

bodies-cities

exploring embodied knowledge of urban sites through interactive virtual reality experiences

By Manori (Manik) Gunatilleke

A thesis exhibition presented to OCAD University in partial fulfillment of the requirements for the
degree of Master of Design in Digital Futures

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Abstract

bodies-cities presents the multi-sensory complexity of embodied mapmaking as a layered, interactive virtual reality (VR) palimpsest. A palimpsest is a space that holds multiple layers of knowledge, and this research takes the urban public site of St James Town in downtown Toronto for its exploration. The research process exemplifies the entanglement of people, places, methodology, and methods to reflect the complex nature of embodied spatial knowledge. This entanglement is presented through the application of Karen Barad's feminist new materialist theory and the apparatus of sensory ethnography for virtual reality. The virtual reality experience draws on the interactive affordances of VR and reconfigures film montage and architecture techniques to present the entangled elements of embodied knowledge emerging from residents' relationship to the site.

Keywords: embodiment, embodied knowledge, virtual reality, posthuman, urban, new materialism, architecture

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Dedication

I dedicate this to the spirit of places that have remained within me, the traces of which materialize in this work.

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Introduction

where is it that you travel to in your mind? I would like to have the grid reference, the coordinates - Yrsa Daley-Ward

bodies-cities is a research creation project that explores how knowledge generated from the entanglement of mind, body and environment, could be mapped in an immersive virtual space. Situated at the intersection of architecture, place-making and experiential design, *bodies-cities* is a speculative design process that investigates what constitutes human embodied knowledge of an urban public site. This speculative research pathway investigates the nature of this knowledge in the hope it can contribute to the development of future virtual reality tools prioritizing inclusive design practices.

With its history of socio-economic diversity, St James Town in downtown Toronto lends itself to this work, allowing the multisensory complexity of embodied mapmaking to emerge from the urban complexity that lies at the edge of a rapidly changing city. The findings of this project are presented in an interactive virtual reality (VR) palimpsest; a palimpsest being a space that holds multiple layers of knowledge. The conceptual application of the palimpsest refers to the layered and subjective nature of embodied knowledge, and to the layers of architectural drawings that trace layers of site knowledge. Known as architectural sequences, these layers are typically used to reveal both procedural activities related to designing for a site, and morphological factors like lived experiences and the material history of the site. This knowledge presented in VR, is layered on the actual site of the St. James West Park, and results in a spatial re-configuration of the site based on the body's ways of knowing.



Figure 1. Virtual space environment of *bodies-cities*

The name '*bodies-cities*' is borrowed from theorist Elizabeth Grosz's (1999) reference to the relationship between the human body and city as one that produce simulations of each other as forms of the hyperreal; each influencing the constituted nature of the other. In a similar manner, the *bodies-cities* virtual experience presents how the experience of walking through Toronto is never only about engaging with its present-day physical and sensory features of existing built structures, flora and fauna. For residents, the experience is overlaid with personal experiences, both past and present. For some, it would be the Toronto from their childhood replete of experiences and meanings. For others, Toronto would evoke something of other home towns, other cities that mattered or current lifestyle choices. To reflect this, the virtual reality experience produces layers of simulated virtual experiences that constitute the layers of embodied knowledge of the chosen site.

This project emerges from personal reflections on my attachment to urban places I have chosen to reside in over the years and a growing curiosity to understand what such responsiveness in

architecture can signify; a responsiveness that is a complex multi-directional, looping exchange of material bonding between living bodies, and other living and non-living entities, that occupy urban spaces. I position urban to be a process, not a form, that emerges as crystallizations of “temporary materializations of ongoing socio-spatial transformations” (Brenner and Schmid 2015, quoted in Lieto, 2017). Throughout the project, I will use the words urban site and place interchangeably to refer to St. James Town. The term site is used when speaking of the elements within the physical real-world space that has significance and place refers to the version of the area perceived by the knowledge sharer or myself. To focus on responsiveness is to transcend the Cartesian divide between the socially constituted concepts of the masculine thinking ‘mind’ and feeling female ‘body’. And I believe, responsive design lies in a feminist reading of the world, where the sensory messiness, “the wetware’ limited and confining of bodies, meets the “realms of thought and silicon” (Morie, 2007 referring to Hayles, 1996). Responsiveness of urban placemaking acknowledges the urban environment to be one where living and non-living matter, such as humans, animals, built structures, flora and fauna, are in continuous dialogue through social, political and ecological relationships. From a posthuman trajectory, the project investigates how the sensory ‘wetware’ entangles with the technology of virtual reality to create a realm of ‘thought and silicon’ (Hayles, 1996). The phases of research creation investigate how such an entanglement of sensory knowledge and digital design tools present knowledge that can inform future tools for inclusive design of public spaces. In this VR design space, the emplaced body of a designer, using VR tools, operates within a technologically simulated world to tap in to knowledge that can influence the site design process.

Many philosophers and theorists have proposed that our bodies communicate and interact constantly with the environment we occupy, and this dynamic relationship shapes how both the self and the world inform and redefine each other constantly (Abram, 1996; Grosz, 1999; Pallasmaa, 2005; Merleau-Ponty, 1945/1962). Mediated by the brain and mind (Bateson, 1973;

Damasio, 2010; Clark 1997), these co-minglings form a situated surplus “out of the entanglements of bodies in motion and the environmental conditions and physical architecture of a given space” (Amin, 2006). Situated surpluses are embodied knowledges. They are often invisible sensed dynamics that define the perception of an urban place; affluent, safe, intimidating, and such like. In this study, I define place as urban planning in a new materialist positioning and draw specifically on urban theorist Laura Lieto's definition of the urban as an experience constituted through “a function of the performance of objects, not just of patterns of social behavior; it exists because of the entanglement of people, nonhumans, material objects, ideas, norms, and technologies.” (Lieto, 2017). In this vein, a definition of embodiment emerges from the situated context of each participant, who are also knowledge producers, and who will be referred to them as such from this point on. Some rely more on the culturally influenced perceptions informed by memory of other places from their past, by their gender identification, through daily routines and lifestyle preference, and direct sensory stimulation.

These situated surpluses form urban networks that influence the city-dweller's spatial experience. *bodies-cities* maps one such network in Toronto; a network that emerges from the sensuous knowledge that lies in the constantly morphing boundaries between mind-body as it occupies an environment. The use of immersive virtual space and other 3D technologies in this project allows the presentation of the multi-sensory entanglement between mind, body and environment, or what David Abrams (1996) calls the spell of the sensuous. As a speculative digital design process experimenting with 3D technologies for urban architecture, *bodies-cities* assumes technology is the answer to the question of how best to present the outcomes. Much like the purpose and practice of architecture, VR is a manipulation of the environment a human user occupies. It is no wonder the medium as a design space is growing in popularity. 62% of large firms and 28% overall are using VR (Chaos Group, 2017), creating demand for related services like cloud rendering, mobile VR, and better access to affordable virtual design tools.

Like with all emerging practices, practitioners must stay curious about the purpose and potential of design tools. As Nick Puckett (2014) reminds us in his work with intelligent environments, it is important to frame the questions within the language of a practice, in order to identify, test, and prototype a tool-making pathway that works for architecture. For the exploration of embodied site knowledge in *bodies-cities*, the framing of questions became an entanglement of people, place, methods, and design practices that ask what kind of experiential design tool would allow the designer to experience the significance of embodied knowledge as a spatial sequence. In architecture, spatial sequences can take geometric form, or other dimensions that relate to transformational sequences based on lived experience (Tschumi, 1996). In this project, embodied experience is experimented with as a spatial sequence emerging from the mind-body-space relationship the resident builds over time. It is collected by the direct spatial experience of neighborhood walks and paper mapping practices that overlay sensed knowledge on geographic maps. The embodied mapping experience and digital artefact are the prototypes of new forms of digital spatial sequencing, similar to the intent of design tools like the VR-EP Dementia Platform (Aitken Turnbull Architects, 2017), where designers plan for dementia-friendly buildings and spaces by navigating virtual simulations of challenges faced by dementia patients.

To gather embodied knowledge from residents of St. James Town, the methodological approach had to question the constitution of multi-directional communication loops of mind, body and environment, which meant the abandonment of pre-conceived boundaries of human bodies, and de-centering of the human body to explore how new boundaries of embodied experience emerge through its spatial relationships. This framing found the most resonance in Karen Barad's (2003, 2007) feminist new materialist philosophy since it asks what it means to explore the messiness of subjective experiences (Hayles, 1996), such as the body's knowledge as it emerges from a relationship with elements that are perceived to be

'disembodied', like public space and architecture. Barad's theory of agential realism allowed the knowledge gathering work, through sensory ethnography, and the VR design process to be positioned as apparatuses that enable readings of entangled meaning between living and non-living matter. Barad's "ethico-onto-epistemology", also leaves room for knowledges to emerge in its subjective and temporal formations. These can vary with each person and their lived experience within the urban site, to create larger patterns we know as trends.

The *bodies-cities* VR is presented as an immersive and interactive virtual reality experience accessed by wearing an Oculus Rift head mounted display (HMD). In the experience, the user navigates scenes that present knowledge shared by two people; one a resident of St. James Town with immediate history in the area, and the other is memory of Toronto land as shared by Elder Gary Sault of the Mississaugas of New Credit First Nation, a group that has a long history in Toronto. The Elder's embodied memories of Toronto land is an acknowledgement of the reconciliation process in Canada. The layers of VR experience reveal the depths of knowledge that was erased, forgotten or re-discovered through this specific process of responsible knowledge seeking and presentation in virtual space. The user experiences how the residents perceive the site by acknowledging the avatars of residents, and by interacting with other sensory cues in the virtual world. The time the user spends in the VR space is mapped separately and will be used to explore ways in which the tool can be used in future work.

Context

Motivation

"Not only subjects but also objects are permeated through and through with their entangled kin; the other is not just in one's skin, but in one's bones, in one's belly, in one's heart, in one's nucleus, in one's past and future. This is as true for electrons as it is for brittlestars as it is for the differentially constituted human." - Karen Barad

In recent years, I have been learning to understand what constitutes my entangled kin, my embodied self, and a large part of it is a dialogue with lands that speak to me. Lands I have felt I most belonged in, now holding no one I knew before, but animate and non-animate phenomena linked to memories of others and ecological experiences that ask me to acknowledge the complexity of how I identify myself.

Born in one country, raised in another and having spent a large part of my adult life in seven cities, I have been questioning what constitutes my attachment to the ones that feel like 'home', regardless of years spent in them. The answer lay in noticing the spatial and ecological patterns I have grown used to over time, and responded to through my senses, and the memories of which I have stored as emotional blueprints. Reflective practice has revealed that my personal preferences include, among others, a need for a mix of greenspace and dense human activity in an urban hub.

These sensorial impulses dominated most of my research and creative plans in recent years, beginning with the instinctive draw to the biophilic synthetic environments created by Philip Beesley and the Living Architecture Systems Group. At the core of relentless curiosity is the exploration of the human embodied experiences and related sensory response loops, to which I find both resonance in posthuman philosophies, in particular, feminist new materialist discourses. This resonance lies in new materialism's de-centering of the human, and the approach's ability to reconfigure the mind/matter and nature/culture divides of 'transcendental humanist thought' (van der Tuin & Dolphijn, 2010, quoted in Fox & Alldred, 2018) by exploring the agential nature of all matter. By doing so it offers a lens through which I can discover, analyze and present what Barad refers to as a "relational ontology" that explores the causal relationship between all that constitutes an embodied experience. And agential realism allows the researchers to practice

the material practices of know, think, measure, theorize, and observe as they intra-act within and as part of the world (Barad, 2007). Practices through which specific configurations of worlds can be understood.

During the summer of 2014 I lived in St James Town and was fascinated by the diverse density of people, lifestyles and architectures thriving within its boundaries, and the adjoining lanes of scenic Victorian homes and wild gardens of Cabbage Town. These flows were most apparent on early morning waits at the bus stop, when people of all ages, hues and clothing swirled around me. Short walks would take me to Ethiopian, Indian, Filipino and Sri Lankan markets, or to Toronto landmarks like Jet Fuel Coffee and Allan Gardens. A hop west across Sherbourne Street meant a walk alongside pristine condominium towers and a hop east was the Toronto Community Housing and the front porch drama of residents mingling on garden benches. It is still home to the largest high-rise community in North America and maintains a high ratio of immigrant (59%) to non-immigrant (33%) populations (Census, 2011).

On hearing the neighborhood was marked for rapid gentrification, which meant a potential loss of this complexity, I decided to explore what it meant to gather sensory knowledge of the area from residents who lived amidst such urban complexity.

