and myself co-created meanings of immersion throughout the art creation process and experience. In Contemporary Arts, audience participation has been encouraged in various ways: physically, remotely, etc. Interactive Art particularly focuses on participant response, with system interaction often pursuing new aesthetic experiences. This interaction is a great opportunity for artists to design artworks that allow them to communicate with participants and share their artistic vision. During the creation of *Light Strings*, I was able to contact audience to get their feedback about aesthetics, interactions, materials, and structures. After I finished the work, I designed a case study using *Light Strings* to investigate participant experience in detail. Through the entire process of this research, art creation and case study, I was able to examine my own experience and participants' experiences in terms of immersion.

8.2 Collaborative Meaning-making System

From my art/research experience, I have learned that I cannot create interactive artworks by myself because participants and participants are critical in my interactive projects. The relationship between an artist and participants can be considered a collaborative meaning–making system.

8.2.1 Through Creation and Exhibition

When New Media / Interactive artists create artworks, they cannot be independent from the technology and the participant of the work. My art creation process is illustrated in Figure 71 using a river or Ki (See also 1.2.2) metaphors. A river connects different places through water and one side affects the other parts. Ki also works as an 'energy flow' similar to rivers, veins, and ocean currents. It is an invisible force, like energy surrounding us, that fills us up and gives us life. My art creation process starts from artistic enquiries and from these questions I develop concepts and technical ideas. Finally, I create a finished piece and exhibited it. Each step cannot be separated from the others and they form an iterative process.

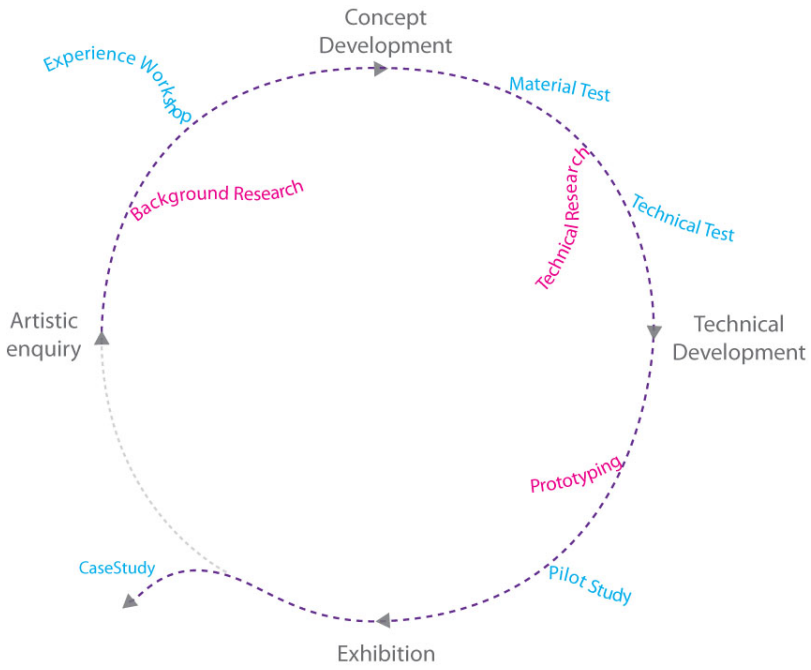


Figure 71. Art Creation Process

Figure 71 illustrates how participants and myself are involved together in the process. The pink elements represent the artist's first-person experience and the blue elements represent participant's involvement. Therefore, my art creation river flows from the starting point of artistic enquiry to the ending point of exhibition via iterative integration with participants. Even though "Experience Study" looks like the last step in the process, all the knowledge that I learned from this process forms the roots of my next projects.

