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Master's Thesis
Academic Year 2022

Aerie: A Multi-sensory Affective Urban Furniture
for Enhancing Social Connectedness in Outdoor
Urban Spaces



Keio University
Graduate School of Media Design

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A Master's Thesis
submitted to Keio University Graduate School of Media Design
in partial fulfillment of the requirements for the degree of
Master of Media Design

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Abstract of Master's Thesis of Academic Year 2022

Aerie: A Multi-sensory Affective Urban Furniture for Enhancing Social Connectedness in Outdoor Urban Spaces

Category: Design

Summary

Humans are profoundly social creatures; the need to belong and socially connect with one another are considered to be fundamental human needs. Throughout the world, activities, socialization, and gatherings were restricted due to the outbreak of the Coronavirus in 2020. The reduction of physical meetings affected our relationships, straining our sense of connection to others. The closures of indoor facilities also resulted in more people spending time outdoors on parks, beaches, and hiking trails instead. In the midst of the pandemic, spending time outdoors, being involved with outdoor activities have helped many people take their minds off of anxiety from stress and uncertainties of getting through the pandemic. However, while many of us still spend the majority of our time indoors, physical inactivity resulting health concerns still remain a societal challenge and finding effective ways to promote healthy lifestyles is an important goal in government, practice and research organizations. As the global population continues to urbanize and technology is increasingly integrated in urban environments, designing seamless interactions between humans and computers could play a key role in bringing people together.

We present the design of Aerie: a cloud shaped cushion like multi-sensory urban furniture for people to relax, feel and resonate through ambient sounds, vibrations and illuminating led lights. The sensory outputs are responsive to the user's biofeedback sensing, creating a feedback loop between our inner states, the self-transcendent emotions and the multi-modalities, designing a seamless human-computer interaction. Through this experience, we explore how these experiences can facilitate social connectedness.

We conducted field studies under different conditions to observe human interactions and iterated processes after each implementation. The research setup is designed to investigate the facilitation of emotions by testing out the sensory effects, especially on the outcomes of the feelings evoked by our experience design. We intend to develop creative urban technology that cultivates artistic, social, and cultural flourishing in public spaces through our design and research.

Keywords:

emotions, empathy, social connections, public installation, interactive designs, urban furniture, smart city

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Chapter 1

Introduction

1.1. Social Connectedness

Social connectedness is variously defined as having a connection or connections, or feeling a connection to other individuals or groups either through social networks. Various entities, such as researchers, schools, and governments employ differing forms of “social connectedness scales” to rate the level of connection that individuals have within their institution. Social connectedness correlates with other important aspects of health and well-being.

Multiple studies have shown the value and positive health impacts of social connectedness. In a 2013 study in Canada, those who reported having close friends reported nearly 50% more healthy physical activity than those who didn’t report having these friendships [2]. A 2015 study in Australia by Steffens et al. [3] reported the risk of death amongst recent retirees more than doubled if they lost contact with one social group they were associated with, and that risk of death went up sixfold if they lost contact with two social groups.

Social connectedness is becoming more difficult to sustain, but COVID lockdowns further exacerbated this issue. In Zuo’s [4] cross-sectional study of social connectedness conducted during COVID quarantine, it was found that social connectedness could be increased using even simple actions such as sharing one’s physical activity with others. This shows that social connectedness can have other sources than in-person contact. In multiple studies of the health impacts of biodiversity and green spaces by Raf et al. [5], found positive impacts on both emotional and physical health gained from nature-based outdoor activities and exposure to green spaces.

Similarly, in the studies by Petersen et al. [6] describes the connections we have, human-nature interactions, social connectedness and nature-centric connectedness

are all underpinned by the same kind of emotions. However, with the outbreak of the Novel Coronavirus in 2020, activities, socialization, and gatherings were restricted throughout the world. The closures of indoor facilities also resulted in more people spending time outdoors on parks, beaches, and hiking trails instead. In the midst of the pandemic, spending time outdoors, being involved with outdoor activities have helped many people take their minds off of anxiety from stress and uncertainties of getting through the pandemic. Finding effective ways to promote healthy lifestyles is an important goal for governments and researchers. As the world population continues to urbanize and technology is increasingly integrated into urbanized environments, designing seamless and complementary interactions between humans and computers could play a key role in new and novel ways of bringing people together. This social connectedness can be achieved through emotions and empathy for others. Using nature as a positive connecting element can make social-relational emotions more interactive and enticing to experience.

1.1.1 Emotions and Empathy

The phenomenon of *positive empathy* is described as an act of imagining, recalling, observing, or learning about other people’s positive outcomes, in Morelli et al.’s [7], or positive empathy, is related to “prosocial behavior...a sense of social connection, and subjective well-being.” A more in-depth study by Gable et al. [8] further concluded that this positive empathy increases social closeness, intimacy, commitment, and trust.

Emotions are difficult to express openly in public, especially while strangers are present. Cultural aspects come into consideration with behavior in social settings. The barriers to expressing and sharing one’s emotions vary widely from one culture to the next—for instance, displaying sensitive emotions such as crying conveys weakness and could be interpreted as lack of self-control, depending on the culture that it is expressed within. However, when we understand the context and the reasoning behind their tears, such as when observing a person resonating deeply with a movie, we can better understand and empathize with them.

The ways that emotions are expressed vary tremendously across cultures — both in terms of emotional expression and their meaning. Without understanding these emotional languages, crossing cultures can create severe misunderstandings,

while interactions can easily be “lost in translation.”

In Japan, there are strict cultural boundaries about when and where people are “allowed” to display emotion. Generally, Japanese tend to shy away from overt displays of emotion in public, especially in work settings, because of the disciplinary ways that Japanese culture emphasizes conformity, emotional control, and humbleness. These are all traits that are taught and passed down to help facilitate relationships in society.

The link between social connectedness and human physical and emotional health is stressed by research and studies by a social neuroscientist Lieberman [9] found that social connections are in our very nature, stating, “Our brains are wired for reaching out to and interacting with others.” And further goes on to conclude that social connectedness and our social nature, “are central to making us the most successful species on earth.”

1.2. Problem Statement

The Need for Social, Cultural and Emotional Sustainability

As stated in the background, humans are compelled to belong to one another and connect socially. However, as a result of widespread restrictions on face-to-face contact, the constant use of social media, the digital transformations that have lead to faceless contact, social isolation and loneliness can result in a variety of negative outcomes, particularly when it comes to our health and well-being. The feelings of belonging and connectedness can play key roles in maintaining a well-balanced life.

Urbanization is an increasing phenomenon. The United Nations, Department of Economic and Social Affairs¹ [10] states that 55% of the worlds population lives in urban areas and by 2050, 68% of the world’s population will live in urban areas. Due to urbanization, we are becoming increasingly distanced from nature.

Many studies and technological improvements have emerged which attempts to combat our well-being to intervene the barriers that come in between social connection. However, our need for social connection is reflected in the most ba-

1 <https://www.un.org/en/desa>

sic ways humans communicate with each other such as the tone of our voices, facial expressions, and sense of touch. Now technology is being injected more directly into our lives. It is important for cities to cultivate places and interactions that enrich the richness of the human experience: by offering socially rewarding, culturally stimulating, and emotionally enriching experiences.

1.3. Motivation

My biggest motivation is the exploration of the intersection of design and technology, making a step towards more meaningful designs for our society. More specifically, designs that integrate human and machine and augment our capabilities and fulfill our needs, rather than replacing them with the convenience of becoming dependent on those technologies. Through the design process, my goal is to enable users to explore and develop their mind's potential or to enhance their natural cognitive abilities. It is important as a designer that the solutions we propose, implement and test are comfortable and stimulate curiosity and playfulness while supporting real-life studies and interventions.

Modern digital devices allow us to access information from all over the world but do not provide assistance with developing some of the most fundamental and critical cognitive abilities needed for leading a successful life, such as motivation, creativity, communication and empathy.

At present, people are accustomed to interacting with machines such as smartphones on top of spending time on computers for working and personal use, which adds up to a lot of interaction time or “screen time” as Apple’s iPhone identifies, which makes ergonomic design more important to us than ever before.

It is commonly accepted that leisure can be beneficial to our mental health, making us feel refreshed, less stressed, and be ready for being more productive. However, depending on values and culture, people regard productivity as the primary goal, believing that leisure time is a waste. Regardless of choices and values differing, we believe there is still room for creativity while tackling complex problems by understanding our diverse realities, true to the nature of the users’ lives.

We aim to develop designs that represent a more natural and seamless expansion

of our being and enable us to grow into the people we wish to be.

1.4. Purpose

There are many factors that influence a sense of social connection. While difficult to define, social connectedness is present and significant throughout our life. In this project, interventions aimed at reducing social isolation and improving connectivity are demonstrated to improve health and well-being. Through this project, we aim to create a captivating experience that would allow the participants to develop a sense of belonging to their community, environment, and other individuals, to communicate the essence of feeling connected. We hope to contribute towards socio-emotionally sustainable innovative movements.

1.5. Thesis structure

Chapter 1 introduces the background of this research and related fields: Social Connectedness, Emotions and Empathy, Social Relational Emotions for Human-Nature Connections

Chapter 2 covers the related works, first conceptualizing the Biophilia hypothesis, urban biophilic design, technological interventions for social bonding, and augmented infrastructure for interactive systems.

Chapter 3 presents the conceptual design, technical implementation and the iterative prototyping process of product design in a multi-sensory urban furniture

Chapter 4 describes the proof of concept, the validation of our concept, and the testing of prototypes, including studies and a field test, followed by a qualitative analysis through the installation in a public space.

Chapter 5 concludes with summaries of the current research findings, limitations, discussions of the conclusions, and future prospects of this research project.

Chapter 2

Literature Review

2.1. Nature-Involving Outdoor Social Bonding

As discussed in chapter 1, the emotional and empathetic connections we can explore through the human-nature connection pathways are based on Biophilia. This, when combined with our sensory connections to nature, gives rise to a design process that helps us explore solutions that induce social, cultural and emotional stability.

2.1.1 Biophilia and Biophilic Urbanism

Biophilia, or literally "love of life," is a concept in architectural, building, and city design intended to connect inhabitants to nature, either implicitly or explicitly, by the inclusion of plant and nature-based designs and the presence of plants or other nature-inspired architecture and items in a space. Biophilia was coined by Erich Fromm [11], who posits in his 1973 book that biophilia is the "passionate love of life and of all that is alive...whether in a person, a plant, an idea, or a social group." Based on his study of the unconscious mind, Fromm characterized Biophilia as a phenomenon that is biologically driven and a natural instinct in humans [11].

Biophilia is at the heart of this vision of future cities, which biologist and entomologist Edward O. Wilson has conceived as the "Biophilia hypothesis" in his literature and text. Biophilia, according to Wilson [12] is, "the innate tendency to focus on life and lifelike processes," and concludes that the human connection to nature, and need for a natural connection, is a part of both our psychology and physiology, as well present in our very genetics.

Innate refers to hereditary characteristics and, therefore, is a part of how hu-

mans are innately wired, according to Beatley, written in the Handbook of Biophilic City Planning [13]. In his view, humans carry with them our “ancient brains,” and this explains why being in nature makes people happier, relaxed, and productive.



Figure 2.1 Top Left: Apple Park, Apple’s Global Headquarters in Cupertino, California. Top Right: Google’s London Headquarters. Bottom Left: Mark Zuckerberg and Frank Gehry at Facebook. Bottom Right: The Amazon Spheres biodomes in Seattle. Source: The Guardian²

Thus, the biophilia hypothesis suggests that humans are genetically predisposed to connect with nature and other living organisms as a result of our evolutionary dependence on nature. This idea is relevant in daily life – people possess an innate tendency to seek connections with natural settings like beaches, mountains, and other forms of life. In short, biophilic design is a form of design that responds to deeply rooted human needs.