With this history of entangling myself with urban centers, in this thesis I focus on the embodied self in an urban public space. And, the more I listen to the cues of my embodied self, I ask how such experiences affect one's sense of belonging in urban spaces designed for all that must exist together, and what it means to draw out and present these forms of knowledge in experiential mediums designed to reveal the entangled nature of embodied knowledge.

Objectives & Research Questions

The overarching objective of the project is to present the embodied spatial knowledge of an urban site as a virtual reality experience that informs future use of VR as a design tool for inclusive public space design.

Primary: How might we create an embodied map of an urban site in an immersive virtual reality design space?

Sub-questions:

1. What constitutes embodied knowledge of an urban site?
2. Which research methods facilitate the gathering of embodied knowledge of the site?
3. What affordances of virtual reality contribute to the presentation of embodied knowledge and mapping?

Research Framework

"What is on the other side of the agential cut is not separate from us--agential separability is not individuation. Ethics is therefore not about right response to a radically exterior/ized other, but about responsibility and accountability for the lively relationalities of becoming of which we are a part." - Karen Barad, 2007

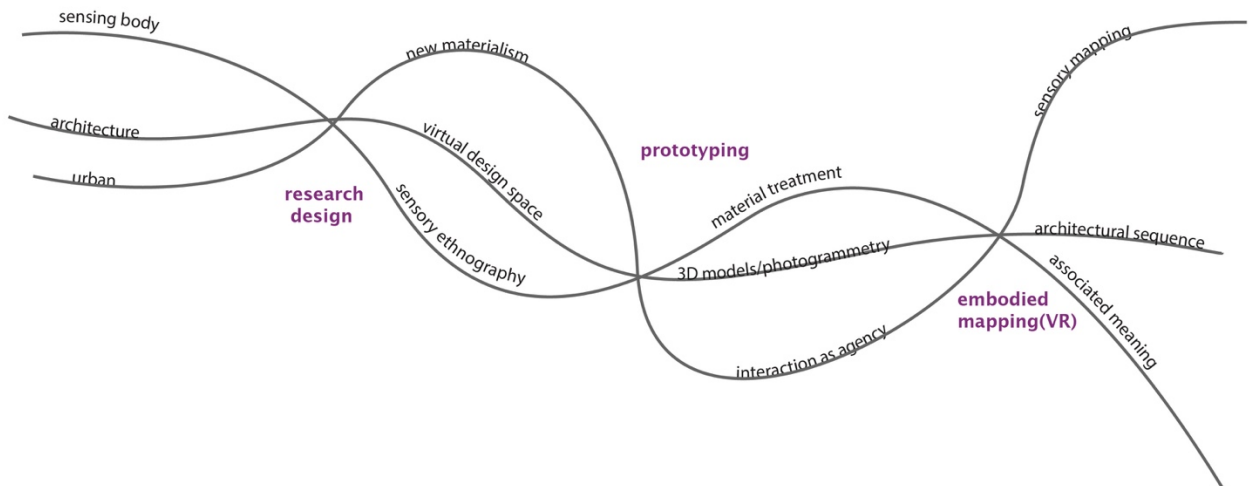


Figure 2. Research Framework

In the light of the opening quote, embodied mapmaking is one such process of becoming , through which the performative nature of all matter occupying a site – human, flora, fauna, buildings, rock and other in-animate matter – create patterns of spatial relations. Like Baruch Spinoza's (Gough, 2015) lingering influence on architecture whispering through the ages, new materialist approaches like Barad's offers apparatuses through which we can understand the performative nature of urban life on a site. By apparatuses, I mean frameworks that offer insights into experiences.

In this project, embodied knowledge is sought and presented as an alternative form of experiential spatial mapping. To trace these patterns, I draw on Barad's posthuman reflections on world-making to both explore this relational nature of the embodied knowledge through the apparatuses of method and immersive experience design. Acknowledging the complexity of Barad's work, with roots in feminist theory and quantum physics, I choose specific theoretical concepts that relate to the task at hand.

Before presenting my framework, I will explain how Karen Barad's new materialist approach positions experience as "dynamic topological reconfigurings/entanglements/relationalities/(re)articulations of the world" (2007). In this approach, a body and the environment (including all experiences within it) are constituted as phenomena that "acquires boundaries and properties through the open-ended dynamics of intra-activity". In the context of Barad's intra-action theory, animate or in-animate entities do not exist prior but emerge as a specific recognizable form/experience called phenomena. Phenomena emerges from the dynamics of relations between subject and object, each being a relata, and where each is mutually constituted through the intra-action between them. Intra-action differs from inter-action by not assuming the properties/boundaries of each relationship is determined prior to the intra-acting. Intra-action refers to how each relata (subject or object) are defined by the dynamics among them (there can be more than two). For example, in the context of humans and an environment, one such phenomena can be a usage patterns resulting from daily routines. This pattern emerges from the relational dynamics between the resident and whatever it is that takes the user through that path. The path is not a fixed entity and will change given a change in either the resident's plans or choices, or a change in what lies on that path.

Therefore, a "part" of the world defines its boundaries and properties based on another "part" of the world" (Barad, 2003). These boundaries and properties are also dependent on what

apparatus is used to seek knowledge about the emergent phenomena. In this study, how embodied knowledge emerges is influenced by the processes and methods through which the knowledge is sought. Different approaches result in different patterns of how the world comes into being. The research methods and the virtual reality design space are apparatuses that allow for rearrangement, rearticulation, and other reworking (Barad, 2003) of how urban public space is perceived and utilized. In *bodies-cities*, these re-workings lead to reconfigurations of perceived urban space.

The research and design process is an entanglement of intra-active elements that involved the researcher, knowledge producers, the methods, and the medium of presentation (VR). The relational patterns created space to seek knowledge, reflect on its constituted meaning, and assembled a web of techniques that presented the embodied knowledge as an embodied virtual reality experience, and dynamic digital map generated through the user's embodied navigation through the embodied worlds of others in virtual reality. The key concepts that influence the research framework are out below:

Research as an apparatus of responsible becoming

To seek the intimate experiences of residents in the area, and more so from (mostly) strangers in a research project that engages with the public, asks that the researcher facilitate an "iterative opening up to, an enabling of responsiveness" (Barad, 2007). Embodied knowledge studies in Phase I are based on my experience and they allowed me to immerse myself in an auto-ethnographic experience to get familiar with the challenges and opportunities presented by the process. This sensitized me in ways that helped me adopt methods that can ease the process for knowledge producers from St. James Town.

In the sensory ethnography conducted with community, iterative sessions were offered to provide the time to build trust between researcher and knowledge producer. These sessions also

allowed time for knowledge producers and researcher to reflect on how best to express experiences that were sometimes difficult to articulate. The 'questioning' was situated in a natural conversation flow, based on a semi-structured questionnaire, while taking a walk in the neighborhood. The walk allowed the knowledge producer to lead when sharing their experiences, and also allowed for some experiences to be remembered or noticed during the act of moving through the neighborhood. The paper mapping method triggered more reflection and remembering of overlooked experiences. Once the sessions were complete, the categories of embodied meaning (phenomena) emerging from the experience were discussed with the knowledge producer to ensure all parties agreed on what was understood. The sensory ethnography methods required that both knowledge producer and researcher co-create experiences on walks through the site. These allowed me, as the researcher, to experience the sensory nature of the site alongside the knowledge producer and blurred the boundary of objectivity that usually sets the researched subject and experiences, apart from that of the researcher. In the design stage, direct experience is helpful when deciding on visual design in the virtual reality experience.

At the virtual reality design stage, I was left with the responsibility to decide on aesthetic and design affordances. Responsible design practice at this stage included ensuring the knowledge producers accepted the creative license taken to present embodied experience in VR, and the inclusion of specific VR interaction techniques that required the public to seek access to these intimate knowledges. The VR scenes developed in the design process, were shared at the midway stage where key elements of animation and aesthetics were developed, and later when the first full experience was ready for viewing. Changes were made as requested by knowledge producers. These consultations ran parallel to my own knowledge seeking on VR and spatial design practices and techniques, and included topics like respectful access by users and the priority sequence of VR layers and what that meant.

Embodied knowledge as agential cuts

Through intra-actions "the boundaries and properties of components of phenomena become determinate and particular concepts (that is, particular material articulations) become meaningful" (Barad, 2007, p.139). The embodied knowledge categorizes are phenomena that emerge from this study. They are created through the agency of the knowledge making 'cuts', where the knowledge producer visually or orally articulated out how they felt, what they sensed and what relational meanings materialized. Agential cuts are not separations, they create new boundaries of meaning. Though, the categorization 'separates' the knowledge, the relations between how the human body and brain related with non-human elements are inseparable. These new categories are material articulations that give new meaning to the experience of the embodied self within an environment. For example, the new cuts of knowledge take the user beyond the physical confines of the St. James Park West site and to other lands, and the proximity of translocal experiences dominate Viji's preference for the neighborhood.

Virtual reality as apparatus

The medium of VR is an apparatus that allows the "*practices of knowing to manifest as material engagements that participate in (re)configuring the world*" (barad, 2007). This happens through the way in which the VR world is created and by how it engages the user. Much like the real-world experience of embodied spatial knowledge making, knowledge producer knowledge and their virtual selves(avatars), 3D models, and game engine features entangle to create an apparatus that generates an embodied map.

In the *bodies-cities* VR experience, the VR medium is an apparatus through which the embodied reality of knowledge producers is materialized in a virtual environment. The apparatus-like function of VR world-making presents the relationships between, and characteristics of, the

world perceived and real-world by applying aesthetic treatments, animation and interaction features possible in the VR medium. The technique of photogrammetry itself is an entangled process, where multiple images re-configure the photographed object as a 3D rendering that is placed in the VR world. In this manner, the real-world captured through textures and contours of elements that knowledge producers valued within the site, materialize within the virtual. In VR, we experience their transformation as the materialization of meaning attached to objects in the environment as, shared by the knowledge producer. Texture choices in the virtual environment presented the sensuous qualities of living things, while animations presented the intra-active dynamics that constituted embodied realities; the sensations of animate elements on human skin, and the memory based significance of the site in relation to one elsewhere in the world. To the user, the apparatus allows access to a virtually embodied experience of an embodied reality. These ethical dimensions are detailed in section (1).

The VR medium is also an apparatus of design awareness. The layers of the experience are an initial test of presenting layers of embodied site knowledge for urban architecture purposes. Much like the traditional architectural design making process where the layers of site experience are presented in tracing paper layers, the layered VR design layers the deepening layers of site meaning that can influence the spatial design process. As the user navigates the experience a map is generated based on their attention to, and interaction with, elements of the virtual world. The detailed workings of this apparatus are beyond the scope of this thesis but the layers of the experience are structured to reflect the layered embodied knowledge dimensions of a site; the ways layers of ecological and human activity knowledge are arranged in other urban site design processes.

Thus, the apparatus of VR presents a mapping of the site that is re-configured by embodied knowledge of residents and other occupants (virtual visitors and traditional land owners). As

discussed earlier, embodied knowledge presented in first person immersion within another's experience gives the audience access to the intimate knowledge of another. Taking the request made by Viji and Elder Gary, I have used VR's interactive affordances to ensure the user gains access prior to experiences the worlds shared by others.

The flatter ontology new materialist theory de-centers the human, and gives agency to other matter. Yet how do we decide which matter, matters? Which relationships have the more influence over which aspects of embodied experience in urban place-making. One such answer lies in understanding the agency of material elements? This agency lies in the space of potential between the object/entity's affordances. This is the space of agency between how open the object/entity is to discursive practices and how limited it is by the material, physical boundaries (Lieto, 2017). For example, Alda (a knowledge producer) perceives (relata) the community management groups (relata) to have ineffective strategies (relata) to make the best use of the multicultural community dynamics of the neighborhood. She believes this leads to exclusion (phenomena) of people, and a loss of the community's resilience since there is lower capacity to connect and support each other better (phenomena). While being important, it is not a primary driver of other factors that, to quote Alda, make her 'happy' (phenomena) in the neighborhood. Such as being able to enjoy walkable access (relata) to multiple greenspaces (relata) afforded by the location of St. James Town. In this project, the work will limit itself to presenting in VR these primary influencers of sensory embodied experience and leave other intangible such as socio-political forces of urban design dynamics for future research.

This research framework draws on a specific new materialist worldview to unravel what constitutes an embodied mapmaking process for the urban complexity in St. James Town. The concepts inform the research creation process in *bodies-cities*, enabling responsible and emergent mapping of theoretical discourse and ethnography to materialize types of knowledge and prototypes of experiential design that can be presented to the public. On the way to the

final design, the next section presents the affordances theoretical and design practices lend to the research creation process.

Scope

Given the time constraints of the thesis period, the project limited by participant numbers, cultural context and stage of design tool making. The research takes place in the cultural context of North America. Though knowledge sharers originated from other parts of the world which may reflect in their subjective experience, urban design dynamics in other parts of the world can vary as studies show (Lawhon, M., Ernstson, H., & Silver, 2006). Findings of this study relate to experiences in Toronto, Canada.