In the beginning of the concept development phase, artists often conduct workshops with participants. This allows artists to have a clearer understanding of participant responses in terms of the artwork's concept. When I was creating *Light Strings*, I did not conduct these kinds of workshops. I was already aware of the response to the concepts I was using because I did preliminary studies using *Sky Reverie* and *nite_aura*. When I was working on these previous projects, I tried many different variations of the systems and conducted workshops with participants. When the concept was built, I started experimenting with visual effects with participants. I built a small model that was big and tall enough for participants to experience a similar enveloped feeling. By exploring the system, I understood what was possible from the experience. Through building a couple of prototypes and getting feedback from the participant, I learned that a space with fiber optic strings evoked immersion effectively. However there was some negative feedback too. When I heard some the negative response about the environment for first time, I did not want to acknowledge them. Therefore I invited more people to get more positive responses. The more participants experienced *Light Strings*, the more their experiences were obviously positive and/or negative. I couldn't avoid the fact that *Light Strings* created both positive and negative valences.

As an artist, I wanted to be honest about my work and my own response to it. I spent so many hours in *Light Strings* by myself, as a participant. Surprisingly, *Light Strings* affected different qualities of my emotional states even though I liked meditative experience in it. This is an example of co-creating meaning between an artist and participants. Therefore I decided to examine the different qualities of participants' experiences. When I developed the concepts of *Light Strings*, I had expectations about participants' experiences to some extent. My artistic intention was developed and modified iteratively by collaborating with participants. *Light Strings* enabled to provide multiple ways for participants to co-create meanings which I observed in narratives that participants described. This will influence my future work. Therefore my art and research on immersion can keep its intersubjectivity even though the concept is very subjective. This collaborative system continued in the case study with participants.

8.2.2 Through Conducting Participant Study

As I worked iteratively with participants in the creation of *Light Strings*, my first-person experience and the prior knowledge I learned from the process helped me to design a case study. Because there is no standard research method for interactive artists, I adopted research methods from other disciplines that used considering phenomenological approaches (See also Chapter 4) and had to adjust them to fit my research goals. Through that process, the first-person data of my own experience provided a lens to evaluate a range of possible experience and helped structure my research methods (Figure 72).

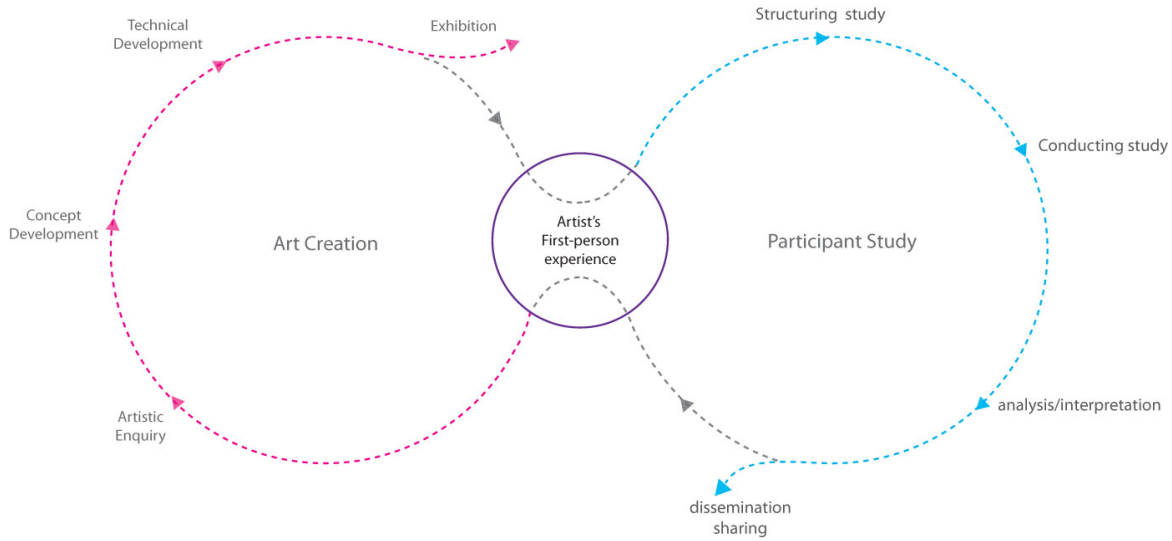


Figure 72. Collaborative process of art creation and participant study

My research method of triangulating first, second, and third person data with phenomenological attitude, enabled me how to evaluate the qualities of immersion that I tried to create, contain, and explore in my installation. In particular, it helped me to interview participants in a way that allowed their experience to be drawn out as data. The interview questions were developed based on my experience. All the participants' first, second, and third person data was analyzed based on the system I developed.