In recent decades, urbanization has largely contributed to the substantial growth

² <https://www.theguardian.com/artanddesign/2017/jul/23/inside-billion-dollar-palaces-of-tech-giants-facebook-apple-google-london-california-wealth-powerbyRowanMoore>

of biophilia. The headquarters of companies like Facebook (Meta), Google, Amazon, Apple and LinkedIn have taken a step further by incorporating Biophilic design principles into their modern design choices. The set of images in Figure 2.1 by The Guardian, Moore [14] shows various aspects of biophilic design used in architecture by these tech giants. They do not just follow trends, but they also strive to provide their employees with a positive working environment that is not only functional but also provides a positive health element.

We can see that the biophilia hypothesis may provide an interdisciplinary framework for understanding humans' motivation to connect with life and nature. A further research investigation of how feelings of connectedness to nature are achieved remains to be conducted.

Understanding the biophilia hypothesis and how biophilic designs are implemented in urban design can lead to an application that integrates natural elements and processes into the built environment in order to appease this need for nature [15].

2.1.2 Sensory Connections with Nature

According to the studies of the Biophilic design patterns by Browning et al., [16], the concept of connection to nature using senses to gain insight into nature. The experience of this connection to nature is described as the ambiance in an environment that is connected to nature through the sounds, aromas, and textures, gives us the sense of being outdoors. An environment with a true connection to nature, has a uniquely fresh feeling, complex yet familiar, with a feeling of comfort and yet also with potential, all accompanied by sounds and aromas that give us a sense of being outdoors [16]. Compare these feelings and emotions to the common office space or even home office that we associate with bleak sterility and discomfort.

Auditory: According to a study by Alvarsson et al. [17] on stress recovery during exposure to nature soundscapes such as fountain sounds and tweeting bird sounds and environmental urban environmental noise such as road traffic noise, exposure to nature sounds was found to speed up physiological and psychological recovery after psychological stressors, reduce cognitive fatigue, and improve motivation by up to 37%. This study was conducted to determine whether phys-

iological stress recovery is faster in the presence of pleasant nature sounds as opposed to noise. Based on the results, physiological recovery of sympathetic activation after psychological stress is faster in the presence of pleasant nature sounds than in the presence of less pleasant sounds with a smaller, similar, or higher sound pressure level.

Haptic: The popularity of pets and animal assisted therapy pet therapy ³ have been gaining attention in recent years. Commonly, nature therapy ⁴ has also been gaining attention. Plants and nature are reported to have therapeutic properties in various studies; Koga et al. [18] studied the psychological and physiological effects of touching plants, investigating the mechanisms behind people experiencing an a feeling of calmness when touching a plant. The linkage between tactile or sense of touch and nature studies have been emerging areas of studies, however, there is still yet to unveil how exactly the stimuli influence people’s moods and minds.

2.2. Urban Furniture

To better understand the idea of urban furniture, we must first begin with the understanding of “urban space.” According to The National Institute of Statistics and Economic Studies⁵, the urban space means “several urban areas and their related multicentric municipalities forms a whole in a single stretch” [19].

According to the historical developmental studies of urban furniture by Uslu et al., [20] furniture in urban settings contributes to elements such as aesthetics and functionalities, on top of facilitating individuals’ personal and social urban lives, referring to all the elements used in landscaping to provide fundamental functions and needs such as sitting in public spaces such as streets and parks.

In the same historical study, Uslu et al. [20] also point out the purpose of urban furniture is to provide an ‘experience’ for the user, rather than just serving a functional purpose through the placemaking initiative, it is integrated into the urban realm to enhance the quality of life for its users.

3 <https://www.healthline.com/health/pet-therapy>

4 https://en.wikipedia.org/wiki/Nature_therapy

5 <https://www.insee.fr/en/accueil>

Seating Element A British psychiatrist, Osmond [21], who examined the functional aspects of architecture at the Weyburn hospital settled on two seating arrangements that either encouraged or discouraged social interaction - sociofugal and sociopetal settlements. The sociofugal seating arrangement creates a solitary environment with seats looking outwards. These types of seating formations are quite commonly used in public places. By sitting in this position, strangers who aren't comfortable sharing spaces are not forced to have to look at each other face to face. On the contrary, the sociopetal seating arrangement involves people facing each other inwards; the arrangement encourages interpersonal interaction and communication. In order to promote social interaction, both styles can coexist in design elements [20].

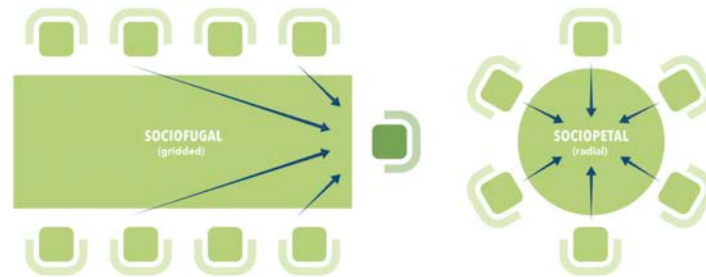


Figure 2.2 Osmond 's Sociofugal and Sociopetal seating layouts; Illustration by Donald Rattner, Architect

6

In that sense, having well-designed furniture enhances the social and inclusive nature of urban spaces, makes them safer, and boosts community. Some existing pieces of urban furniture include benches and lamp posts. Planners will incorporate furniture pieces that attract people to these locations, not just serving the purpose of functionality such as sitting or lighting but a meaningful purpose. Furniture allow us to sit and chat, provide a place to socialize. We can say that street furniture is an essential part of urban development and important element for the community.

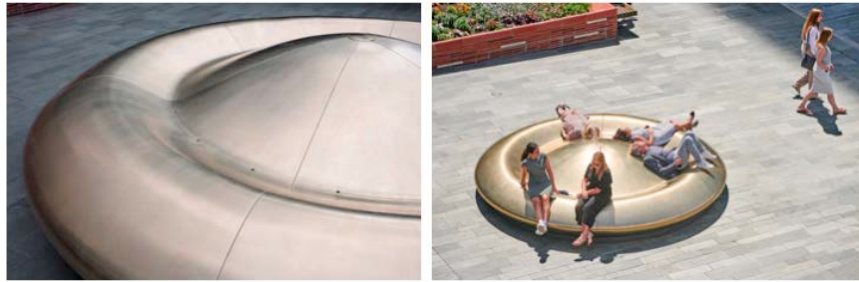


Figure 2.3 *Sky Station* by Peter Newman; Photo by David Hares

Skystation⁷, an interactive public aluminium seating bench installed in various locations of the UK and the busier places such as the financial district in London, designed by Peter Newman, encourages people to rest in a recline position and look up in the sky. Newman explains in an interview how “Art and design come alive through interactions with the people experiencing it.” The aerodynamic aesthetic makes this look like the Skystation could travel. The L S:N Global, a subscription-based trends intelligence media service by The Future Laboratory publishes that “The Skystation creates an opportunity for pause, reflection and interaction within the public realm. Gravity puts the past beneath us, so looking up is akin to thinking about the future.” [22] Intended to create a sense of togetherness, the flying saucer shaped bench seats up to around 12 people.

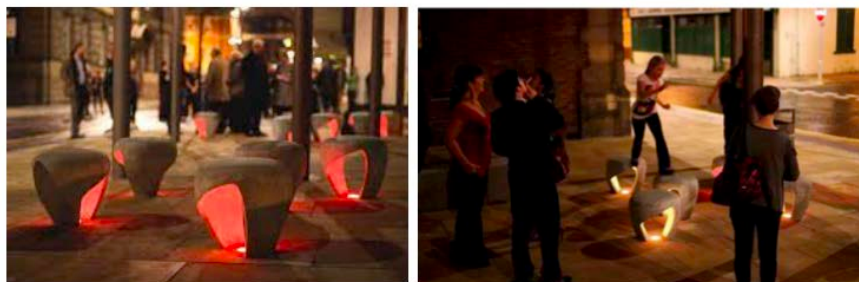


Figure 2.4 *Illuminated Stools* by Charlie Davidson; Photo by Modern Chair Design

7 <https://www.dezeen.com/2022/07/03/ufo-bench-skystation-peter-newman-canary-wharf>

Charlie Davidson created Illuminated Stools ⁸, a public seating installation to revitalize Sunnyside, Sunderland, the UK, through sound and interactive lighting. The idea behind Davidson’s concept was to make public furniture an interactive element that feels alive rather than fixed in place; the marble like casted stools wind down the town street from the popular shopping area towards Sunnyside park changing colors by the LED light system enhancing the effect of other installations and soundscapes in the park [23].

These examples of urban furniture allow us to speculate how street furniture could play a role in the future of urban spaces. Urban furniture serves more as a means of creating an experience, rather than purely as a means of providing functionality, according to The Street Furniture Direct, The Bailey Street Furniture Group [24].

2.3. Technologies for Social Connections

To begin, we consider technologies that can contribute to social connection. According to Fingerman et al. [1], the term “information and communication technologies” (ICTs) refer to a broad range of these technologies, including smartphones, websites, social media, video conferencing tools, and other types of applications.

Because social disconnection among older populations has been addressed by several public health and research initiatives their study discusses how new technologies can help reduce social isolation in the elderly and promote social connection.

For example, they refer to older adults generally being more comfortable placing calls on mobile phones as opposed to using social media, emails or texting. Contrarily, the younger generation may spend more time texting or interacting through social media. Older adults are often assumed to be unwilling or unable to embrace modern technology, and yet Koon’s [25] research reports willingness of these individuals to make use of digital assistants, such as Echo from Amazon and Siri from Apple, to make their daily activities easier.

⁸ <https://www.designboom.com/design/charlie-davidson-sunnyside-public-realm>

Type of ICT	Definition	Software & Devices	Examples
Health	Often wearable technology that has the ability to inform doctors and other health care providers of a patient's well-being. Information that can be communicated includes heart rate, pulse, blood pressure, sleep, step count, etc.	Smart watches	Apple Watch, Whoop Fitness Tracker, Samsung Watch, FitBit Measures: heart rate, accelerometer, sleep analysis, calories burned,
		Smart clothing	Levi's Commuter x Jacquard, Sensoria Fitness Socks, Nadi X Measures: heart rate, distance traveled, altitude, posture adjustments
		Mobile phone health apps	Apple Health app, MyFitnessPal, Strava Measures: step count, distance, heart rate, calories burned
Business	A category of ICT that is concerned with the presentation, preservation, and manipulation of data in a workplace or classroom.	Word processors	Word, Google Docs, Pages
		Spreadsheets	Excel, Google Sheets
		Presentation software	Powerpoint, Prezi, Keynote
		Communication meetings	Webex, Zoom, GoToMeeting
Social	A type of ICT that facilitates information exchange and communication between two or more individuals	Social media	Instagram, Facebook, Twitter, Snapchat, Pinterest
		Video messaging	Skype, FaceTime
		Text messaging	Mobile phone apps: Messenger, GroupMe, WhatsApp, iMessages
		Dating	Bumble, Tinder, Match.com
		Video sharing	YouTube, Tik Tok
		Digital assistants	Alexa, Siri, Google Home
		Transactions	Venmo, PayPal, Cash App, mobile banking apps

Figure 2.5 Types of ICTs and Definitions by Fingerman et al. [1]

Older people are commonly reported feeling lonely by socially isolation as their social networks grow smaller, loss, etc. Relying and incorporating the use of ICTs could play a significant role in fostering social connections among older populations. Still yet, communicating through ICT does not fully replace person to person contact to fully feel connected.