Knowledge was shared by two residents in St James Town. It was challenging to find time to spend on an intensive knowledge gathering process and some did drop out initially, and more so as it took place during the winter season. Most participants were not keen to spent time outdoors to explore deeper levels of site based knowledge. This research project and the early stage VR mapping tool it created intended to identify, gather and present embodied knowledge in an immersive manner. The tool was not intended for testing with practitioners at this stage as it requires a separate research pathway. However, the longer-term goal is to have the research feed into the design of embodied mapping tools that supports the design of inclusive public spaces.

A Case for Embodied Mapmaking in Virtual Reality

"Another world is not only possible, she is on her way. On a quiet day, I can hear her breathing."
– Arundathi Roy

An investigation into embodied mapmaking is an interdisciplinary process as it involves the understanding of current theory and practice on all elements involved in making such a map; human behavior within spatial boundaries, known practices of embodied mapmaking, research methods and approaches that facilitate embodied knowledge gathering, and the quest for an ideal medium through which to share one's research. This literature review draws on discourse and practices within these areas to propose an approach for an embodied mapmaking process; tracing what constitutes an embodied self in a spatial context, implications for mapmaking and the rationale for choosing the medium of virtual reality.

The embodied self in the city

The public spaces we inhabit are sites of visible and invisible networks created through the presence, activity and perceptions (from the humans and animals stand point, as it stands today) of all that occupies such spaces. These networks create material-semiotic meaning defined in the works of feminist theories (Barad, 2007; Grosz, 1999; Haraway, 1992). In the urban design context, these ideas appear in works of theorists who propose that the cohesiveness and resilience of urban neighborhoods and spaces occurs through the complex relational patterns that emerge from human and non-human activity (Batty, 2013; Jacobs, 1961). Adding to these widening perceptual layers of urban space, the Situationists (Sadler, 1998) and the Archigram Group (Sadler, 2005) have presented the emotional and visceral experiences of urban spaces through art and installations. In recent years, for urban design and related architecture, interest in sensory information rose in the late twentieth century when geographer Yi-Fu Tuan stressed the role of the senses by

proposing that 'An object or place achieves concrete reality when our experience of it is total, that is through all the senses as well as with the active and reflective mind' (1977).

This active and reflective constitution of place is performative, where the mind's embodiment and embeddedness in the environment Haugeland (1993) results in the co-mingling of mind, body and environmental factors. To Amin (2006) these extensions of embodied selves, entangling with the social and functional dynamics of a site lead to a situated surplus that "is collectively experienced as a form of tacit, neurological and sensory knowing" (Pile, 2005; Thrift, 2005a, quoted in Amin, 2006). This surplus is pre-cognitively and reflexively constructed by the routines emerging from the neurological impulses and material practices that contributes to the research knowledge producers' sense perception of their immediate neighborhoods (Amin, 2006). In the case of St. James Town, it creates a sense of ease, or discomfort, in the face of urban diversity, multiplicity, and urban growth Toronto is currently witnessing.

This project explores the the subjective nature of such patterns and related sense perception knowledge revealed through sensory ethnography conducted with residents of an urban site. I position this perception of public space as a feminist new materialist perspective since the performative nature of embodied knowledge gathering demands an approach that prioritizes the subjective experience of human bodies, and opposes a dualist view of relationships among all human and other elements in an environment. Feminism has a history challenging dualist views of lived experience. As Mohanty (1984) reminds us, the feminist project is an investigation into the material constitution of what it means to be a woman, questioning the dynamics of power held in the animate and inanimate relationship that constitute gender roles. Early feminists like Simone de Beauvoir (quoted in Lennon, 2014), and her peer Merleau-Ponty (1948), brought subjective embodied experience in to the center of philosophical debates. Recent work in the postmodern feminist project has sought to understand feminist experiences of the world in spatial terms, developing conceptual and critical tools such as 'situated knowledges'

(Haraway, 1988). Coupled with a new materialist approach where the agential nature of matter decenters the concept of human superiority, the feminist new materialism philosophy of Karen Barad (explained in detail in the Research Framework section), with its emphasis on open ended meaning making, lends itself to this project's intention to explore the relational ties between the human body and its environment.

At a macro level, a feminist new materialist approach speculates on the re/configuration of Cartesian notions of pre-determined separations between bodies and environments. It offers an approach that questions assumed relationships that create value and significance in a neighborhood. Instead of assessing the area based on the physical layout and amenities, the sensing body is also given agency to define how it perceives the use of urban space. Throughout this project, I will use the term sensing to refer to the constant making of sense through the multi-sensory faculties of the human body.

Urban sites are mostly designed by urban architects and planners, with varying degrees of participation by humans and other animate beings occupying the sites. Among influential architectural theorists, Juhani Pallasmaa has written extensively about the need for a sensory architecture (Pallasmaa, 2005, 2013) that does not end where the in-animate structure ends. He envisions architecture that extends beyond the in-animate structure to include the corporeal bodies of humans, and thereby influence the "mental and existential sphere of life" (Pallasmaa, 2013). For it is through this structuring and articulation of lived experience and symbolic space, that architecture reflects our body-mind's "most important system of externalized order, hierarchy and memory." (Pallasmaa, 2013). This corporeally entangled significance of architecture is magnified by the subjectivity of lived experience of residents in urban neighborhoods. They feed into the situated surplus that defines the urban experience.

Drawing on these views, this study takes the position that the human body-mind taps into the

biological, cultural and mental dimensions of public architecture when creating bonds within a neighborhood and intends to explore the ways in which these neurological mapping processes of mind, body and environment produce embodied maps of St James Town.

The mapping body-brain

The embodied self whose knowledge lies at the heart of this study emerges from not the mind alone but through the mapped coordinates of experiential relationships that form between the mind, body and environment. Current theories place the construct of the mind beyond the boundaries of the skin (Bateson, 1973; Clark 1997). Beyond this boundary lies the world embodied spatial meaning-making created when the body is aware of sensory stimuli from outside and inside the body (Rothschild, 2000, in Chodorow, 2013). According to neuroscientist, Antonio Damasio (2010), the image-producing brain networks map our interactions with the world and the embodied self. He stresses that "Action and maps, movements and mind, are part of an unending cycle, an idea suggestively captured by Rodolfo Llinás when he attributes the birth of the mind to the brain's control of organized movement." And this mapping what creates patterns we understand as "sights, sounds, touches, smells, tastes, pains, pleasures, and the like—in brief, images. The images in our minds are the brain's momentary maps of everything and of anything, inside our body and around it, concrete as well as abstract, actual or previously recorded in memory" (Damasio, 2010).

In her work on dance therapy Joan Chodorow (2002) maps the spectrum of spatial awareness extends beyond the five senses to include the somatic (flesh bound) senses of proprioception/kinesthetic sense which is the sense of the body's position and motion in space, and the senses of balance (vestibular), temperature(thermoception), and different types of pain (nonciception). It is through the body awareness processed through the senses that the brain makes the maps that aid the body's survival in the world. The map making is a constant process

and one that continues while we sleep and dream (Damasio, 2010). Dance studies reveal the integrated sensory complexity of bodies as they sense the demands of the environment and adapt accordingly.

While the precise mapping of such neurological data is not the focus of the thesis, these findings support the arguments for sensory architecture (Pallasmaa, 2009,2013), and helps explain the way humans define and engage with their environments. Even more recent developments in neuroscience point to another helpful body-space relationship, the peripersonal sphere (Blakeslee and Blakeslee, 2007). Here a special mapping capacity of the brain annexes the peripersonal space to the limbs and body and adds an extended layer of 'ghost skin'. What is even more interesting is that this layer holds coordinates to the maps that encode the physical body (as explained earlier) and influence the potential to perform action in that space. In VR, studies have tested the validity of this space to define immersive perception (Cheon, M., Lee, J., Lee, J., & Moon, S. (2016). Their experiments with first and third person interaction in VR reveal that first-person perspective, where the user's peripersonal space is used to understand position and notice what is happening in the environment. They noticed that first person experiences increase the scope of visual perception and improved navigation in the wider environment. The study helps decide on using the first person perspective in VR to sensitive the use to the sensory experience perceived by the researcher and knowledge sharers in this project.

The concepts of the peripersonal and kinesthetic spheres and their influence on the body's capacity to navigate an environment, influence the framing of questions for the sensory ethnography process, and the design of VR space as peripersonal spheres of immersive virtual space that engage the user's senses.

Embodied mapmaking

Given neuroscience's explanations of how the mind is a construct of the body's need to make sense of the world it inhabits, it is not surprising that embodied mapmaking has a long history in Western and Indigenous traditions from around the world. Perkins (2009) presents a range of Indigenous and Western embodied mapmaking. Indigenous traditions offer maps that transcend space and time, and base the creation of maps on how the human body relates to the world, through songs, walking paths and other manifestations of embodied experience. These traditions that transcend the workings of the 'logical' colonized mind defined by traditional cartography, and echo what Abrams (1996) argues for as world experienced by the sensing body.

Mapmaking, therefore, is a performative process where "meaning is constituted in the actions the mapping processes call in to being (Perkins, 2009). This project is one such performance where embodied knowledge is constituted through the action of sensory ethnography that reveals the relationships between humans and the urban environment occupied. It also calls on the researcher and knowledge producer to look deeper in to the landscape explored (Corboz, 1983) to first get to 'know' and then to 'act' on that knowing through mapmaking process. The experience of embodied mapmaking in virtual reality add other elements of respectful access and knowledge organization to reflect the performative nature of the processes needed to seek and present embodied rituals within the neighborhood. The result is a mapping experience that is "process, product and project" (Corboz, 1983).

In bodies-cities, the embodied mapmaking process is explored as a performance that takes place between the resident's body moving through the area, and engaging with elements of the environment to create meaning out of this aspect of his/her lived experience. It is also a mapping of historical significance to the Indigenous people of the land.

Virtual reality as an embodied medium

Virtual reality is often critiqued for its origins in the patriarchal Western military complex and for

perpetuating the dualist Cartesian divide of disembodied, mind-centric experiences of space that values mind over sensing bodies (Davies, 2003). In this context, it would seem unusual to use this medium for a presentation of a feminist new materialist reading on the nature of embodied knowledge. However, when considering the mind-body mapping practices in previous sections, as revealed in neuroscience (Blakeslee & Blakeslee, 2008; Damasio, 2010), and drawing on and beyond Murray and Sixsmith's (1999) work on the corporeal body in virtual reality, I design from an argument for a re-claiming of VR's affordance as potential feminist design space.

To state that the ocular-centric space of VR is a dualist space pre-supposes the dominance of sight (Murray and Sixsmith, 1999) as an isolated function of the body. Neuroscience has shown that the mind is a sense making creation of the body that supports the body's experiential navigation of the world. The workings of the senses are not isolated since they work together to generate associated meaning. Thus, the use of VR is not the functioning of a dualistic understanding of the mind, but like most experiences of environments occupied by humans, it is a multi-sensorial experience based on sight, sound, proprioceptive and kinesthetic awareness of spatial dimensions and objects with VR space. Work on adding other sensory stimuli such as haptic and olfactory elements will take place in future iterations of the prototype.

Immersive design spaces are particularly powerful in how they engage users. To test Pallasmaa's claims about the sensory perception of space, the *Feel Your Design* team (Maria da Piedade Ferreira, Andreas Kretzer, José Pinto Duarte, Didier Stricker, Benjamin Schenkenberger, Markus Weber, Takumi Toyama, 2017) conducted research in non-VR immersive worlds. They successfully tested the perceptual changes of users immersed in architectural models placed in a booth. Users experienced the immersion through a specially constructed peephole, accompanied by audio and olfactory elements. Results showed that (a) the user's emotional response to an immersive architecture model could be evaluated through objective measurement of emotion through special tools (b) architecture is an immersive experience that

can be re-created using techniques of “emotional design” and “sensory design”, and (c) such models can induce the feeling of presence and emotional activation. When I transpose these findings to replace the peep hole with the Head Mounted Display (HMD) in virtual reality, this immersion has even more potential for embodied immersion since the mapping mind-body (Damasio, 2010) perceives the 3D spatial simulation of space and objects in VR (Cheon et al, 2016) in ways that creates and empathetically embodied spatial experience. In this manner, the *bodies-cities* VR experience asks users to submerge themselves in to a feminist perspective of spatial knowledge emerging from the sensing-body, where interaction is a mechanism that asks the user to follow specific participatory preferences of residents sharing their knowledge in the simulated world.