Before I conducted the case study, I had a vague idea of what experiential qualities I might find. That was discovered from unofficial conversations with participants and preliminary studies. I mostly observed two types of experience in *Light Strings*: playful and meditative. I did not know that *Light Strings* would invoke so many metaphors and narrative

stories related to nature. My artistic concept and vision about the project seemed to transfer to the participants and become richer and flourish through interactions.

This case study allowed me to develop a structure of immersive experience full of rich descriptions. Studying participant experience in *Light Strings* enriched my ability to understand the core ideas of immersive experience and enabled me to play with different components to create different qualities of immersion in the space.

9: DISCUSSION AND CONCLUSION

In this dissertation, I aimed to investigate the aesthetics of immersive experience in physically immersive environments in the context of interactive art and to examine the phenomenological relationship between the creation of an immersive environment and the articulation of immersion from the experience of participants.

A sense of immersion is one of prominent aspects of interactive art. As a concept, immersion has traditionally been explored in cultural domains literature, art, architecture, and film theory. With the development of virtual environments, immersion research became more prevalent, scientific and focused. In chapter 2, I traced scholars' research on immersion and studied the meanings of immersion. I carefully reviewed scientific VR research and VR artworks to study different notions of immersion because many of the foundations of understanding immersion came out of VR work. Then I expanded the understanding of immersion under consideration to other immersive environments using Milgram and Kishino's virtual space continuum: real environment, mixed reality, and virtuality. Creating a taxonomy of immersion in interactive art using the virtual space continuum helped me to build a broad understanding of immersion in different immersive environments.

Following a trajectory of different immersive environments and different qualities of immersive experience, I established a foundation for an embodied conception of immersion based on my research-creation. From my artworks, *Sky Reverie* and *nite_aura*, it is clear that immersion could be created in physically immersive environments without complex or scientific hardware such as HMDs, CAVEs, and other VR environments. In the art, it was more important to provide bodily experience with the physical and virtual components of the artwork. Bodily interaction with physical materials provoked visceral and imaginative engagement and induced playful and meditative qualities of experience.

Light Strings is a minimalistic but physically surrounded environment: it operates as part of a phenomenological case study. In the project, the physically immersive environment was created using fiber optic strings, with interactive components projected through the

fiber optics and a surround-sound system. Due to the artistic use of fiber optics, kinesthetic tactility was found to be the main sense used in experiencing *Light Strings*, in association with other senses. The interactive system for *Light Strings* was designed based on different qualities of gestures and movement in the space (ambient, exploration, play, meditation).

During the participant study with *Light Strings*, different data collection methods were used to collect participants' subjective experiences. All participants were able to report their own experience very clearly even though they took part in three sessions for an average of 30 minutes of total times spent with the system. It was apparent that *Light Strings* provided opportunities for the participant to get immersed through bodily experience and enabled them to build up spatial, contextual, and temporal conscious experiences. My qualitative data strongly suggests that people experience immersion in somatic, visceral and imaginative metaphoric ways. The way participants described and metaphorically-illustrated their experience showed that they were connected to or engaged with the space. These results reveal the primary qualities of *Light Strings* to be: connection, engagement, and attention. *Light Strings* became a medium for creating the participants' narratives by provoking metaphors. The participants brought various narratives and images related to nature and natural experience from the memories, books, and movies. Immersive environments like *Light Strings* provoke the participants into being creators instead of passive receptors. Immersion is induced not imposed.