2.4. Playscapes and Interactive Installations for Social Bonding

In this section, we explore **Playscapes, Interactive Installations and Environments** that have used Technology and Design to form Social connectedness in people.

*“People can interact and play with it together...community forms, people talk to each other, they meet each other and there is a connection that happens within the piece itself.” - Jen Lewin*⁹

Play Today’s culture and society suffers from social connections that grow increasingly sparse and lack the meaning of deep connection. Play supports social affordances, according to Bertran et al. [26] referring to a catalog of studies of “playable cities”, enjoyment is a key concept in understanding the social world, as humans are motivated by pleasure, emotional connection, and joy.

Parks, squares, and streets are much more than just tools at the service of our community. In their very nature, they consist of interactivity between human beings that occur from moment to moment. These features of cities should support cultural, social, and emotional stimulation. Technology may make cities more efficient, or better-functioning, from an arbitrary perspective, but on its own it can replace the playfulness of spaces such as parks with the repetition, sameness, and sterility of pedestrian overpasses.

Contemporary art installations can incorporate technology and engineering, creating artworks that can evolve into a visual and tactile experience. These installations often evoke a sense of self, transparency, and sensuality, leading to a feeling of play and interactivity. The artwork can be interacted with by touching, walking, or setting the artwork in motion. Unlike paintings and sculptures, viewers are able to participate in and interact with these art forms in a way that goes far beyond gazing at more traditional forms of art, such as architecture, sculptures, and paintings.

The Pool, by Lewin, is an interactive environment of giant, concentric circles created from more than 100 interactive circular pads, inviting visitors to walk, dance, jump, and play with the piece. The boards are programmed that responds to touch, when stood on, each platform lights up. As a person moves in either direction stepping on different platforms, they create light ripples. Art, technology, and community come together in her designs and work. Her art work exists for anyone and everyone to not only experience the piece itself but for everyone to experience each other’s experiences together.

⁹ <http://cmky.org/spotlight-light-artist-jen-lewin/>



Figure 2.6 The Pool, an interactive traveling pool of light (Source: Jen Lewin Studio)

*Urbanimals*¹⁰, and *Hello Lamp Post*¹¹ are examples of urban infrastructure designed for people to interact playfully, in ways that spark creativity. *Wiggle the Eye* is another example of an interactive installation that consists of multiple benches that wobble with sensors that activate lights from the motions of wiggling and wobbling. The way it invites people to sit on the benches and wiggle and play, it creates a fun atmosphere.

Play infiltrates different contexts and spaces, and offers new meanings, new constraints, and new motivations over time through these works, re-semanticizing the urban space [26] [27].

2.5. Human-Computer Interactions

There are “four elements of technology used outdoors: one or more humans, a computer system, human interaction with the system, and being outdoors,” introduced in the book, *HCI Outdoors: Theory, Design, Methods and Applications* by McCrickard et al. [28].

Ubiquitous Computing or calm computing, introduced in *The Computer for*

10 http://lax.com.pl/portfolio_page/urbanimals/

11 <https://www.hellolamppost.co.uk>

the 21st Century by Mark Weiser, is a concept where computing technologies are becoming small enough to be seamlessly integrated into our everyday life and “find their way invisibly into people’s lives” [29]. Weiser mentions, “The ubiquitous use of computers will help overcome the problem of information overload,” by fitting into our lifestyles and to our convenience, instead of forcing us, almost as though “using a computer as refreshing as taking a walk in the woods.” [29].

Interface Design and Ubiquitous Computing examine how to design technology to fit individuals, environments, and contexts and how to make them healthier, more connected, and more productive with technology [29].

HCI will be a guiding principal in our design methodology, defining how and why the interaction between human and computer is initiated. Using human-centric technology in an outdoor setting represents a challenge, but it also represents the potential for humans and machines to interact seamlessly in an environment where such interactions are more the exception than the norm.

2.5.1 Interactive Textile Objects

To bring this to another level using technology, interactivity can be added to textile-based objects and wearables, offering another deeper layer of potential emotion, community, and connection “by integrating sensors and actuators, textiles can be developed into something more than garments and decoration objects” [30].

While interactive textiles are not a new concept, newer technologies such as wireless connectivity, and improvements in batteries and sensors have unlocked new applications. According to Ziefle et al. [31] one of the goals of interactive and smart textile applications is to extend technology beyond the objects we must pick up and look at to use, like a screen, to those objects we can simply wear or otherwise interact with in more passive and natural ways.

Ståhlberg, [32] the designer of *MusiCushions*, interactive cushions explored in depth the options for controlling and experiencing the cushions. They found that plastic remote controls and other more traditional forms of technological interaction were disconcerting and broke the immersion that interactive textiles could offer. Breaking from these more traditional forms of interaction into something more natural and subtle could instead foster deeper senses of connectedness. The researchers and designers of these cushions highlight the importance and challenge

of keeping the aesthetics of object items appearing soft and not machine-like, hiding the sensors and actuators inside them [32].

Interactive Pillows by Maze, et al., [33], another example of interactive textile objects, examines how a textile-based object can seamlessly integrate into its construction all of the technological components necessary for interactivity without compromising its form. Further, it is explored how this technology can be used to tie to objects together, tethering the experiences of those who simultaneously interact with them. With a combination of glowing lights, sounds, and haptic motions, the object can create a shared experience across space and a shared emotional state between two or more individuals.

Thus by combining an integrated design with multiple modes of interactivity, and finally by further tethering that into a larger experience, the concept of interactive or smart textiles can reveal a technology-based facsimile of more traditional biophilic or social experiences.

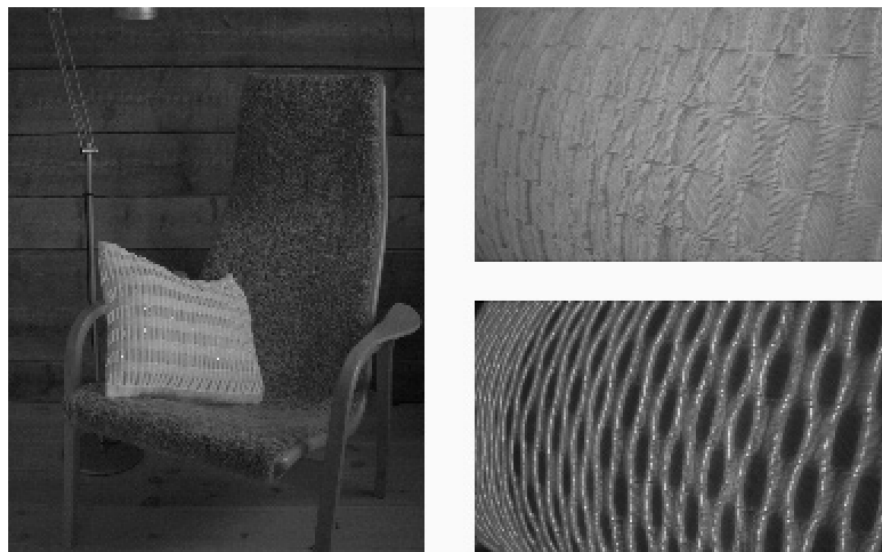


Figure 2.7 The Interactive Pillows by Redström et al.

In previous works, interactive textiles studies have demonstrated that thermochromic or electrochromic properties can provide display function in interactive textiles. However, cushions containing multi-sensory capabilities have not been explored previously.

Through previous works of the biophilic urbanism concept and application, interactive installations and interactive textiles studies, the followings are the aspects that will be incorporated and considered for further investigation through the design process.

2.6. Summary

Existing research shows the value of nature-centric and human-centric designs, the ways these designs can emotionally effect individuals and promote a number of positive emotions as well as better perceptions and outcomes. These design concepts promote a social element of design, encouraging collaboration and collective use. The aesthetics of design, in terms of biophilic design, human-centered design, and interactive and smart technologies should all be seamlessly combined into an experience that represents a unified experience that touches on all these concepts. This design should further ensure that control interfaces and technology should be hidden within the devices to ensure an unencumbered experience. In total, these existing works inspire us to explore and develop our own designs and that bridge play, technology, and mediated socio-emotional textile designs in urban places.

Chapter 3

Concept Design

3.1. Design Process

We follow a design research approach for implementations to demonstrate the viability of the concept of a modernized *aerie*, building 3 prototypes: starting from a lo-fi prototype to a functional conceptual prototype, and a final product for investigating the concept and potential product. There were three prototypes made for each iteration, with the devices working together or separately. Due to their ability to embed components ubiquitously into textiles, the interaction relies on the affordances of soft cushions. We go through various iterations of design, evaluation and analysis; this process leads to qualitative and situational insights. The iterative prototypes and tests are to see the interactions and see if the user's emotions are provoked by the sensory stimulus, focusing on the perceptual experience the ambience of the lights, audio, and haptic sensations brings. The experimental setup is conducted after each prototype is made. We started out by testing usability indoors, internally, amongst our team and collaborators. The later iterations were taken out to be installed in real-life public settings, aiming to observe and test in an uncontrolled, in-the-wild environment and setting.

3.1.1 Objective

The objective of this chapter is to present the concept of Aerie: a lounging furniture-like device for people to feel and resonate through ambient sounds, vibrations and illuminative led lights. We focus on the embedded interactive technology that is responsive to the user's biofeedback sensing, creating a feedback loop between our inner states, the self-transcendent emotions and the multi-modalities that stimulate the emotional intensity, or the feeling of awe.

We hypothesize that the complex emotions of awe offer a uniquely powerful emotion that is directly tied to connectedness and survival in a social setting. Research by Keltner [34] shows that feelings of awe bind “...us to social collectives and enables us to act in more collaborative ways that enable strong groups, thus improving our odds for survival.”

In the field of emotional research, awe is certainly less well studied and understood than more common and better understood emotions such as happiness or anger. In fact awe is often not highly distinguished from other emotions. And yet it seems awe can be triggered by simple and seemingly everyday situations and occurrences.

Intriguingly, surveys indicated that awe was felt in people’s everyday living, as: “*seeing gold and red autumn leaves pirouette to the ground in a light wind,*” or “*being moved by someone who stands up to injustice*” and even something common as “*hearing music on a street corner at 2 AM* [34].” As this body of research grows, it stacks up up against cultural trends away from awe-inducing experiences, spending more time indoors, away from nature, and too often alone. Aerie aims at shifting our attention and focus back to our immediate surroundings.

Thus, the motive and intent of this research not only lies in the technological intervention of proposing a novel way of bonding through interactions that promote awe and related emotions while simultaneously being built using a human-centered design methodology, which is a design framework that takes human behavior and retains them as the primary focus through the prototyping process, implementation and studies. Through the studies and workshops qualitative research, we will investigate the unfolding of the responses to these stimuli, as our experience of awe may differ due to the spectrum of emotions associated with it.

3.1.2 Survey

As a pilot study, a survey study was conducted to examine the preferences to soundscapes in the context of relaxation and wanderlust, a strong desire to wander, travel and longing for far-away places to explore the world has been put on hold.

We reached out for people to take part in a survey on answering questionnaires on relaxation and social connectedness with the purpose to gain insights around these topics to guide us with design choices for the following research questions:

- Would feeling the sense of co-presence create or increase social connectedness between distant places and people?
- Would feeling the sense of co-presence create or increase social connectedness between distant places and people?
- What kind of physical public installations can assist in creating shared experiences?
- What kind of sensory feedback provide the best relaxing experiences?