In the urban design and architecture context at present, virtual reality's growing popularity in the fields of urban planning and architecture is often limited to presenting walk-through models of proposed built environments. Other proprietary tools used by design houses may attempt to do more, but require a separate study as the knowledge is not always accessible to the public. Predictions of mobile VR launching in 2018 and the integration of VR devices with the Internet of Things and Big Data (ArchiStar, 2018) can change the way VR is used in architecture as the new affordances of mobility will allow designers to indulge in interactive design practices on site, while linking to related data sets that can new data to the site analysis process, and influence design outcomes. Drawing on Puckett's (2014) advice again, asking the right questions to meet these changes head on means to ask what form of interactivity is required for a VR design tool for practitioners interested in designing inclusive public spaces. Questioning use within a practice gives designers a head start on leading the change instead of relying on others to find solutions at a price, and possibly, with functional trade-offs where the tools do not meet the exact needs of that practice. *bodies-cities* explores one such proof of concept layer of knowledge presentation for a potential future urban architecture tool.

Embodied Design in Practice

Three interactive and immersive design projects expanded my knowledge on the ways intangible experiences like embodied knowledge inform research creation. Each offered insights related to my aspirations for the research methodology for sensory knowledge creation, the tools to be used, and the conceptualization of immersive design.

Bear 71

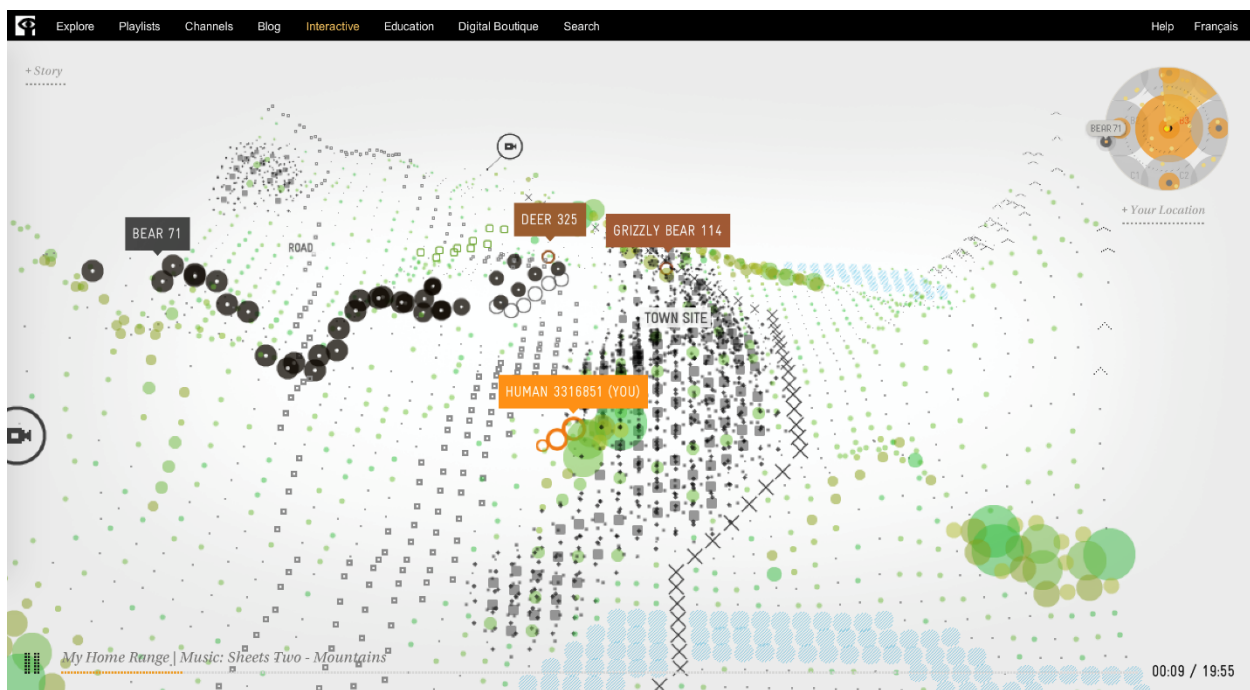


Figure 3. Bear 71 Interactive web experience

Bear 71 is an interactive documentary that maps the life of a living bear in Banff National Park in Canada, as she navigates an increasingly digitized and human-marked wild space. Created by Leann Allison and Jeremy Mendes and hosted on the website of the National Film Board of Canada. The experience is mostly user driven; the user chooses where to go and what film clips to watch, while Bear 71 narrates her worldview whenever she is in range. She shares the park with other animals, a few of whom feature as moving dots (tagged animals) that represent their real-

world movements. Surveillance camera footage and data on the type of animal is available on clicking the relevant moving dot. The animals on the park and the site visitors are experientially entangled through their digital presence on the interactive map, and by the fact that they can both be under surveillance.

Bear 71 stayed with me as an emotionally engaging audio-visual experience, but more so as the first interactive media experience that revealed the relational dynamics between the senses of animate entities like the bear, and other animate (humans) and non-animate elements in an environment through interactive techniques that added layers of experience to an illustrated aesthetic of the grid-like map. Video links on the interactive map created a layer of video footage of Bear 71 and other animals, bringing the illustrated style of the interactive map to life. The active presence of the visitor, bear and other animals are seen through GPS positioning. Users viewing with a live web camera appear wherever the animals go. If the user switches a view, all current viewers are shown in a "surveillance wall", reflecting the animal surveillance back on the human online visitors. Narrated anecdotes like "each year each railcar filled with grain leak the equivalent of 300,000 loaves of bread – it's a smell that is impossible to ignore", the first rule because you can't sense something doesn't mean no one else can't", and "it's hard to say where the wired world ends and the wild one begins", made me acutely aware of the implications of sense based boundaries traversed through the relationships between human, animal, technology, and the environments we inhabit. Over the years, these presented layers of sense based experiences emerging from a living organism stayed with me as a primary influencer. In *bodies-cities* I see these subliminal workings come through in how I chose to explore subjective sensory knowledge that emerges from human and non-human occupation of an urban site.

The Palimpsest, Interactive Architecture Lab



Figure 4. The Palimpsest VR experience, Interactive Architecture Lab

The Palimpsest project (Beaumont, Torisu, Tvieta 2016) was created to address the controversies surrounding the community engagement processes during the construction of the High-Speed Rail 2 (HS2) project in the United Kingdom. It aimed to use emerging technologies like virtual reality and 3D scanning to improve participatory urban design. These technologies are harnessed for two purposes (a) to allow communities to capture 3D recordings of themselves, their community, and the architecture for preservation and for public debate sessions (b) to provide a neutral platform through which all parties present ideas for debate and discussion. The Palimpsest influenced the creation of *bodies-cities* in three ways. As (a) an example on the interactive use of virtual reality for design processes, (b) it exposed me to the texture of 3D scanning cameras and their point cloud mesh caught my imagination as an aesthetic device that aligned with my intent to visualize matter as an active 'substance', and (3) their open sharing of resources for designers like myself helped me navigate the prototyping process.



Figure 5. The new space of Extra:Muros:Intra

Extra:Muros:Intra: Into the Heart of Quantum Matter is a thesis project by Jay Irizawa from OCAD University. Irizawa conducted a phenomenological investigation in design processes between digital and physical space. Quantum space theory was materialized in the design of the site-specific installation which was placed at Evergreen Brickworks for a 9-day period. The installation captured the “interiority of phenomenological affects of a body-space from the outside-in, working within the design apparatus of digital and physical interaction. This work as particularly eye-opening as its intent on materializing quantum space theory to explore reconsiderations of spatial design elements is similar to my own. It helped to understand how another designer presented a spatial prototype developed as a sectional cut of spatial experience, and how they worked through a process to create the design. With similar intentions of exploring the real-world use of quantum space theory, my work explores the body-environment entanglements that emerge from the lived experience of humans on an urban site,

gathered through the apparatuses of ethnography and virtual reality, where each medium maps the agential cuts and intra-active forces that constitute embodied spatial knowledge.

Through this review of literature and design practice, I conclude that embodied map making in an urban context is a performative process emerging from the actions of human actors and other materials. It is given meaning through the subjectivity of lived experience explained by, in historical order, feminist studies, neuroscience, urban planners, and new materialism. A feminist new materialist reading of spatial knowledge making is an attempt to step away from the dualist Cartesian cut, way from the dominance of socially and politically constituted concepts that prioritize the masculine thinking mind over the feeling female body. These are the used to argue for or against emerging technologies and knowledge making practices. This research in to responsiveness merges the two, allowing "the wetware" limited and confining of bodies, to meets the "realms of thought and silicon" (Hayles, 1996) through the technology used. The definition of place is informed by this positioning, as is the pathway to using emerging technologies like virtual reality.

To best present the knowledge and the mapping process, I draw upon research in immersive and experiential spatial design and affordances of virtual reality to create a virtual reality simulation of embodied mapping. The following sections will elaborate on the experience creation process.

Phase I: Tracing the Embodied Experience in Eglington

It is through specific agential intra-actions that the boundaries and properties of the “components” of phenomena become determinate and that embodied concepts become meaningful – (Barad, 2003)

This section of the document presents the knowledge gathering and prototyping experience. This apparatus of sensory ethnography allowed the boundaries of embodied concepts to emerge as agential cuts of knowledge that revealed the entanglement of bodies, objects, buildings, flora, fauna and social relationships. It allowed me to remember previously stifled sensing-body practices that reveal the “breathing landscape” as a “potentized field of intelligence (Abrams, 1996). Within the affordances of the virtual reality apparatus, these cuts were conceptualized and prototyped as immersive embodied experiences and presented in a series of four virtual reality studies created in the Unity game engine. The sensory auto-ethnography used in Phase I entangled my experience as both sensing-body and designer to produces learnings that informed the final research and design process of Phase II. The concept of ‘knowing in practice’ (Pink, 2009), through sensory ethnography materialized in other ways; due to the demands of the virtual reality medium chosen and the straddling of real and perceived worlds in VR, I tested various 3D capture technologies like the Structure Sensor and the Canvas application, the Kinect and the Depth Kit Beta, and Agisoft Photoscan for rendering the 3D models of like trees, grass, stones and other site elements. To document the outcomes of these experiments would be beyond the scope of this thesis, but I hope to make them available through a blog to be updated in summer 2018. Details of 3D real world model and texture used to present embodied worlds are discussed in the Embodied Mapmaking in Virtual Reality section.



Figure 6. Photogrammetry: tree in garden site, Toronto



Figure 7. Photogrammetry: rock in garden site, Toronto

Tracing Apparatus: Sensory Auto-Ethnography

I used my embodied spatial experience in my neighborhood, to create the first four prototype studies of embodied experience. This sensory auto-ethnography provided two specific opportunities for me as researcher and designer; (a) direct immersion of the researcher in ethnographic practice to understand demands of the entangled process that seeks to draw out embodied knowledge from others (b) test visualizing practices for subjective and nuanced nature of embodied knowledge based on the full awareness of my own. One can never fully know another person's experience as is the case in Phase II and it helped to understand what factors needed to be considered.



Figure 8. Auto-ethnography in Toronto

Interview

I used sections of the semi-structured questionnaire created for the knowledge producers I intended to collaborate with in St. James Town. The questionnaire was based on Gruenewald's five dimensions of place framework, which included questions structured around perceptual, the sociological, ideological, the political, and the ecological relevance of experiences (Gruenewald, 2003) as they relate to the sensing-body's experience of animate and inanimate spatial elements. A sample of this questionnaire is included in Appendix C. However, I focused more on analyzing what my body was telling me and how that translated in to meaning I attached to the site. Prior to the research project, this was a garden I spent a minimum of fifteen minutes of each day, at least five days per week. During the research process which included five sessions over two weeks, I supplemented my daily sensory explorations with my reflections on experiences from daily exposure over the past six months.

Walkabouts: experiential knowledge gathering

During this period of initial research, the seasons were changing from summer to fall and I added more walks to my routine to get a body based sense of why I enjoyed my neighborhood. I spent longer hours in the adjoining Sherwood Park and lingered on Yonge Street more than I usually do, taking in the sights, sounds, smells and associated thoughts.

Embodied Knowledge in Yonge and Eglinton

My experience turned out to be a layered one that included sensory stimuli, memory based significance, and an increasing awareness of my spatial positioning in the area. Animate and non-animate matter intra-acted with my mind and body to create phenomena in the form of associated memory of other places from my past, emotions, and spatial significance that was

integrated with my sense of well-being, and an expanded version of my peripersonal space (Blakeslee and Blakeslee, 2007) informed by an expanded kinesthetic sense that results in my sense of being located within a grid of green space that includes the large park that spans adjoining streets and the visual line of trees along my street, and by knowing I am easily connected to city hubs.