One of unique aspects of this study was experimenting with different sensory components to see how they affected the qualities of participants' felt immersive experience. In all cases, when I started with visual and sound and then took the visual away, no matter what the order of taking away, loneliness and affective perturbation was invoked but the immersive qualities were maintained. This data illustrated that it is possible to create specific emotional valences by starting with a higher or richer level of sensory input and then using the notion of narrative to slowly reduce the perception of those senses. This mechanism can be adopted in different immersive environments that combine materiality and embodiment. *Light Strings* invites and enables this possibility, by providing light that is not figurative or representational but functions as a seed or trigger for the participant's own memories to cascade and form a story.

The whole experience in *Light Strings* can be interpreted as a meaning making experience with an immersive property that is co-constructed by the environment and participant. In the model I elucidate in this thesis, immersion consists of bodily, spatial, and contextual consciousness intersecting with temporal consciousness. This model suggests how to explore immersion as a meaningful experience. My research journey through this model shows that immersion is not only present in virtual reality environments but also in physical but interactive realities that strengthen body, space, and contextual consciousness. This is very critical. I believe that awareness of our immersive experience will provide a highly promising path for transforming all fields of human experience, including the artistic, medical, pedagogical, and entertainment fields.

In terms of research methods, this experiential model also offers a way to analyze phenomenological data. This can be used as a tool or device for how meaning is constructed and what kind of qualities are elicited from the experience. I believe that my art creation process and participant study were well intertwined in a research process to examine immersion. My approach can be adopted by other interactive artists and used as an "art as research" frame. Moreover, the phenomenological qualities discovered from *Light Strings* can be re-examined in different spaces. In the case study, it was possible to investigate subjective experience and create intersubjectivity among the participants and the artist.

10: FUTURE RESEARCH

This research opened up a novel way to investigate immersive experience from the participants' perspective and to explore the relationship between an artist and participants through an art project. This case study was conducted with a physically immersive environment that had interactive multimedia components. In the virtual space continuum, this installation is in the area of augmented reality. In the future, I would like to conduct similar studies in different spaces, even including traditional virtual reality (HMD and CAVE). The experience model of immersion proposed here can be utilized. As this model expands. I would like to undertake research on immersion beyond the scope of an enclosed space that covers all peripheral vision. The next question: Is it possible to create similar qualities of immersion with interactive wearables? Portable durable immersion would be a challenging research area.

In *Light Strings*, an interactive system to create interactive virtual agents (visual and sonic) was utilized. It was observed that the virtual agents' behaviors affected to create participant's engagement and immersion. However the case study didn't focus on the correlation between the agent system and degree or quality of immersion. For the next study, I would like to focus on the relationship between an interactive system and participants' behaviors and how it helps to creating immersion.

In terms of a research method, for the current dissertation I focused on qualitative data analysis even though I collected some third person data. If I conduct another study that more rigorously emphasizes scientific analysis, it would be a good comparison study to the work presented here.

APPENDICES

Appendix A: Artwork Documentation, DVD

Artwork Documentation Folder Structure

01_*Light Strings* (2010)

(Artists: Jinsil Seo, Greg Corness, Diane Gromala, Thecla Schiphorst)

01_Documentation Video

02_Documentation Photos

03_Program codes

Appendix B: Participant Study Data, DVD

Participant Study Data Folder Structure

01_First-person Data: the participants' written responses

- Writting_Transcriptions.pdf

02_Secon-person Data: interview data

P01_VSB.pdf	P02_BVS.pdf
P03_BSV.pdf	P04_VSB.pdf
P05_BSV.pdf	P06_SVB.pdf
P07_BVS.pdf	P08_VSB.pdf
P09_BSV.pdf	P11_VSB.pdf
P12_SVB.pdf	P14_SVB.pdf
P15_BVS.pdf	P16_BSV.pdf
P17_SVB.pdf	P18_BVS.pdf

03_Third-person Data: movement data

- 01_Movement Visualization
  - MovementVis_1BVS.pdf
  - MovementVis_2BSV.pdf
  - MovementVis_3VSB.pdf
  - MovementVis_4SVB,pdf
- 02_Processing Codes

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