The purpose of this pilot study is the investigation of whether shared presences through exchanging the surrounding soundscapes in distant places such as urban and rural places could foster social connectedness. The idea is based on the hypothesis that machine-mediated interactions could play a significant role in bringing people together under restrictions at times during the spread of a pandemic where social activities were limited. Under the speculation where there was a greater need, especially for one) individuals living in foreign countries, who suffered more from the obstacles to meet their friends, family and loved ones from travel restrictions, and two) individuals experiencing stress from the changes in lifestyle such as remote work and social isolation.

The demography of the survey respondents included a total of 53 participants (female=29, male=22, prefer not to say=1) in the age range from 22 to 46 years old (average age=31). The survey was constructed of two topics: relaxation and sounds. The first part consisted of questions that targeted to ask about their general emotional and physical states. 88.7% of the respondents answered “yes”, to the question of whether they felt like they “need some type of intervention to deal with stress to relax”. The later part consisted of questions that investigates the preferences of sounds they preferred as a method to cope with stress and boost their states.

The survey was anonymous, and though we can not match the respondents’ answers to questions on their residing location and “where they would like to be right now”, a total of 78.4% of the respondents answered to reside in Japan, and within that proportion, 26% answered to prefer to be in Japan. The most popular answer to where they wanted to be was simply on the “beach” or a place that

suggested beach-like environments like the “Maldives”, “Bahamas” and “Hawaii” with 36%. Other answers included popular travel destinations like Thailand, South Korea, Australia, Paris, The United States of America, etc. The remaining 2% preferred to be in the “city”. We can point out that the current place you are in, does not necessarily mean that they prefer to be in a more relaxed environment, not only beaches but in “mountains”, “rural” or the “onsen” (hot springs).

In the comments sections, many answered that utilizing social media helped stay in contact with distant friends and family as a way to feel less alone. Many also stated different ways of keeping in touch with friends, family and loved ones outside of staying in touch through social media, and we can infer from the ways they share these episodes that social media and online communications can not fully replace real-world human interactions and connections.

3.1.3 Inspiration



Figure 3.1 Inspiration Board

Some of the most important conceptual inspirations come from nature, or more specifically, how we interact with nature. The most powerful sources of inspiration, awe, and connection, with each other and with nature, can come from the most basic sources, such as simply looking up at the night sky.

Stargazing represents a significant inspiration. Despite often being a utterly

solitary experience, it still manages to promote feelings of connectedness with the universe and nature. Stargazing gives an individual a sense of scale often lost in everyday life and a sense of peace and serenity, calmness and awe that few other experiences can be replicated. When experienced with others, stargazing can provide another level of connection that, at the same time, is both individual and shared. This type of connection to nature, to shared experiences, and the ability to extract an individual from the often hectic pace of life, were all inspirations for the design.

Paul Piff [35], Associate Professor of Psychological Sciences at the University of California-Irvine, found that awe inspiring sights, including the night sky, could combat or even neutralize narcissism, causing individuals to “forego their strict self-interest to improve the welfare of others.” The simple act of gazing at the night sky and the awe that it brings has been shown to make people less self-interested or self-absorbed and more likely to see themselves as a part of something bigger, promoting empathy and kindness toward other individuals.

Another Associate Professor of Psychology at Arizona State University, Lani Shiota [36], studies the impact of the emotion of awe on the human nervous system. She found that awe has a unique effect as compared to other emotions, in that awe promotes an empathetic willingness to provide help to others, while many other emotions cause the individual to disengage and move on.

An inspiration board is created as a visual representation of the concept in design. It is compiled of mainly images of elements of nature, and specifically, the type of feeling captured in those particular situations or with the object. Figure 3.1) We plan on creating an artifact around our main inspiration element: the clouds, as a comfortable, and will incorporate other elements conceptually in the non-machine-like interface product design along with the seamless interaction experience designs.

3.1.4 Ideation

Based on the findings, our aim is to create a prototype that induces an emotional sense of connection through one or multiple sensory stimuli for fostering a sense of connection with the world around us.

In the design thinking phase, we dedicated a few sessions to brainstorming

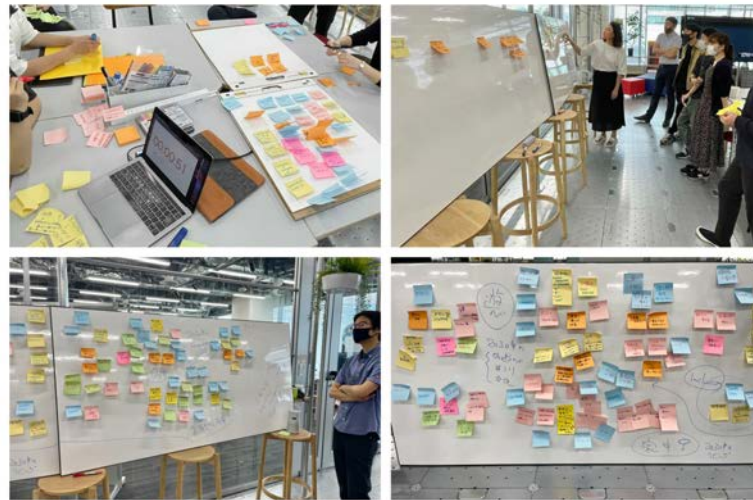


Figure 3.2 Ideation Session

and sharing ideas of what the future city might hold for us. We centralized the creative thinking process on imagining the experiences we would people including ourselves expect to experience in the future city? (Figure3.2) The sessions took place at the Cybernetic Being/Embodied Media lab with the members of our collaborator, Toyota R&D Central Labs., Inc. The ideation expanded to any possible creative thinking and ideas within realms, which followed into processing and categorization of the ideas into sections, such as “food”, “home”, “play”, and “inclusiveness”. We came to understand that human-to-human interactions would be an important overarching theme in all categories. We saw potential in the possibility to explore further into interpersonal interactions. Discussions then developed into a diving point of *how can we redesign the way we socialize, connect and find belongingness; and how can we generate a human-to-human interaction mediated by technology?* The key aspects we took into consideration are one: cultural uniqueness, two: an integration of people, nature and technology, and three: stimulating the feelings such as the feeling of awe, a complex emotion mixed with pleasure, surprises, admiration, sadness, etc. The refined research topic was: how could we explore the possibilities of creating interpersonal interactions by enhancing the feeling of awe with synesthetic or tactile feedback? We also utilized Miro, a collaborative whiteboard-like platform to work remotely. (Figure 3.3)

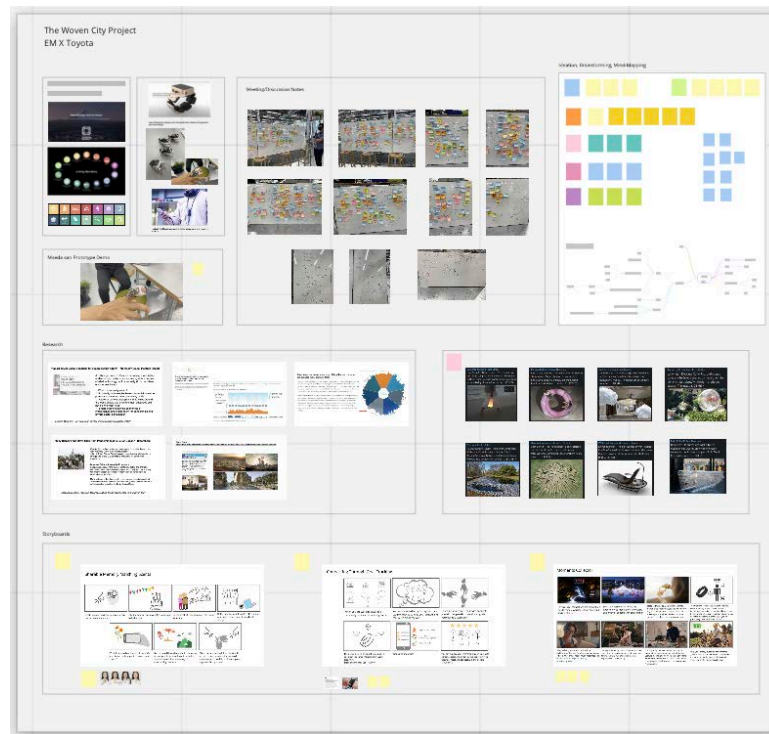


Figure 3.3 Miro board

3.2. Concept

3.2.1 A Modern Aerie

Inspired by the etymology of the word “aerie”, which in old French is “nest” and Latin in the Medieval Latin area “garden bed”, the concept of aerie inspires to design an experience that brings a sense of comfort with the use of technology embedded in a non-machine-like interface - a place to gather, nest, and linger around for a sense of belongingness and connectedness in an urbanscape. The chapter for concept design is dedicated to fully realizing and prototyping *A Modern Aerie: A Multi-Sensory Outdoors Installation*.

3.2.2 System Architecture

Here are the components that have been considered for operating the system:

Hardware: A pressure Sensor is placed under the first layer of the artifact,

embedded inside for finding presence and posture detection, and command to start running the system.

Sounds: Each device holds a round Herdio Bluetooth 10.5 cm wireless Bluetooth ceiling speaker, 160W.

Haptics: Each device contains a vibro transducer, a VP6 by Acouve Lab, to transfer the tactile sensations.

Lights: The devices are installed with a 2-meter long RGB programmable Nano pixel LED tape. The LEDs are fixed around the cylindrical bottom acrylic base with an aluminum support to keep them in place and sturdy. The lights are programmed to express different modes, designed to match the sounds.

System: The system is turned on and off by a switch, similar to how household lamps are turned on and off. The computer is programmed with C#, controlling lights, sounds, haptics, and sensors. It is also able to connect to a pulse sensor, for sensing a person's physiological data. A software system is used to filter and regulate the data.

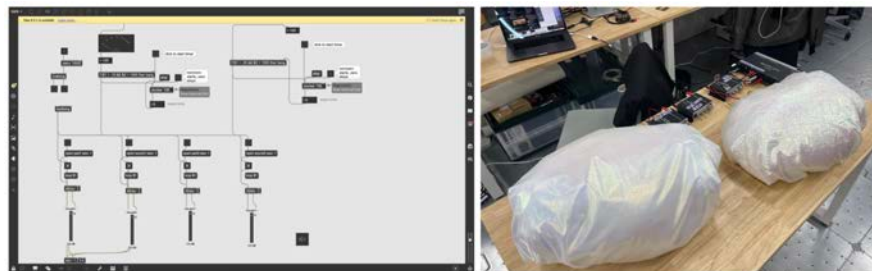


Figure 3.4 Left: Screenshot of the max patch; Right: first prototype connected to the Max program

3.2.3 Product Design

Furniture in cities or urban furniture contributes to elements such as communication, aesthetics, functionality, and facilitating the personal and social lives of individuals who constitute the city. For a more concrete definition, urban furniture¹ refers to all elements that serve basic functions such as seating, sheltering,

1 <https://pdfs.semanticscholar.org/ebf5/535670e51031abf373d3660a89246ae7b86f.pdf>

lighting, in public areas such as streets and parks.

An outdoor seating element is an important part of urban furniture that is necessary for short-term rests. Our intention behind building and installing the products is to offer a small gathering place that serve functionality of a comfortable outdoor pillow-like cushion for a place to rest, an illumination that enhances the dreamy-magical feelings, and a multi-sensory experience created by sounds and haptics, to get in touch with our emotions.

We hypothesized that when emotions are stimulated and experienced communally or publicly through our system setup, a sense of connection can be felt with the people taking part in this public space installation. The product works as a mediation to bind humans and nature, and reach a deeper level of opening emotions.