The knowledge emerged in sequences of deepening awareness as I noticed what elements caused the sensory stimulation, where I felt these, and how each element related to others like memory and identity to materialize as embodied knowledge. It began with immediate sensory recognition that then, both immediately and over time, these began to form cognitive and physiological links to present and past experience.

- (i) Stage 1: the senses began to acknowledge the placing of my body in the environment; tactile perception of my environment experienced through the feel of flora infused air on my skin as a fresh cool misty shroud, the stimulating smell of grass and soil that seeped into my body through my breath, the subsequent effect this had on my emotional state, moving me from agitated to calmer states. Sensations of animate elements of tree leaves, bark, soil, birds, grass and air (relata) within greenspaces were directly sensed through my tactile (on skin), visual, olfactory, auditory and kinesthetic sense (relata). These relata within the environment intra-acted with the relata of my sensing-body to create the phenomena of feeling calm, soothed and grounded.
- (ii) Stage 2: Past the immediate sensations, the patterns of emotion started to impact how my body felt as it settled heavier into the rock I was sitting on, the soil and grass my feel rested on. The body began to react to the prolonged exposure but creating sensations in muscle and deeper layers of skin. In my case, the deeper bonding patterns on site, over time, are relata that link to the reflexivity of Stage Three.

(iii) Stage three: After a few weeks of immersion, I began to see patterns of relevance to past experiences with animate and inanimate environments that I identified as important in questioning the ecological/sociological significance of my experiences with an environment. These stages influenced the design of virtual reality scenes described below. The tree and the memory it triggered are related that create a bond of familiarity that draws me back to this specific site. While I do not understand the full context of this psychological dimension as it may require other psychology methods to understand it all, the memory presented itself to me when I reflected on the significance of the tree. I noticed I went back to memories of time spent under trees at particularly challenging moves to new cities; as a toddler to Dubai in the Emirates, as a young adult in Portland, Oregon. In Toronto I instances in St. James Town in 2014, and Eglinton in 2015.

This stage also revealed how the spatial awareness and environmental elements of parks nearby are related. They allowed the phenomena of connecting to what matters to emerge. The spatial awareness of being connected is part of my identity, of wanting to access lifestyle choices that reflect who I am and what make me tick. I have always sought connectivity in greenspace and city hubs wherever I live.

This experience with urban spaces was a reflection emerging from my experiences settling into Canada. As I set down roots in a new city, something I had not done in over 17 years, I was immersing myself physically in to a land I was belonging in, and this influenced what type of daily experience I wanted from my neighborhood. The seeking of spaces acceptable for physical grounding defined what kind of area I lived in and what it offered me. My internalized experience reflected in my choices of preferred external spaces. And by choosing to live at the heart of a heart of city was an old habit based on having been raised at the center of an urban hub in the Emirates. By doing so, I could see how it related to the way Grosz explains in bodies-

cities (1993). The knowledge materialized feeds in to the larger spatial experience of situated surplus that emerges from the body, the physical architecture and the environmental conditions of the area (Amin, 2006). They are tangible and intangible affects emerging from the intra-action between the perceiving body (relata) and the elements of the environment (relata) it is functioning within. This knowledge then materialized in to five immersive scenes, created through the process defined next.

Prototype Studies

Initial Concepts

Given the phenomena that emerged through the research and the performative sequence, the initial prototyping was an exploration of the techniques that conveyed the nature of multisensory experiences that constituted embodied knowledge in the three stages outlined in the previous section.

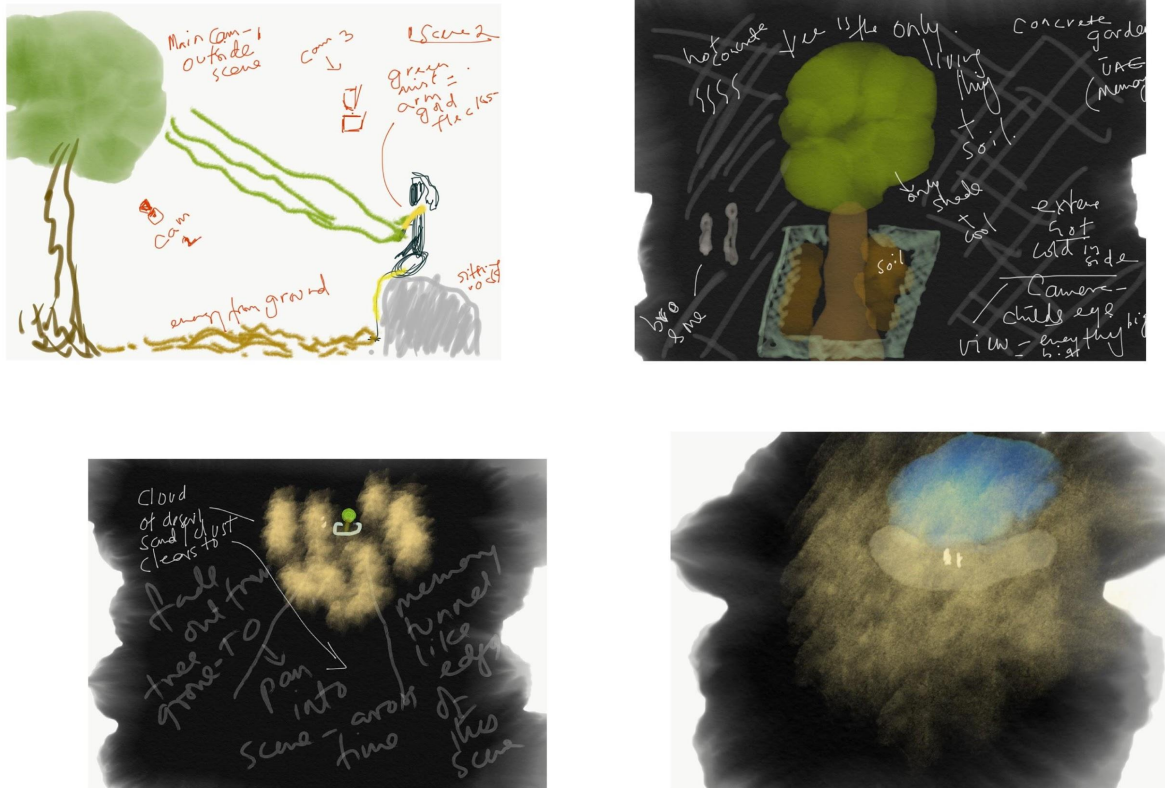


Figure 9. Conceptual visualizations of my embodied knowledge

The conceptual design storyboards shown in Fig. 10, shows how each scene was developed to convey the details of a specific embodied experience.

An interesting challenge in this process has been to allow the experiential design to reflect the body based emergence of knowledge, instead of allowing my visual storytelling mind's habit of organizing the visual narrative in to logical sequence. The sequence presented is shown in Fig.11, and was based on my attempt to rationalize the linkages between the embodied knowledge and narrative principles in the sequence: my experience is never from one country-site but a mix of three (3 maps), in Toronto my experience is situated here (map of Eglinton), this is what I connect with and this is how my body feels about the tree space), it has significance in

the memory of the tree that dominated my childhood, and finally I show I connect to this area by my spatial awareness of access to more green space and the rest of the city.

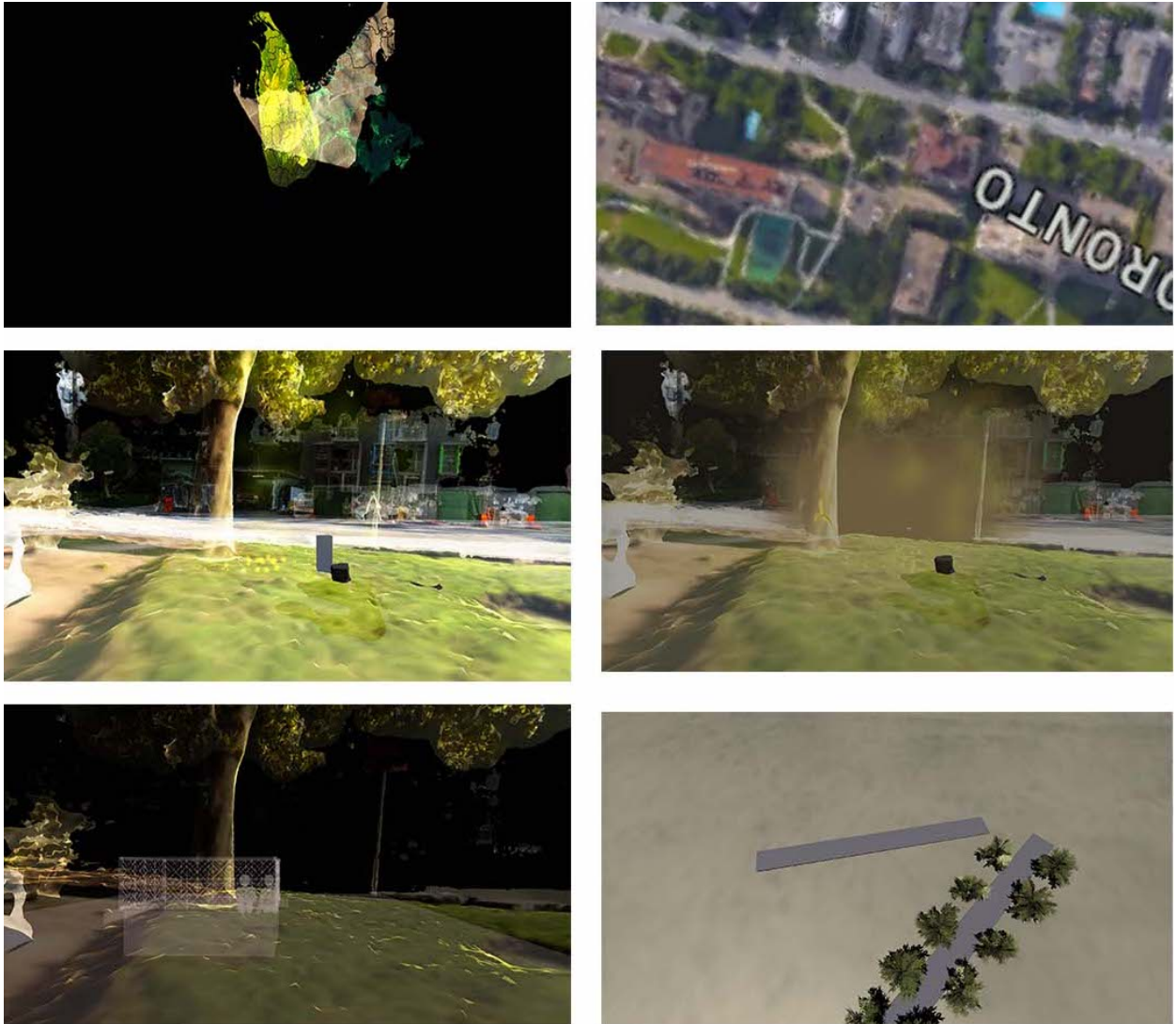


Figure 10. A rationalized narrative sequence for Prototype 1

However, to design the sequence based on the multisensory experience is somewhat different and begins from the direct sensory stimuli when on site. The following sequence reflects this sensory prioritization.

Emotional balancing in greenspace



Figure 11. Prototype Study 1: body dialogues with trees

Knowledge: The air, soil, leaves and bark of this living flora in this garden intra-acts with my body to create the phenomena of calmness and inner peace. As I sit in this spot under the tree each day, I sense the cool, lively freshness of the living tree, grass and soil through my skin and, in some inexplicable way, deep in my muscles. The longer I stay, the heavier my feet sink into the ground, and the calmer I get. The breeze is a sensation on skin as is the smell of the grass mixed with slight wafts of vehicles fumes (if it is rush hour) that invades my breath.

Design Techniques: This scene in Fig. 12 uses Unity's particle effects to visualize and animate the sensory 'dialogue' that take place between my body, mind and this particular tree in a grove in front of my apartment building. The particle effect deepens the dialogue the longer the user

stays within the scene watching the tree, the way my time spent on site increase my sense of communication with the living energy feel of the tree.



Figure 12 Prototype Study 2: sensory affects with soil, air, sound

In Fig 13, the post processing bloom effect added to the tree brings an ordinary 3D scanned tree to life as I begin my daily meditative 'dialogue' with the tree.

Similar animations of the soil and grass were planned to present the way my body relates, through skin and muscle sensations, to the grass and rock space within this garden site.

Sense of tactile/proprioceptive memory

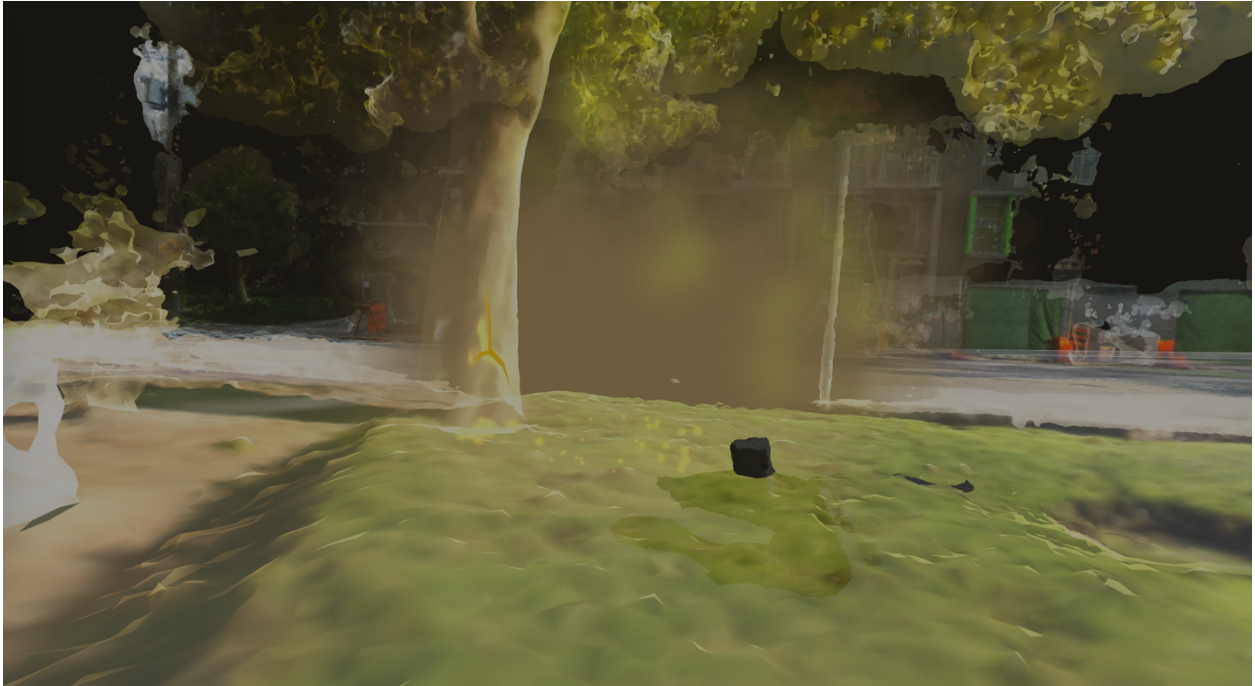


Figure 13. Prototype 3: site and memory affects

Knowledge: When reflecting on how and why trees may have held significance in my life I remember the only living thing in the cement garden of my childhood home in the United Arab Emirates. It gave my brother and I shade to play in during the desert country's spring and summer. As children who could only be cooped up inside a house for so long, the tree was the spot to which we could escape the burning ground. Its soil was a site of exploring and minor digging activity.

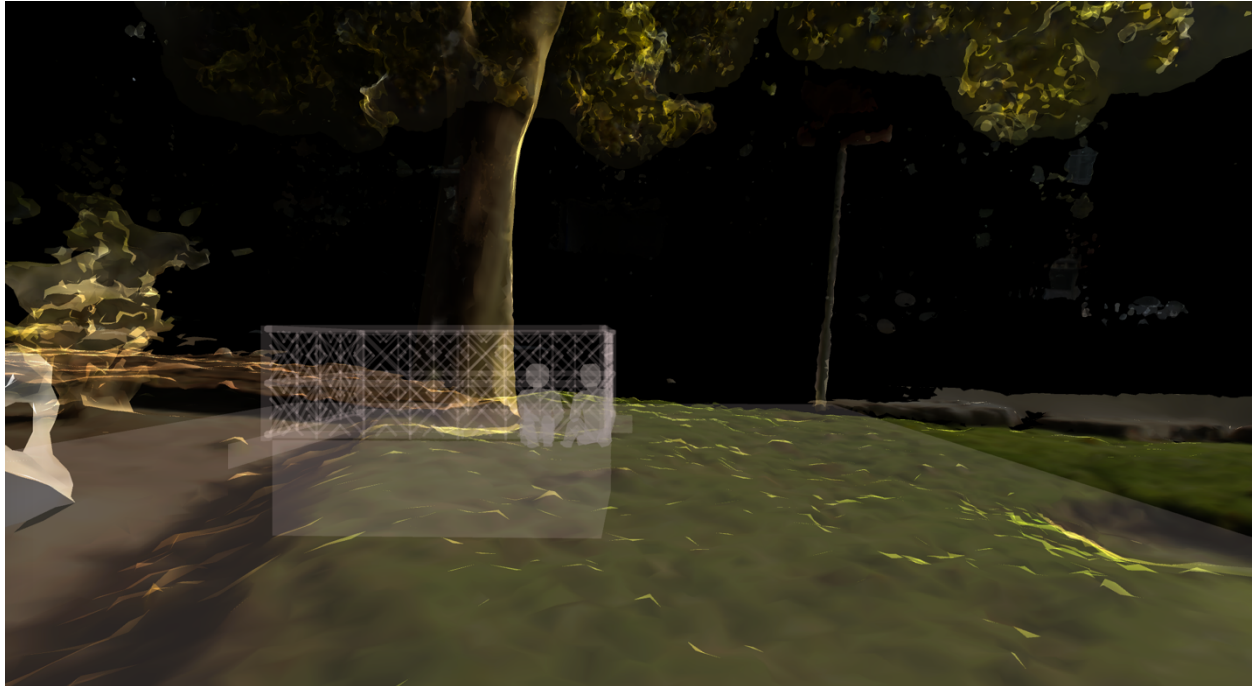


Figure 14. Prototype 3: Related site and memory scenes

Design Techniques: In the scene in Figures 14 and 15, my adult virtual self walks to the tree and triggers a scene transition. The ground shimmers in a heat haze effect created in the game engine. The dust particle effect plays on the desert context of this memory and adds an affective transition to this memory scene. Heat effects were created to refer to the desert climate again and my abstracted childhood self was 3D modelled is present in the scene along with my brother. The scene fades back to the present day after 5 seconds. The materiality of the tree changes with the transition to the dense cloud mesh generated by the photogrammetry model, communicating the multiple significance of the 'tree' at point on the timeline of my life.

Sense of self as constructed by current and past site experience: multiple locations

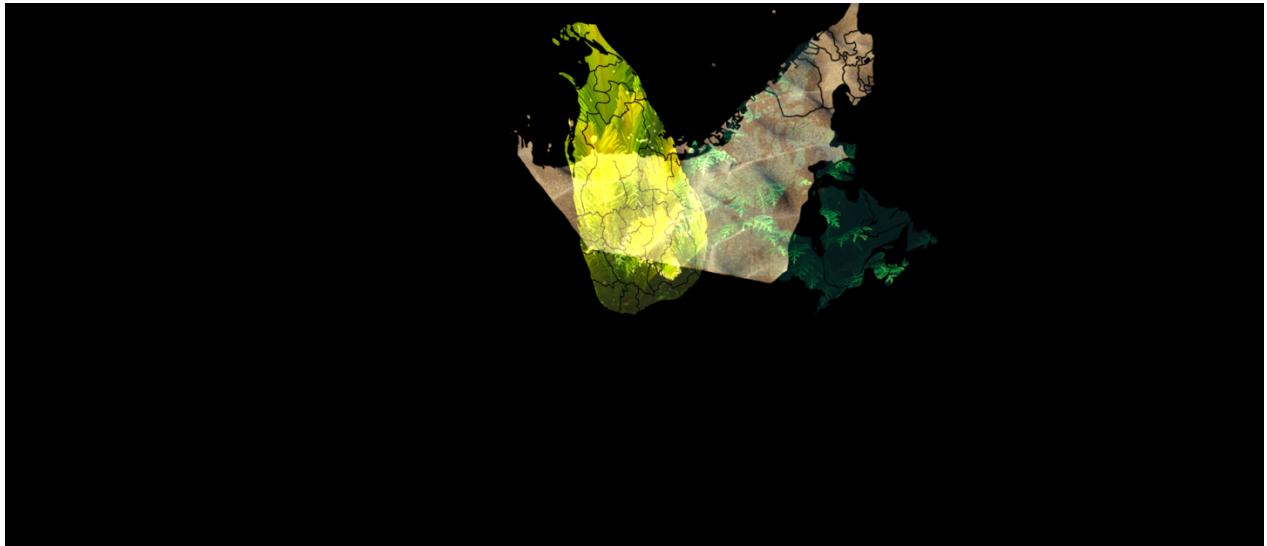


Figure 15. Prototype 4: Identity tied to my history with places

Knowledge: During the design process, I found myself needing to present my awareness of my urban environment as an embodied presentation of the sites that influence my identity.

Technique: Fig. 16 shows the maps that were created of the three countries that influence my sensing-body and there were placed as moving objects in 3D space of VR, to signify the entangled nature of sensed experienced as it influences my choices of urban neighborhoods chosen today. To enter the VR experience of the experience in Eglington, the user has a bird's eye view of the area and chooses to descend in to the tree grove site.

Access to lifestyle choices

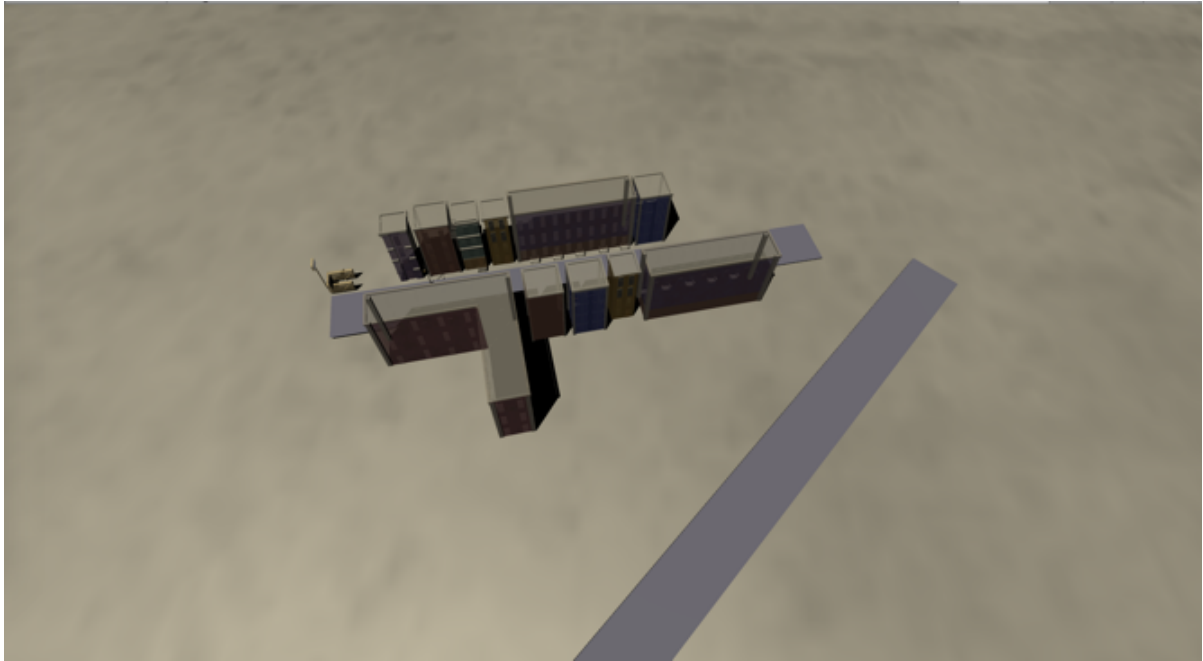


Figure 16. Prototype 5: Body in the grid of neighborhood space

Knowledge: When I had to identify why I preferred my neighborhood, the spatial awareness of its proximity to what matters to me was primary; the transit that allows me to move freely about the city, the access to large and small natural habitats like parks including the small grove in front of my building; the visibility of trees along the street; and the sense human and vehicle bustle of this urban site. These constituted a macro-level sense of connectedness that was essential in a neighborhood I lived in.

Technique: The scenes in Figure. 17 trace the different elements around the user in a sequence; linked green spaces around me, transit, retail, other humans.

Through this Phase, I learnt how sensory ethnography could work, and how I can generate realistic photogrammetry models, and through work with my technical collaborator I learnt how to use of shaders, texture and animation effects that allowed free reign to my imagination. It was helpful to learn that I had to be mindful of staying focused on presenting the layers of embodied knowledge and not let the narrative logic of such design processes to take over as explained at the beginning of the Initial Concepts section. The Phase I experience made me familiar with the tools as I planned for the conceptual design of an interactive VR experience in Phase II.