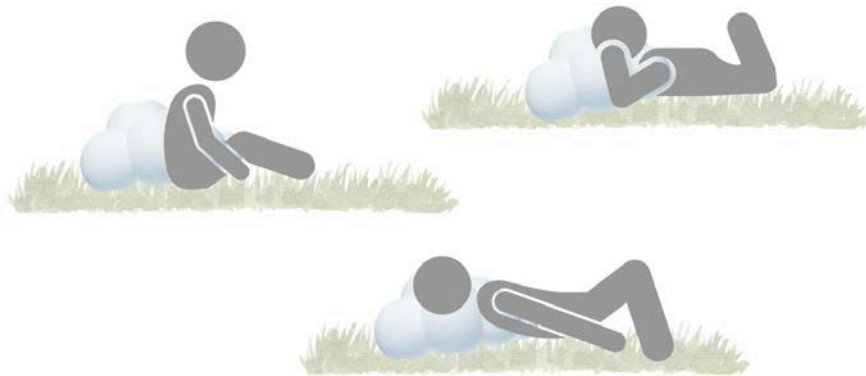


Figure 3.5 Ways of interaction between artifact and human

The purpose for building a prototype of the product is stated below:

- To make an artifact with textile that could potentially serve the affordances of a soft, cushion-like furniture that embeds with components to for a multi-sensory experience
- Using the components considered for operating the system as a base to build on testing how to design an emotional evoking experience
- Imagining the real-life installments at parks, considering a passive way of interacting and engaging with the artifact, as the main focus of the expe-

rience should orient around human-to-human interactions of perceptions of physically and emotionally being together

- Considering a seamless human-computer interfaced interactions

The overall form factor, design decisions, and physical arrangements for feasibility were made in the prototyping phase. Rough sketches were made to imagine the use-case scenario or implementation. (Figure 3.6) The sketch shows a rough setup of the internal components enveloped by the outer cushiony layer. (Figure 3.7)

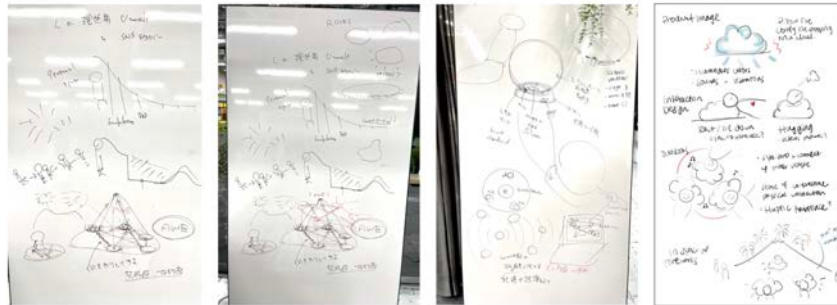


Figure 3.6 Early-stage sketches of concept, interaction and product designs

For modeling the cloud-like artifacts in 3D, we used the software, Tinkercad. (Figure 3.8)

Installation image of the initial finished prototype

3.2.4 Features

One of the core efforts with Aerie's designs is to create an immersive, affective, and memorable experience. These were concerns that we focused on from the very beginning of our ideation, design and prototyping processes. The three main factors which we focused on to achieve this were sound, haptics, and lights. By utilizing these three modalities, our goal was to create an experience that would hit several of our senses and lead the users to an affective interactive experience.

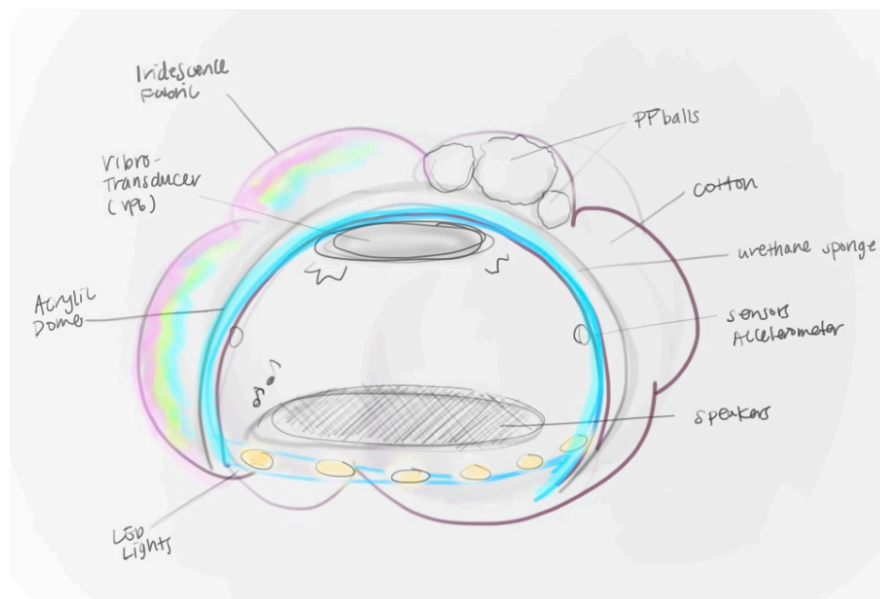


Figure 3.7 Product Design Sketch

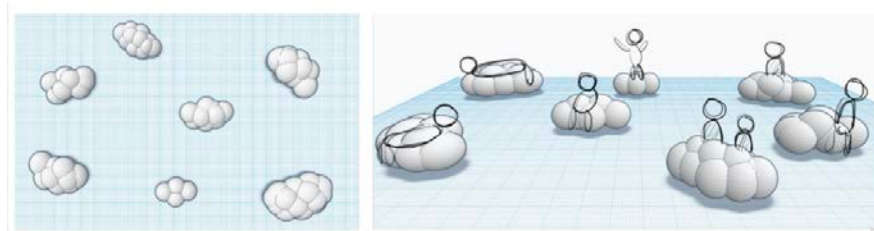


Figure 3.8 3D Modeling using Tinkercad

Form Factor

The clouds being symbolic of a daydream, travel, an escape, a wander of the mind, the idea of discovering new things, new people and feelings; the cloud shapes are incorporated as design inspirations to form a cushion type object, as commonly used in our daily lives. To maintain a soft, huggable, giving the affordances of a cushion and non-machine like physical interface, technologies are embedded inside.

Sound System and Sounds

One of the most important factors in designing an immersive or affective experience [37]. Many new technologies have been employed in recent years to achieve an immersive sound experience, such as virtual reality audio, many-channel audio



Figure 3.9 Prototype 1: Installation Image

systems, and binaural recordings. For our work, we decided to focus on multi-channel responsive music and sound design using Max/MSP as the control system. In this program, we designed a system that would detect the interaction with Aerie through a pressure sensor which would then send a signal to Max/MSP. Once Max/MSP detected this trigger, a new and unique sound layer would begin to appear. Our intention was to give the user a sense of presence and response from the object. In addition to the responsive sound layer, there were additional layers of ambient sound, intended to create a general atmosphere in which the user could relax and become more focused on the experience.

The sound designs choices are based on the data collected in a pilot study survey. The 4 different soundscapes: water sounds to evoke a floating sensation, rainforest sounds of birds and water to evoke relaxing and adventurous feels, ambient sounds to induce awe, and lastly fireworks sounds for making people feel excited and nostalgic. These elements of nature are intends to bring a sense nature in the city, where city residents have limited access to nature.

Haptics

In order to achieve a physically immersive experience, we used haptic devices in addition to and in conjunction with the sound design. These large haptic devices were installed inside the proposed system and were made to accept and respond to the same audio signal which was being used. Thereby, we were able to excite two of our senses (sound and vibration) simultaneously. Whenever a sound would



Figure 3.10 Visualization of the Intended Sound and Sensation Designs

begin to play from the Max/MSP patch, this audio signal would also be sent to the haptic device. In order to fully actuate the haptic motor, simple graphic equalization (or EQ) was applied to the haptic audio channel to boost the low frequencies. This would lend the sound to activating the haptic device much more clearly and intensely.

Lights

The main function of lights is for illuminating the the space at night. The presence of streetlights in public spaces after dark gives people a sense of security. This element includes all kinds of streetlights, lamps, bollards with lights, and low-level lighting in the public space. The third layer of interaction we used was LED lights installed within the object. The illumination synchronizes with the sound and haptics, therein creating a seamless and unified gesture. The lights would fade in and out along with the data and interaction. In addition to the interaction, music compositional elements were composed specifically to enhance the strength of the lighting and impact on the overall experience. When the lights would be slow and fading, the music was created to be slow and flowing. When the sound would be more intense or rhythmically involved, the lighting would accompany this in fast patterns. This was all intended to create a synchronous experience.

3.2.5 Experience Design

In our presentation of the Aerie system, we intended to give the user an affective experience through a multimodal approach featuring sound, light, and haptic vibrations. The interactions of the user with the object would trigger and manipulate these features, thereby affording a sense of being and dialogue with the system. It was our hope that this kind of reflective experience would lend itself to allowing the user to feel more connected to the object and the people around them.

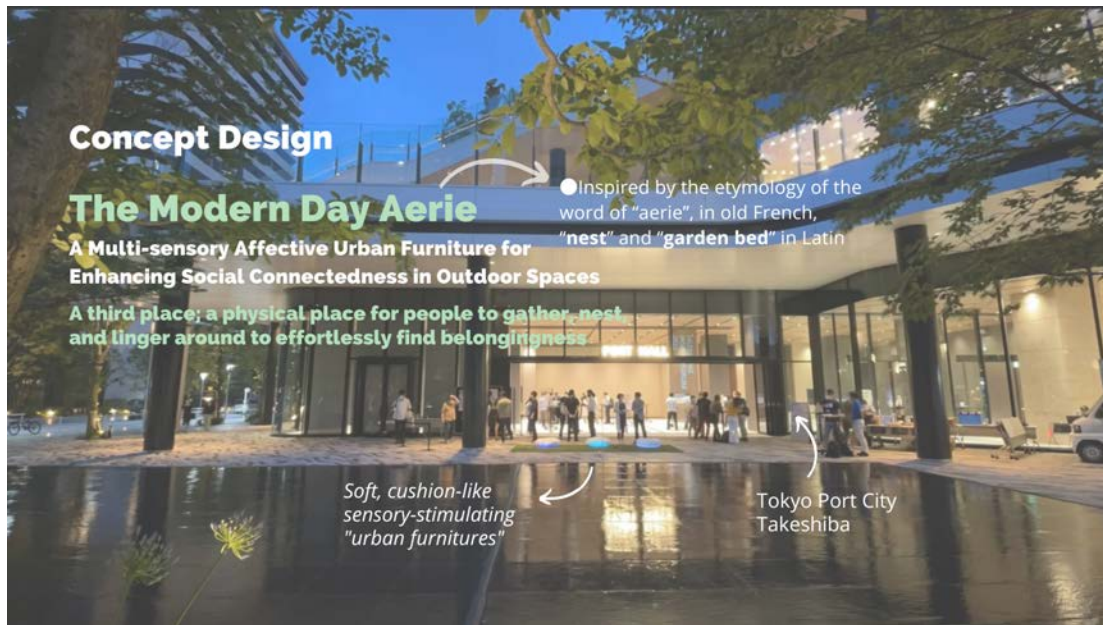


Figure 3.11 Concept Design of Aerie

Intervention for Fostering Social Connections

Aerie as a place

We design Aerie as a place for where people meet informally or to be used as meeting places in alternatives of as cafes, bars, schools and or events. Simultaneously, with access to parks, plazas or open places of green space for recreational purposes being limited in urban areas, a place where people can relax, refresh and find peace is an important context. Aerie aims to create a social gathering space like common areas for casual meeting spaces, where connection and community can be facilitated. Our first design initiative is to creating a place where people

can stop by at any time of the day. It can often be challenging to meet new people; to lift this barrier, we create an opportunity for putting people in public spaces where they are bound to meet others. Opportunities to make new connections or run into a friend or a familiar face could make us feel comfortable and encourage us to stay outside longer, while getting to know the people in our community.

Aerie as an activity

Even when one is in an environment otherwise conducive to connecting with others, most of us often don't have a conversation starter or feel shy about opening up about themselves. These can both be made easier by having people seek out in group activities and events. Sharing mutual interests can be a starting ground and opportunity for people to get to know each other and possibly bond over a course of time or triggered by chance. We imagine Aerie being used collectively, with no timed starting and ending points. Instead, we offer an accessible, open-to-use for everybody at any time of the day, to best meet the public needs, whether it is a late lunch break for someone or killing time in between appointments, or unwinding after work. As an individual sink into Aerie and the system starts, the sound and haptic stimuli will allow the individual to enter their own worlds by exploring their own feelings, memories or states. In the peripheral vision, individuals are aware of the presence of others, experiencing Aerie. While our designs are intended for multiple people to engage in this activity, we imagine multiple Aerie placed, per location. For people to join this activity repeatedly, we design the activity to be effortless and passive, allowing people to engage in the moment, from simple interactions such as exchanging smiles and hellos between participants or being mindful to each other by reading social cues to a more direct interaction such as having conversations.

The series of emotions and feeling we want to see people go through:

- Comfortable
- Calm
- Self-Transcendent
- Intimate
- Emotional

- Awe (i.e. fear, wonder, reverence)
- Excited
- Nostalgic
- Energized

Through the experience of Aerie, we would like to see people feel connected to:

- Place
- People
- Experience Aerie brings with Sounds and Haptics

In summary, it is important for Aerie to function as both place and activity that allow people to have control over their own lives and their own time. We imagine the experience would vary on a number of conditions such as the weather, the individual's energy level, level of engagement, and chemistry between participants. These factors will effect the outcome of social connectedness; understanding that the feeling of connectedness is subjective and different amongst each individual's way of perceiving things.

3.3. Conceptual Prototype

3.3.1 Overview

The biophilic designs that center around the design print of The Woven City,² are developed to create a sense of a more livable city “in an age when technology, social media and online retail is replacing and eliminating our natural meeting places. The city explores ways to stimulate human interaction” [38]; the architect Bjarke Ingles plans out the redesigning of the way we socialize, connect and find belongingness.

² <https://www.woven-city.global/>

In an ideal urbanized society, how might we design a nature-based shared experience through an interactive media/medium to foster and study social connectedness?

We hypothesize that a social bond and connection can be achieved in a nature-based urban setting by sharing the experience of a feeling of awe, a stimulated sense of intensified emotions. There is often a sense of awe when we are in the presence of nature, feeling that the vastness of it transcends our understanding. A sense of awe diminishes our ego and decreases our sense of self, as a result, awe can cause one to be more positive and mindful to other people.

A set of conceptual prototypes of Aerie were presented in a short concept movie: “Empathic Interactions in the Smart City”, presented by the Embodied Media Project and Toyota Central R&D Labs., Inc. Creatively, we present the basic product features, aesthetics, interactions and syncing between a person and the conceptual model, the collective experience Aerie brings, and finally a display of the seasonal event use.

We coordinated with the Tokyo Port City Takeshiba Building real estate management for filming this concept movie in a real-life environment. With its location in the heart of the city and surrounding abundance of nature, Tokyo Port City Takeshiba³ Office Tower offers employees a green work style that is conducive to integrating greenery and water into their everyday routines. Besides providing environmental education and reducing environmental impact, the complex offer hands-on experiences with plants and animals. “The 8 New Sceneries of Takeshiba” consists of eight different views, including rain, water, islands, rice paddies, fragrance, vegetable gardens, bees, and the sky. They integrate 8 elements into modern architectural designs to create a lush green environment, while at the same time promoting biodiversity initiatives through environmental education, regional exchange, and information dissemination.

During lunchtime or after working hours, the Skip Terrace is a popular area for bringing their lunch outside, socializing, or simply enjoying their time outside. Ideally suited to our concept, the location works out perfectly for our urban furnitures, Aerie, to be installed in the concept video.

3 <https://tokyo-portcity-takeshiba.jp/>

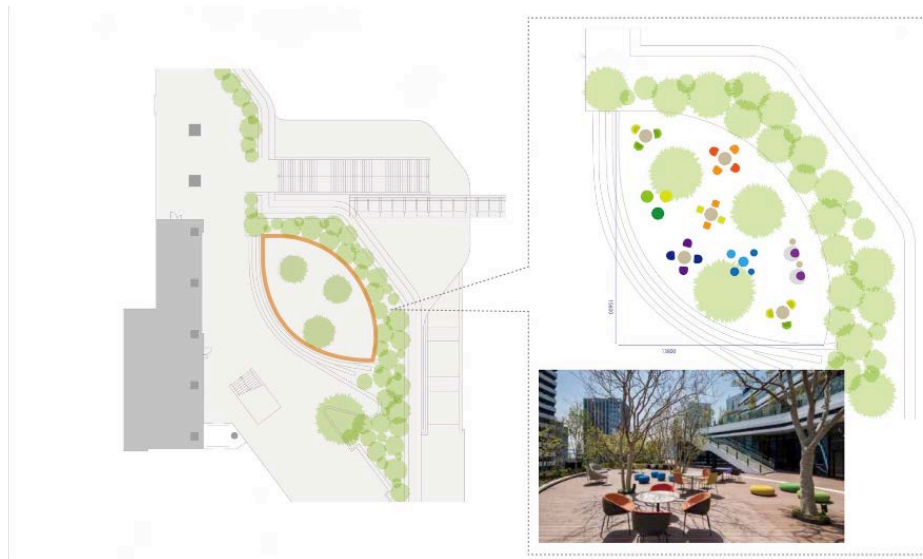


Figure 3.12 The Skip Terrace in Tokyo Port City Takeshiba (Source: <https://tokyo-portcity-takeshiba.jp/>)

Basic Product Features Interaction of the Furniture and Person

- Providing a sense of comfort as a public installment for lounging, relaxing and grounding at an outdoors communal public place
- Biological Data Input and Sync
- Audio and Haptics feedback reflecting an individual's internal state or emotions
- Expressive illuminating lights in sync with audio, haptics and physiological states, interpreted as inner states or emotion.

The concept and aesthetics of the “Urban Aerie” (Aerie)

- How the Urban Furniture would look aesthetically, and installed in the outdoor public area to serve as a place to stall, gather and nest to foster a sense of belongingness

- How the setup of Aerie will bring physical proximity between friends or strangers to create interpersonal or communal types of social connectedness dimensions

Illuminating the City and Seasonal Fireworks

We see that Aerie is illuminating the city in a scene focused on the illuminating furniture. The transition from daytime to nighttime is one of the most aesthetically expressive scenes in the concept video, as the illumination sequences. As it starts getting dark outside, naturally attracting people's attention and encouraging participation to interact with the furniture. In the last scene, it shows that Aerie could be working in sync to seasonal events, such as fireworks, as a way to foster something special, the way people would enjoy seeing a different setup.

The images in the figures below are captures taken from the concept video.



Figure 3.13 Final Prototype of Aerie presented in the concept video produced in collaboration with Toyota Central R&D Labs., Inc.

3.3.2 Technical Implementation

A Render of the Conceptual Prototype The furniture is embedded with the components shown in the exploded rendered image. We have a fully functional

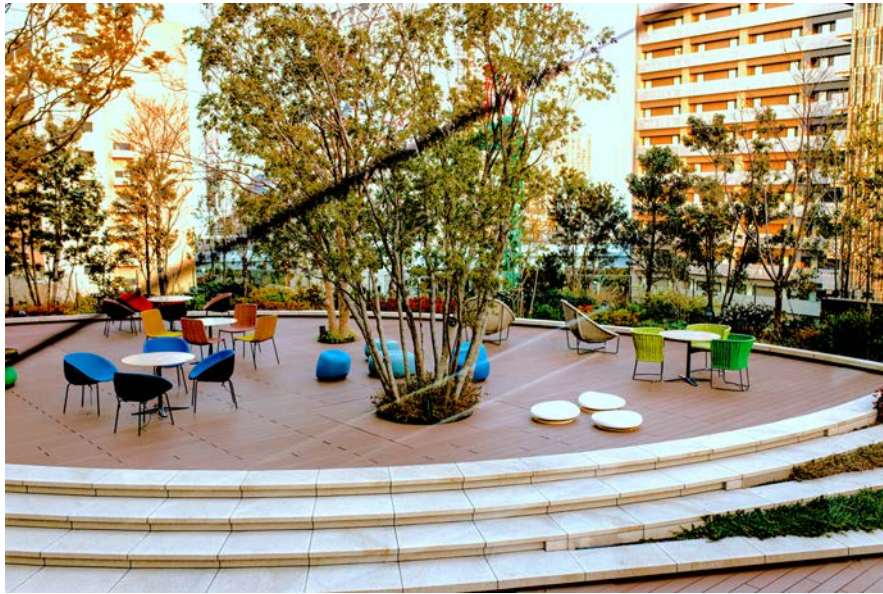


Figure 3.14 Aerie Installation at Daytime

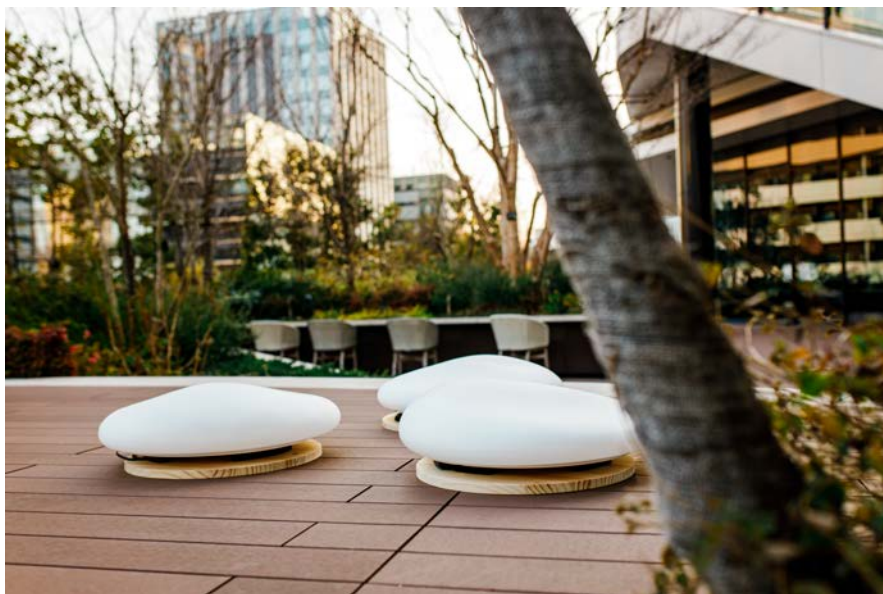


Figure 3.15 Close-up View

conceptual prototype.

The rendered exploded image gives us an idea of the placements of the components. As one can see, improvements were made from the previous prototype; the



Figure 3.16 Captures of the interactions from the concept video

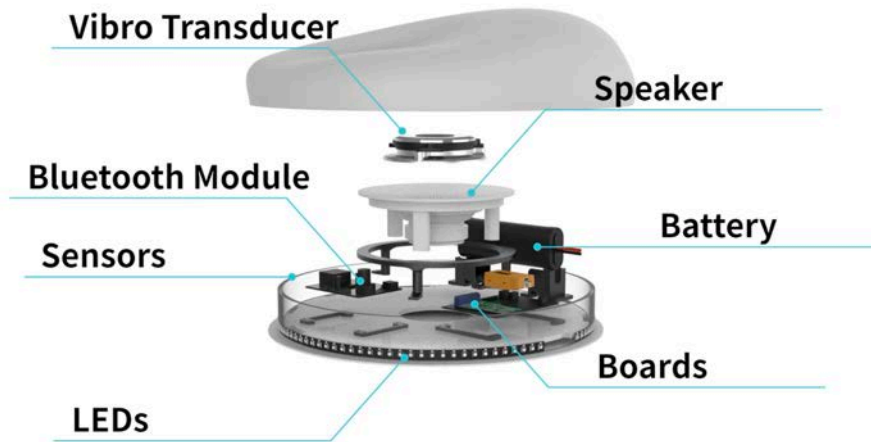


Figure 3.17 Components Labeled

technical features are implemented for a smarter and more urbanized aesthetic.