Phase II: Tracings of Embodied Knowledge in St. James Town

In 2014 and 2015, I experienced the urban complexity of St. James Town. I chose to explore and reconfigure this neighborhood because I wanted to deconstruct a familiar space. My experiences are detailed in Section 1, *Motivations*.



Figure 17. Panoramic view of Howard Street and Bleecker Street intersection, St. James Town

Research Ethics Board Process

Since the research in *bodies-cities* required the participation of the neighborhood residents I submitted an application to the Research Ethics Board and my application was approved. The application preparation process marked a new level of my understanding of what it means to create a responsible knowledge base that enables the nature of what it means to seek knowledge of sensory experiences related to urban site use.

My application considered three elements:

1. The sensitivity of gathering knowledge in a public space.
2. The appropriate level of interaction with participants.
3. My responsibility to ensure the privacy and security of the participants and the knowledge they shared with me.

The REB approval letter is in Appendix B.

Tracing Apparatus in St. James Town

To identify knowledge producers I spent time in the neighborhood, particularly St. James Park, a public park in the area. My time in the park helped reconnect me with a friend who would eventually participate in the project. I found the rest of my participants through social networks like Young Urbanists League, where like-minded urbanists wanted to share their experiences of the neighborhood.



Figure 18. Panoramic view of St. James Town West Park, St. James Town

During Phase II, I utilized the sensory ethnography methods that I used in Phase I. These are informal walkabouts, and a reflective analysis of sensory and spatial experience.

In addition to those tools, I added a paper mapping exercise. The paper mapping exercise consists of a formal interview followed by an informal walkabout. After completing both, the knowledge producer mapped the emotional and functional perceptions of his/her neighborhood. This paper mapping technique allowed participants to discover new relationships and recognize previously unrealized/unidentified patterns.

Sensory ethnography often entangles the “embodied, emplaced, sensorial and empathetic” experiences of a researcher, a knowledge producer, and a site (Pink. 2009). This occurred in my project when I talked, walked, and reflected on the embodied experiences with my knowledge producers. My physical and emotional experiences, combined with the contributions from the knowledge producers helped me creatively design an embodied experience in the VR space.

Two knowledge producers, Viji and Alda (pseudonym), completed the full cycle of walkabouts, mapping, and iterative interviews. Due to time constraints of the research creation process, this iteration of the VR design is based only on Viji's contributions. To analyze Viji's experience, I applied the agential realism (Barad, 2007) research framework to sensory ethnography.

Embodied Knowledge

I followed each knowledge producer around the neighborhood as they mapped the areas they enjoyed, the areas they used daily, the areas that caused them despair, and finally the areas that gave them hope. Walking and talking plotted the surplus that emerges from the body, the physical architecture and the environmental conditions of the area (Amin, 2006). Both tangible and intangible effects emerge from the interaction between the perceiving body (relata) and the surrounding environment (relata). Within my thesis, these relata intra-act and present the contextual and geographic boundaries of the participant's perception of St. James Town.

Viji's Embodied Self

Viji's defines her embodied self as interactions between her senses and animate and inanimate elements within St. James Town. Each element's agency entangles to create her perception of the site, and are based on associated meaning and sensory stimulation. Animate elements include her experience with the flora and fauna in the park, the diverse communities in area. Inanimate elements include proximity to ethnic shops, and communities, as well as the scale and style of the neighborhood buildings.

Figure 20 shows Viji's partial map, created during the research-gathering phase of my thesis.



Figure 19. Embodied Mapping with Viji, St. James Town

Viji is a woman of colour and an immigrant. Her visual recognition of other people of color and specifically immigrants within the neighborhood gave her a sense of belonging because she felt that immigrants are friendlier than nonimmigrants and that she can bond and emphasize with other immigrants over a shared experience of migration. She described the phenomenon of belonging through emotional and cognitive reasoning and noted the places within the neighborhood where she felt happy and content. This sense of belonging was strengthened through the rich effect of interacting with the smells, tastes, and music of the diverse ethnicities of St. James Town.

Viji moved to Toronto over a decade ago and the ecology of St. James Town played a significant role in her decision to make the neighborhood her home. Viji spend a large part of her adult life in Eastern Sri Lanka where both at work and at home, she had access to green spaces such as the Batticaloa lagoon and parks. She wanted similar access to green spaces when she moved to Toronto. The St. James Town West park is a public park spacious enough to hold a variety of flora, fauna and was designed to allow community gardening. Viji has a particular tree and bench she enjoys more in the summer, and though the flora is unlike those of her tropical heritage, she finds time spent in the park essential to her sense of emotional wellbeing.

She feels emotionally balanced through direct stimulation of her smell, sight, and sound (each a relata) as well as the interaction with the living elements of the air, trees, soil, grass, insects, and squirrels (also, each a relata). These experiences link her to her home-place (hooks, 1991) of Sri Lanka. Home- places influence a person's sense of belonging and contentment. This perceptual translocation reconfigures the park space and adds significance to her new life in Toronto. The agency of the trees, soil, air, and sounds of the park is twofold: a memory of belonging simulated in Toronto and the direct engagement of her senses, giving her a sense of emotional balance that defines her experience of the space. Viji lives by herself, so she also uses the park as a place for human connection. The presence of other people as well as the opportunity for direct social engagement and human connection are important to her sense of contentment.

Viji shared her sensory experiences on neighborhood architecture. She liked the detailed facades of historical buildings in the area because they provided variety and were reminiscent of the colonial structures that marked public buildings and her office in Sri Lanka. High rises made her uncomfortable because they towered over her; she preferred low-rise buildings

because they were closer to the scale of her body. She worries about how the neighborhood is changing. New construction of high rises and condos indicate a shift in population from recent immigrants to upwardly mobile professionals. Viji worries that the new resident's lifestyles and attitudes are unlike the current residents and these emerging design choices erodes Viji's sense of belonging and inclusion.

The neighborhood's affordances such as easy access to transit for Viji's commuting and socializing and the presences of a translocal community of fellow Tamil Sri Lankans and their local business support Viji's day-to-day routine, sustain her lifestyle and support her sense of belonging and wellbeing. Translocal communities (Rios & Watkins, 2015) offer sites of cultural re-connection that immigrants find comforting to anchor themselves in as they navigate new lives in new lands.

Viji's sensory experiences trace situated surpluses that, to her, define the character of the neighborhood. These traces are linked and they function as an embodied map of preferred neighborhood experiences, giving residents agency and a sense of home

Alda's Embodied Self

Alda's values her physical connection to St. James Town. Her embodied self emerges from the entanglement of animate and inanimate elements in the area, and social dynamics in the community. through her preference for daily, walkable access to large parks in the adjoining neighborhoods, as well as cafes, groceries, movie theatres and community development forums.

Figure 21 shows Alda's partially mapped experience, created during the research-gathering phase.

that shifts the actual geographic boundaries. By reconfiguring spatial dimension to include embodied experiences of parks Alda adds sensory value to her life.

Walkability to greenspace, cafes, cinemas, essential commerce, as well as Toronto's many events, immerses Alda's body in the city. Her sensory participation (relata) in each site (relata) creates a deep bond between herself and urban public space. Her enjoyment of corporeally experiencing the city emerges from her past experience. She grew up in Colombia and was mostly driven around by her father, so she did not have much opportunity to construct her own paths through her urban environment.

Alda studied architecture and this altered her understanding of the spatial relationships between human and buildings. Past experience and architecture studies are all relata that constitute the phenomena of finding deep contentment in physically immersing her sensing-body in walks that map her lifestyle choices, and mark her way through the neighborhood.

Alda's encounters with piles of garbage on the street corners are important to her perception of the area, because she enjoys the neighborhood but wishes the piles of garbage would be better managed. She perceives garbage through smell and sight, where these relata and the garbage itself form the phenomena of irresponsibility for shared spaces. As a pattern, this impacts her enjoyment of the area and raises hygiene issues. It also motivates her to link with civic action work in her community. She would like to avoid such spots but they are on her walk to the subway and therefore make a significant and daily impact on her senses.

Reflecting on the dynamics that emerge from intangible relationships, Alda shared that the St. James Town community seemed unaware of the potential offered by their physical positioning in downtown Toronto. The phenomena of unawareness leads to loss of resilience potential is

due to various relational factors (relata). These include immigrants and other low-income groups needing multiple survival jobs to pay bills and having little time to take civic action, language barriers that limit participation at events in linked parts of Toronto, and the way many immigrants feel uncomfortable with venturing beyond known neighborhood spaces when adjusting to a new country. The lack of awareness is also related to how the community management groups lack an effective strategy that includes the diverse lifestyles demands of the population, and not knowing how to manage cultural dynamics that would allow different ethnic communities to work together.

In Alda's case, her perception of the neighborhood creates a different tracing of embodied knowledge. The geographic boundary of St. James Town extends to include the greenspaces she uses regularly; Evergreen Brickworks and Riverdale Farms. Walkability and scale of buildings impacts her sense of contentment, and the gaps in community cohesion frustrate her and motivate her to find new ways to contribute to her neighborhood.

This project takes the urban to be a process emerging out of the crystallizations (Schmid & Brenner, 2015) of experiential patterns that emerge from the sensory ethnography. For both Alda and Viji, the relational qualities of both animate and inanimate elements within this urban site entangle with their sensing bodies to emerge as embodied knowledge based on their perception of social, economical, ecological, psychological and political factors. These individual layers of knowledge reveal situated surplus to be the perception of a neighborhood. They also provide insight into the responsive elements of urban place-making.

Tracings of the embodied knowledge discovered in this section are presented through the affordances of the 3-dimensional design space of virtual reality.

Embodied Mapmaking in Virtual Reality

Yet architecture is inhabited: sequences of events, use, activities, incidents are always superimposed on those fixed spatial sequences. These are the programmatic sequences that suggest secret maps and impossible actions, rambling collections of events all strung along a collection of spaces, frame after frame, room after room, episode after episode. – Tschumi, 1996

Embodied spatial knowledge materialized through this research creation process is an immersed experience reflecting the inhabited experience of public architecture, and the “sequences of events, use, activities, incidents” (Tschumi, 1996) that intra-act to create symbolic worlds, or symbolic realities (Heim, 1993). In this project a virtual reality experience, which is a computer-simulated model of embodied spatial experience, allows the creation of this symbolic reality of embodied knowledge, that mirrors some of the limitations of process used to discover this knowledge through sensory ethnographic research with knowledge producers in St. James Town. Due to time demands of the ethnographic process, this iteration of the prototype the work does not include the technological manipulations that could enable some of the multi-sensory elements, like smell and touch, that are part of an embodied experience.

The VR world is a simulation of the embodied experience of one of two knowledge producers whose information I found in other sections. Within this project, I refer to two worlds: the real and the virtual (Heim, 1993). The real world refers to the world where light converges, where actual, physical, environments are sensed, touched, tasted, and felt. The virtual world is the simulated reality which is presented through lenses and technology. In the three dimensional spatial constructs of a simulated virtual world created through a game engine, the virtual self of the user wears a HMD and experiences a simulation of the embodied spatial experience of knowledge producers and, at time, the researcher. The physical self of the user may experience

a mind-body disconnect because it is trying to be in two worlds, simultaneously. Yet, the user is emplaced in the virtual world through the mind-body dynamics discovered in neuroscientists and explained in Section 2 (A Case for Embodied Mapping). The brain's multisensory mind mapping process (Damasio, 2010) allows for embodiment in the virtual world through the sight, sound, proprioceptive and kinesthetic sensing-body navigating the VR environment. These sensings define a peripersonal space (Blakeslee and Blakeslee, 2007) within the VR world. It is a space that expands and contracts to as the user navigates the sensory details of virtual space aesthetically and programmatically simulated to bring as much of the body's subjective ways of knowing into a medium has been perceived to be limited by its dualist, disembodied nature.

This peripersonal space within the *bodies-cities* VR environment would, in future iterations, be used by architects and architectural visualization professionals. The experience within the VR setting would inform their design practice through the specific affordance of embodiment in VR (Maria da Piedade Ferreira et al, 2017; Morie, 2017). The embodied site knowledge would add to the layers of architectural sequence information to the model simulation practices commonly used today. The design process attempts a feminist reading of a posthuman experimentation with design practices, where the sensing-body meets the technological extensions of design. The architect's body works within the technologically simulated design space of VR creating new design ecosystems.

The Experience

bodies-cities is an interactive, multi-stage, virtual reality, exploration of an urban park at the western edge of Toronto's St. James Town.