- A wireless, blue-tooth setup
- A control over sound, haptics and lights done through programming
- Adding interactivenss by adding a feedback-loop system of sound and haptics syncing with our physiological data sensing and filtering

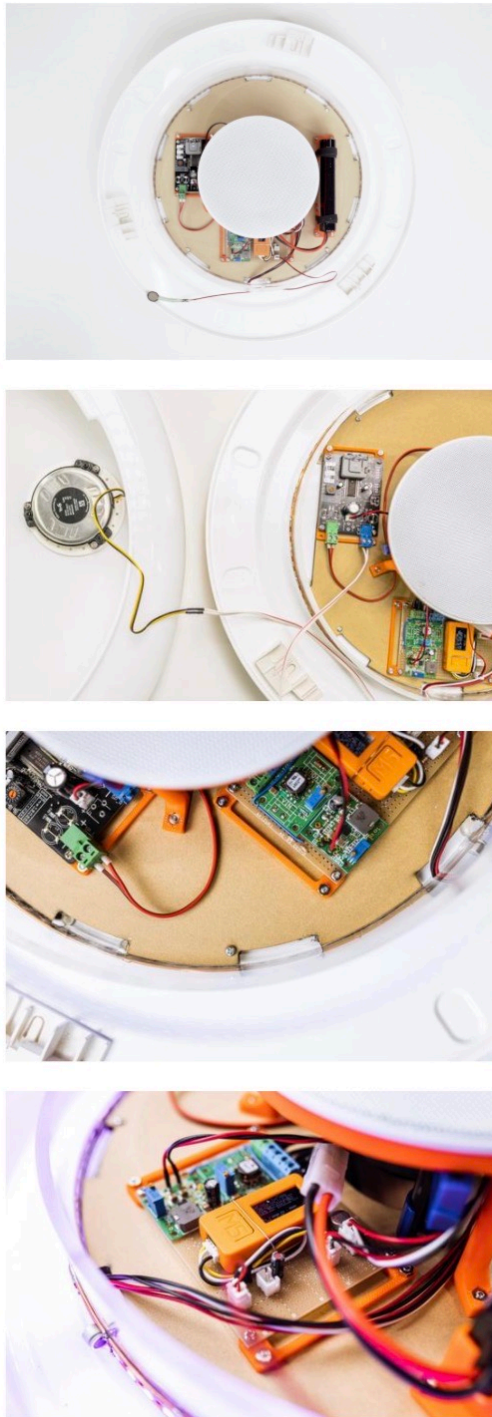


Figure 3.18 Technical Implementation

Chapter 4

Proof of Concept

4.1. Pilot Study at EM:EX



Figure 4.1 Aerie presented at the EM:EX (Embodied Media Exhibition 2022, Open Lab Exhibition)

This pilot field test took place at the Embodied Media Exhibition 2022 at Keio Media Design, Keio University. It was held at the Cybernetic being/Embodied Media Lab over the weekends of March 26th and 27th, 2022. Within the two-day event, we had over 500 visitors. The event attracted a variety of visitors, who ranged from little kids to grown-ups.

It is important to note that due to the limitations of the physical space within the lab, the setup for this exhibition did not allow for a full-body engagement.

A notable factor regarding the placement had a big effect on the ways people interacted. For safety purposes and the limitations of the space, 3 conceptual



Figure 4.2 EM:EX (Embodied Media Exhibition 2022, Open Lab Exhibition) Marketing Visual

prototypes were placed on a tabletop, allowing for participants to engage through touch, listening and looking. With other projects taking place in close proximity, it also did not allow for a full immersion of the sound experience.

4.1.1 Observations

Based on observational studies, we have realized some important factors that must be considered when updating and further developing prototypes for studies.

- **The placement**

The presentation placement was not the most ideal setting, as the design aims to be installed outdoors, preferably in an open space to lie down and get the full experience, a whole-body experience, versus only using the hands to touch.

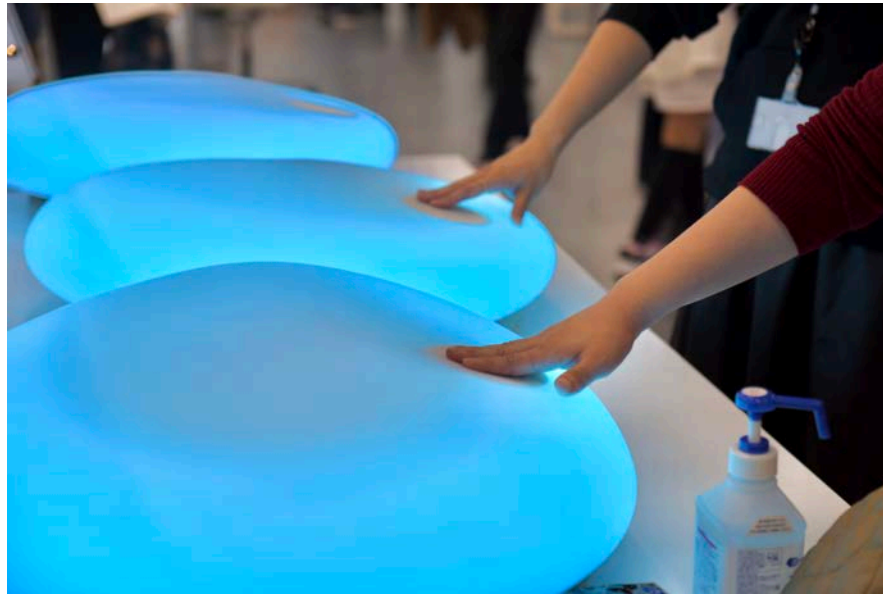


Figure 4.3 Visitors from the EM:EX interacting with Aerie



Figure 4.4 Visitors from the EM:EX interacting with Aerie

- **The sturdiness of the artifacts**



Figure 4.5 A little child interacting with the prototype

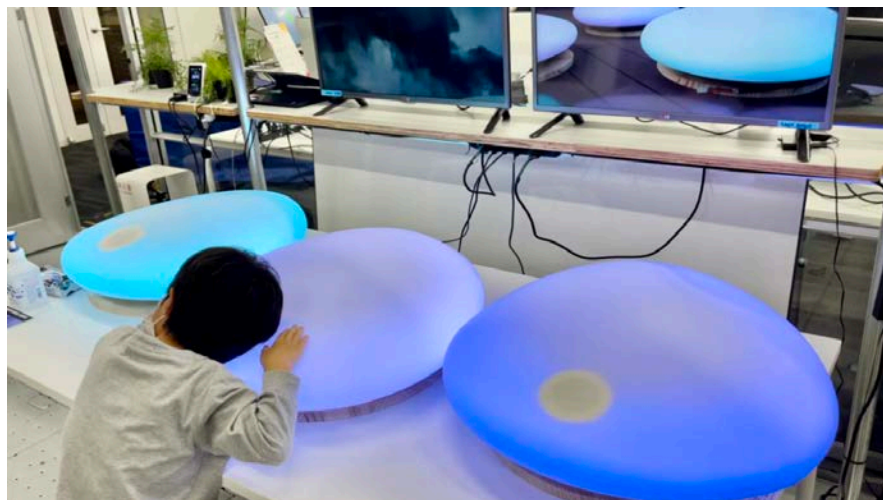


Figure 4.6 A little boy engaging in the demonstration

Children enjoyed a more aggressive or impulsive way of interacting with the artifacts, such as “banging” and “drumming” and generally more excessive touching was seen compared to adults and young adults, who examined the presentation

carefully before making any interactions, the sturdiness can be re-examined

- **The lighting environment**

As lights are one of the key components of this work, the lighting environment also needs to be considered as part of a staging element to maximize its effects. The lab has installments of strong fluorescent lights, not well-suited for the best enhancements for an installation that includes lights, while during the day, outside, would give us a different expression depending on the time of day from bright daytime to dimmer sunset and to night time

- **Haptic sensations as an element of surprise**

The simple way of engaging in this demonstration was to touch the artifact and notably, people seemed intrigued by discovering the haptic sensations, when placing their hands

- **The level of engagement per stimulus**

When observing in what order people engage in interaction, it is almost always the visual - this is the most dominant stimulation people are attracted to. Next was the feel - by placing their hands. As the hearing could not be measured by observations, we need to investigate whether the volume of the sounds was successfully immersed them, as opposed to being distracted by other noises such as people talking, walking by, and in this case, a number of booths clustered in one area, generating different kinds of noises

- **The quality and level of engagement per type of participant**

The length of engagement varied across the different types of participants. People participating in groups of friends and family stalled longer, and were far more expressive of reactions and interest, compared to the single participants.

4.2. Product Design for An Experimental Public Installation

Installation

In order to evaluate the concept design, we went through an iteration of the prototype. This resulted in the following design requirements.

- The form factor designs or aesthetics must naturally invite people to interact with
- The sturdiness must hold all sizes of people
- The Bluetooth connectivity must be stabilized in the wild
- Programs must run smoothly for the entire period of time installed

These considerations were taken into account to create the final product: 雲 (Kumo).

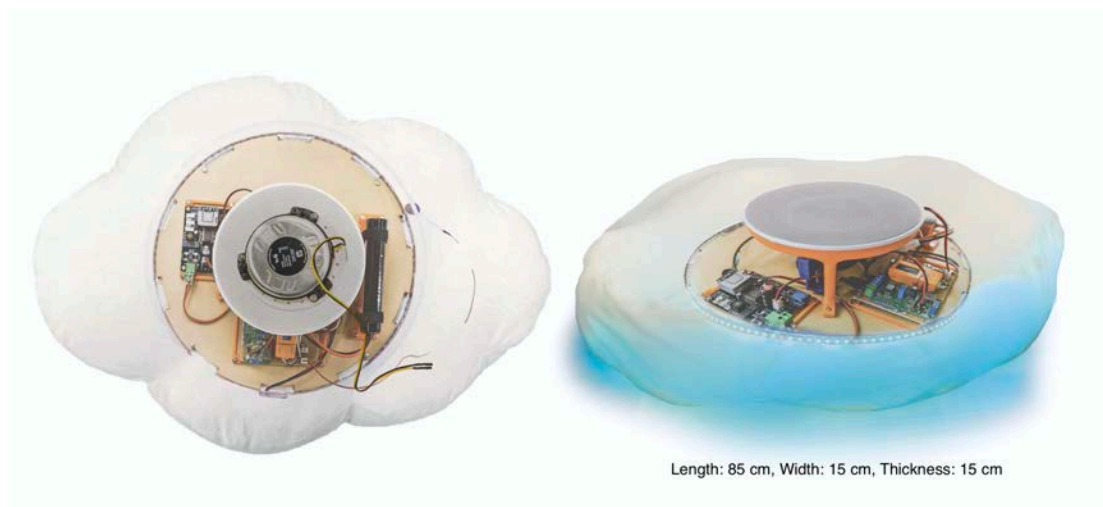


Figure 4.7 Final product, 雲 (Kumo)

4.3. Field Study at Tokyo Port City Takeshiba, Port Plaza

The plaza is ideally suited for various purposes, such as vehicle display, food and beverage provision, promotional events and cultural events. The outdoor area of the building, Port Plaza, is accessible to the public on the first floor. In close proximity to Takeshiba Pier, the location offers a relaxing atmosphere. For these reasons, we conducted the field study at the Port Plaza, Tokyo Port City Takeshiba on June 21st, from 4 pm to 8 pm. We promoted the field study as an installation event, “Connecting People Through the Ambiance of Lights, Haptics and Sound”, to reach out to a broader public. We targeted office workers and participants attending a forum at the Port Hall, adjacent to the Port Plaza. To conduct this study, we were able to invite the people taking part of the Mizubering forum, a social design project and movement for urban development utilizing riverside spaces. Approximately 50 people took part; out of those 50, 15 people participated in the survey followed by a 15 min session, for a group of 3 people to experience our designs. The demography of participants were Japanese Female = 6, Male = 8, N/A = 1; Age Range: 23 - 51 years old, Mean = 26 years old. Instructions were given prior to the session, and other than that, people were able to freely interact and engage. We also tested out the system we created for a heart-rate sensing, processing and manipulating the haptic, auditory, and light patterns. The usability showed some challenges to fully incorporate this system into our designs as users were unable to feel immediate changes of their physiological states reflected on the sensory stimulation designs.



Figure 4.8 Skip Terrace at Tokyo Portcity Takeshiba (Source: <https://tokyo-portcity-takeshiba.jp/facility/>)

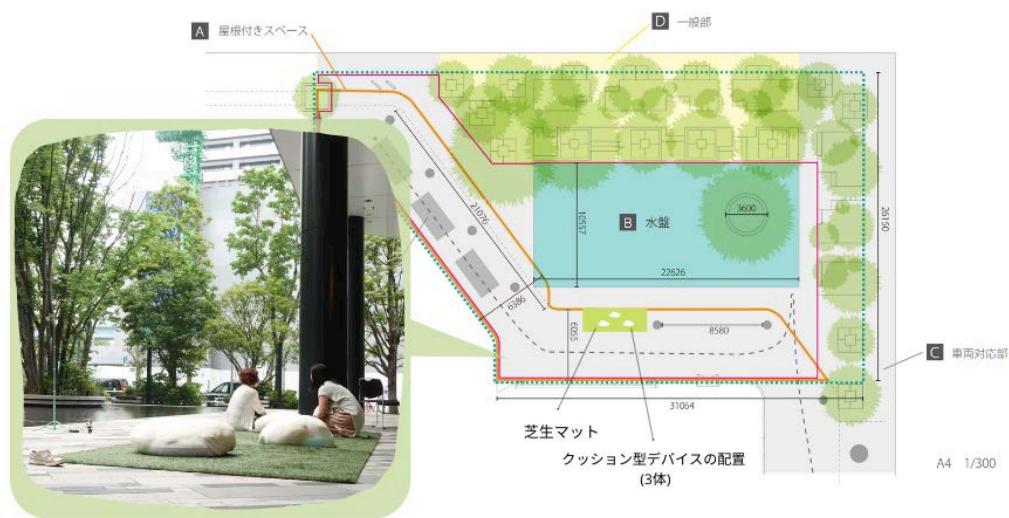


Figure 4.9 Layout drawing of the venue and the placement of Kumo



Figure 4.10 Posters for promoting the public installation

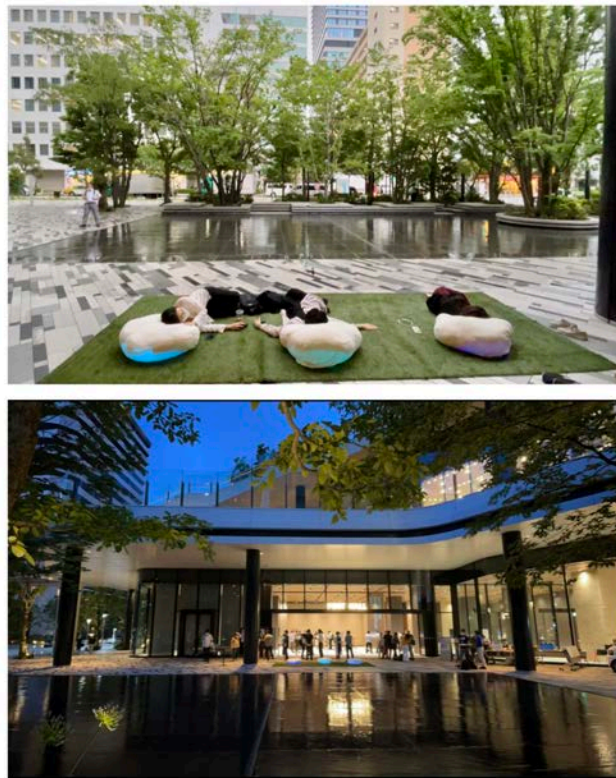


Figure 4.11 The public installation at Port City Takeshiba, Port Plaza, Tokyo

4.4. Results

4.4.1 Feedback

We had the participants take part in a "Social Connectedness Scale Survey"¹ followed up with a questionnaire and an interview session. The questions we asked focused on the experience and how they felt connected and are listed below:

- Please tell us about your feelings and emotions during the experience
- What were your thoughts after the experience?
- Please tell us how you felt "connected"

The table in the figure below is compiled by category, how the participants' feelings of connections with nature, sound and haptics, people and place unfolded.

Question:	Connections with Nature	Connections with Sound and Haptics	Connections with People	Connections with Place
Please tell us about your feelings and emotions during the experience	"The sound of water from the exterior matched the music coming from the pillow and was pleasant and relaxing. The sensation of the pillow shaking made me feel the heartbeat of others, and I felt as if I were surrounded by air."	"Feeling the vibration was very relaxing."	"It made me wish I could experience while looking at the stars with my girlfriend."	"The experience of lying down in the middle of Tokyo felt rare."
Please tell us about your feelings and thoughts after the experience	N/A	N/A	<ul style="list-style-type: none"> • "I immediately wanted to talk about what kind of experience I had. This also enhanced a kind of sense of connection. And most of all, I felt refreshed." • "It made me want to bring my friends and family to share with them, the experience I had today." • "By relaxing together with the people next to me at the same time, I had the feeling that the boundaries between myself and others were blurred. It was a strange feeling of being relaxed, but it was not the same as a sense of bonding." 	"I could hear the sound of cars, wind, and people's voices more clearly than usual. I felt like I was living on the earth."
Please tell us how you felt "connected"	<ul style="list-style-type: none"> • "The sensation of lying on the ground was strange and, to put it exaggeratedly, I felt as if I were connected to the earth." 	<ul style="list-style-type: none"> • "The music and vibrations connected with the exterior waterside ambience, and I felt a slow, but indefinable, connection that enveloped the people who were there." • "The music bothered me and I didn't really feel connected." 	<ul style="list-style-type: none"> • "Lying on the same grass, on the same clouds, and in the same way, I felt as if I was a child again, feeling at one with the people around me without any separation from them." • "Lying on the same grass, on the same clouds, and in the same way, I felt as if I was a child again, feeling connected to the people around me without any boundaries." • "Wondering what other people's feeling" • "Having someone lying next to me, I felt easier to have a conversation with them after the experience, because of the spatial and experience we shared." 	<ul style="list-style-type: none"> • "With Earth" • "I felt a strong sense of presence."

Figure 4.12 A table of the feedback received from the participants in the study

Additionally, we asked the participants to elaborate on general thoughts and comments from the experience:

1 <https://youthrex.com/wp-content/uploads/2019/10/The-Social-Connectedness-Scale-Revised.pdf>

- “It was a very restful experience and I would love to have one in my park or yard! It was a wonderful time.”
- “I would like to purchase this product! And I also want them in movie theaters!”
- “Hope the coffee shop can have this type of furniture”
- “Surprisingly, the weather doesn’t seem to impact the relaxing experience, so I wanted to experience it in various places.”
- “I thought it was very nice. Personally, I wanted to place it in Port City.”

There were a number of valuable feedback that came out of asking for suggestions on future improvements. Those included the following:

- “I thought the light was beautiful and effective in making people wonder what it was at first, but I also thought it would be interesting if the effect of the light could be transmitted, even if only vaguely, to the sleeping person’s side. I also thought that if the pillows were larger and more three-dimensional, each sleeper could transform them as he or she liked, like a Yogibo, to create a comfortable space.”
- “If this was a beach bed, people around you may not look at you strangely, and you may be able to experience it more comfortably.”
- “I would have liked to experience it a little later in the day.”
- “The music was loud and a little disturbing.”
- “It was unfortunate that the music connection was interrupted at times.”

Our set up allowed close observation of the participants, and engage in communication to receive real-time feedback, as we had the participants take part in questionnaires and interviews following the experience.

In an extended interview, a user shared the more specific emotions - a wider range of emotions from relaxed and safe to surprised, fear, and joy, to emptiness and sorrow, going through a range of emotions. As a result, this led them to feel

a sense of intimacy was achieved between the group of people they experienced with.

The user elaborated on the experience from that day: “To me, Kumo provided me a special personal space in an outdoor setting. I initially was hesitant of lying down in public and felt uncomfortable to be stared by strangers walking by. But as I closed my eyes and as Kumo wrapped me with a soft ambient sound and subtle vibration, I felt much relaxed, present, and safer. My worries had drained away and it invited me to focus on Kumo’s haptic feedback which evoked mixture of feelings. As the sound and vibration synchronized and amplified, I felt some tension in my body but it reminded me of feelings like surprise, fear and joy. But the next moment when the sound and vibration suddenly weakens, it then resonated with the feeling like emptiness and sorrow. As I spend some time with Kumo, I became more aware of bodily experience of feelings and also became curious of what others felt. Kumo offered me a space for me to recognize different emotion and recollect memories.”

In summary, we can say that the way an individual perceives their social environment and how it impacts their feelings of connectedness can even differ based on their personalities, traits and experiences from the past.

The field test resulted in great success. Although there were some issues with Bluetooth connectivity that affected the sound and haptic experience, people referred to them as something we can work on for future works. The majority of people seemed to love the idea of having an installation that brings closeness to nature, the place, people, the senses, emotions, and even to someone afar. We received a number of invites for the work to be installed in different venues and events around Tokyo.

Summary on Findings:

- 80% of the participants felt connected to either of the following elements: nature, sound and haptics, people or place
- 73% of the participants answered they would like to experience the installation again

- 80% of the participants found the interaction method (usage) easy to understand

Chapter 5

Conclusion

In this thesis, we presented a design research approach for implementing to investigate the viability of the concept of a modernized aerie by building 3 prototypes: starting from a lo-fi prototype moving on to building a functional conceptual prototype, and presenting a product design for testing out the potential of an installation involving a real, urban place.

Through the iterative prototypes and investigations of seamless interaction between humans and augmented machines, we were able to investigate how the user's emotions and perceptions are evoked by the sensory stimulus that the ambience of the lights, audio, and haptic sensations brings.

We conducted field studies under different conditions to observe human interactions and iterated processes after each implementation. The research investigated the facilitation of emotions by testing out the sensory effects, especially on the outcomes of the feelings evoked by our experience design. Through valuable feedback, we can summarize that the experimental installation evoked the participants' emotional connection to the unique experience Aerie brings and a connection to the physical place. Communal spaces, involving nature such as terraces, parks and plazas may have an impact on engagement in community well-being.

Towards a more socio-emotional urban innovation, we hope to contribute to a better understanding of and sustainable development of our sense of belonging to our communities and environment.

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