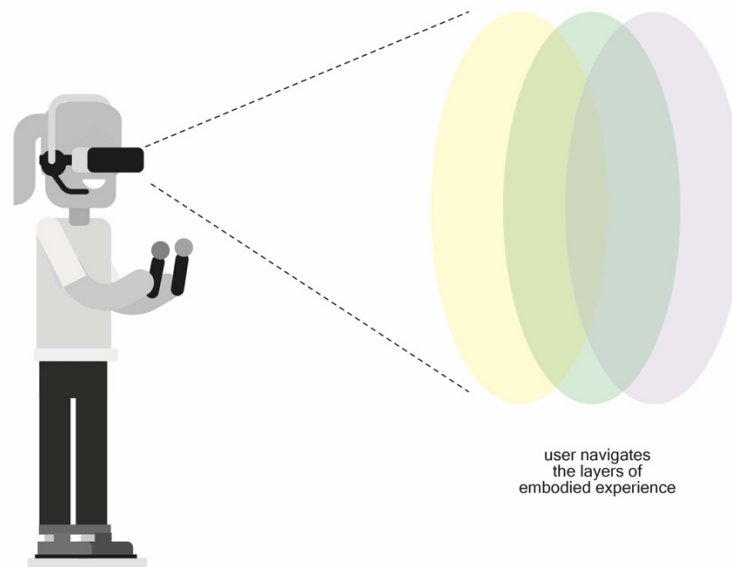


Figure 21. *bodies-cities* user navigation

To experience *body-cities*, a user wears an Oculus Rift Headset and takes a walk in the virtual space. On entering the simulated model of a section of St. James Park West, the sensory experiences shared by knowledge producers and the researcher are activated through affective animations that refer to the sensations felt through the senses. There are two other linked VR scenes the user can access to by choosing to teleport to that park of the virtual environment. Within all scenes, attention the user pays to dynamics programmed in through VR affordances activate other layers of embodied experience. VR's raycasting affordance, where the computer identifies whether the headset wearing user is looking at part of a scene or object, reflects the attention paid. Proximity identifiers, created through the placement of box colliders activates animations to present sensations, and immerse the user into reflective sensory experience based on past memory of other sites known to the resident/knowledge sharer. As the

user experiences this alternative spatial experience of the St. James Town West Park scene presented, an embodied map is generated separately to track the user's presence in the virtual space.

Conceptual Design

VR as a Palimpsest

This design process is an experimental, early stage design space-making for future urban architecture tool making. VR offers the space to simulate the manipulation of real-world space, and allow others to step into experience those new worlds – much like the work of architecture. Except in VR you do not have to build the actual environment before inviting others in to experience it.

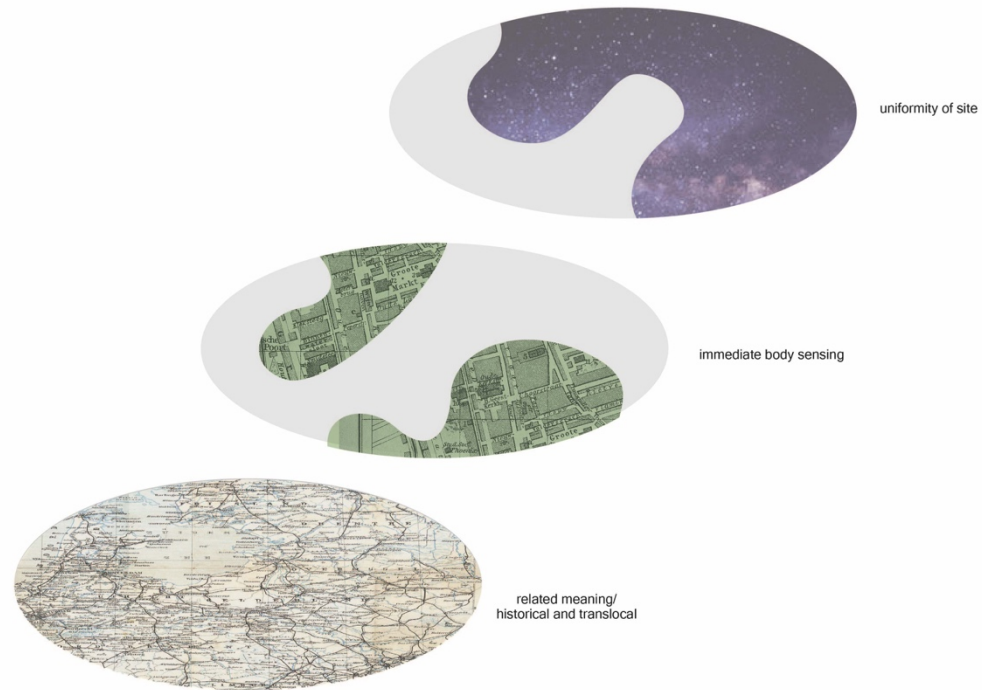


Figure 22. Layers of embodied experience in virtual space. Reference data on images used in this diagram can be found in Appendix E

The conceptual layout of the VR experience draws on another common architectural tactic – the layered presentation of spatial knowledge as a palimpsest. A palimpsest space is one on which historical layers of knowledge have been etched, erased, and etched again. The layers in *bodies-cities* are shown in Fig.23, and refer to the (i) uniform surreal layer of public perception, seen on entering the scene wearing the HMD, (ii) layer of direct sensing by the body, and (iii) the layer of associated meaning. The interactive and embodied navigational affordances of VR allow the designer to fully utilize the layered complexity of this concept to reveal the multiple layers of experiential significance that emerged from the knowledge gathering process. The

experience is designed to reveal the performative nature of the agential relationships between body, mind and environment through the manner in which VR scenes are visualized and the user interaction designed.

This section lays out the significance of the layers, and the use of VR affordances to present the performative nature of embodied knowledge, and agency of the interactive mechanism required to access this re/configuration of spatial knowledge as an embodied form.

The Layers

Layers of embodied site knowledge

The layers of scenes and material manifestations of elements within scenes present current, historical and trans-local material relationships presented as real-world photogrammetry alongside 3D modelled elements.

Historical knowledge: Elder Gary's experience presents the agential nature of Indigenous relationships to land throughout history. These knowledges have been preserved by Indigenous communities through oral and other embodied mapping practices. The acknowledgement of this land through an immersive scene is an acknowledgement of the layers of history. This inclusion of this acknowledgement materialized from my own sensory entanglements with Toronto land that has run parallel to, though not directly linked or influenced by, my exposure to Indigenous activism and to the reconciliation process between First Nations and non-Indigenous people, all of whom now share land in Canada. The presence of the land acknowledgement scene is phenomena emerging from the relata of my own land based rituals, and my exposure to and support of the reconciliation process as a Canadian resident, artist and designer. It manifests in the art and design work as an immersive scene; one that also uses the interactive affordance of the medium to create awareness of how a user show access the knowledge of

an Indigenous elder. This scene depicts the banks of the Humber River to acknowledge the significance of the Humber River which served as highways do today, transporting people and goods to Toronto, or the 'carrying place' as it is called by some, and by doing so allowed social and economic growth of First Nation societies.

Real and virtual layer of elements: This is a layer of photogrammetry models that present the 3D rendered models of real world site elements of significance to the knowledge producers. These include Viji's favorite tree under which you find her in the experience, the trees (Fig.24) from the lagoon and the park in Eastern Sri Lanka that links to a relational-site based on her sensory memory, the researcher's choice to include other site elements like the apartment building adjoining the park (Fig, 25). These bring the real-world textures of the site/s to the experience, linking the user to the real world that the simulation is based upon, and which is ever present, literally and metaphorically as the embodied spatial knowledge is tied to the real-world elements of the site. This layer allows the experience to transition between perceived and real-world space. They also create looping relational flows of meaning related bodies, site elements(matter), memory and ritual that create spatial meaning making for the resident.



Figure 23. Photogrammetry model of Viji's tree



Figure 24. Photogrammetry model of apartment building adjoining park

Layer of sense-based embodied knowledge

The navigation of the scenes is layered in the way the awareness of embodied knowledge materialized in two layers: direct sense perception and reflective sense perception. Both of them relate to kinesthetic and peripersonal range of body awareness, and its extended version of awareness that maps embodied knowledge in relation to memory and other factors like how a person feels linked to larger spatial grids. In the sensory ethnography methods used, direct sensations were the first layer. These are multisensory experiences that materialized through a perceived entanglement of tactile, auditory, visual, proprioceptive, and olfactory; the sounds of the street and accents, the smell of grass, the feel of air when close to flora and fauna. The first layer of VR space presents elements that trigger the senses like the 'living' animated grass and soil, and the green mist of fresh air from the trees. The second level of sharing reflected on the why certain sensations and related emotions were valued over others. This layer of the

experience reveals the memory and ego based embodied knowledge; the sensory pleasure of living near a green space reminded Viji of her the rural habitat she was raised in, the feeling of belonging that came with living among immigrants with common life experiences etc.

The Layer of Architectural Sequence

As layers of architectural sequence the embodied knowledge layers are also the “concealed in embodied metaphors and ineffable unconscious interactions Pallasmaa (2013) writes of as essential to understand for truly sensory architecture that is to be “experienced and lived” (Pallasmaa, 2013). As design layers, at this stage, I am leaving this layer to present the knowledge as it materialized (see previous section on sense-based layers) until user testing can take place with architects and architectural visualization experts. Yet, even as they are these layers reflect the transformational sequences (Tschumi, 1996) traditionally traced on architectural drawings as experiences of humans and animals. In *bodies-cities*, these sequences are traced as sensations perceived through relationships that creates a situated surplus (Amin, 2006) which are perceptions people have of public spaces. Future iterations of this work will have to consult with architects to understand how the layers need to fit in to proprietary design tools within design firms.

Interaction as Agency

Interaction is a feature that has also been a symbol of the dualist and mind/body construct of virtual reality as a ‘white man’s’ tool. As explained in other sections, I use this affordance of VR to reveal the agency that is necessary for a feminist new materialist world worldview where the responsibility to present Other worlds threads through all levels of research and design.

Responsible world making

In this project, embodied knowledge is intimate experiential knowledge of people living in a neighborhood. It is knowledge that can only be accessed only through the intentional and respectful seeking of the situated, re/configured experience of humans occupying an urban public site. It is based on a knowledge seeker's respect for the person sharing knowledge, and the latter's willingness to open up and trust others. In VR, a user immerses their VR-embodied selves into the experience by wearing the headset, to access this experience of a stranger. To ensure the ethical introduction of one person's intimate knowledge to the public, the knowledge producers (Elder Gary and Viji) were asked how they wished their virtual selves to engage with the users in public presentations of the VR experience. Viji preferred that the user acknowledge and engage her, which is why the experience requires the user to make eye contact with her to access her experience. Similarly, Elder Gary preferred the traditional offering of tobacco (this appears on the scene when the user makes eye contact with Elder Gary). Once offered the scene transition to the Humber River Scene and Gary begins his song of welcome to the traditional territory of the Mississaugas of New Credit. I have used VR's raycasting affordance to program an interaction based on eye contact with the avatars, for this gaze is an of acknowledgement of another's place in the world (Berger, 1972).

Creating this direct engagement between knowledge sharers and knowledge seekers (users) reinforces the user's active virtual presence since the user impacts the virtual environment through their actions. It also creates a bond between the user and the avatar who 'controls' the scene. The user's navigation through the layers of VR experience creates a preliminary version of an embodied spatial map. The time they spend on elements and exploring spaces reflects a marking on the map. This gives the user agency to influence the spatial mapping process. This mechanism needs further development in the context of a design tool where the user is most likely a spatial planner/architect, and is beyond the scope of this thesis; such as deciding what

influences I would look for when assessing the times spent by users. Doing so would enhance the functional use of the embodied mapmaking process in future iterations.

Materiality

The presentation of material agency is at the heart of this project's purpose, where animate or not, 'matter feels, converses, suffers, desires, yearns and remembers" (Barad, 2012, in Dolphijn, R., & Tuin, I. van der. 2012) as a co-mingling of body, mind and elements within an urban site. The layers of photogrammetry and built 3D models, and the use of textures and animations. are techniques that allow the VR presentation of the performative and agential nature of the entangled relationships between mind, body and environment. The photogrammetry models mixed with created models allow the layering of real-world material on virtually simulated models and textures. The photogrammetry models allow the presence of real world material rendered on the 3D coordinates of a virtual world. In philosophical digressions into the symbolic world that we perceive as reality, Viji's tree moves through space via the lens of a camera and the rendering platform of Agisoft Photoscan to interact with both Viji and us in the VR world of *bodies-cities*. The photogrammetry captures elements of Daley-Wards's refers to in the opening quote of this thesis (see Introduction), where 'the coordinates' are places and experiences the mind travels to. These are materialized in virtual space and these 'coordinates' in VR take the user to other lands through experiences and memories of the knowledge sharers. These (re)configure the space of St James park to include 3D 'coordinates' of Viji's lagoon trees (Fig. 26) and park in Eastern Sri Lanka, as a relational-site linked through deeply embodied significance (see section title Phase II on analysis of Viji's Embodied Self), to St. James Park West in Toronto.

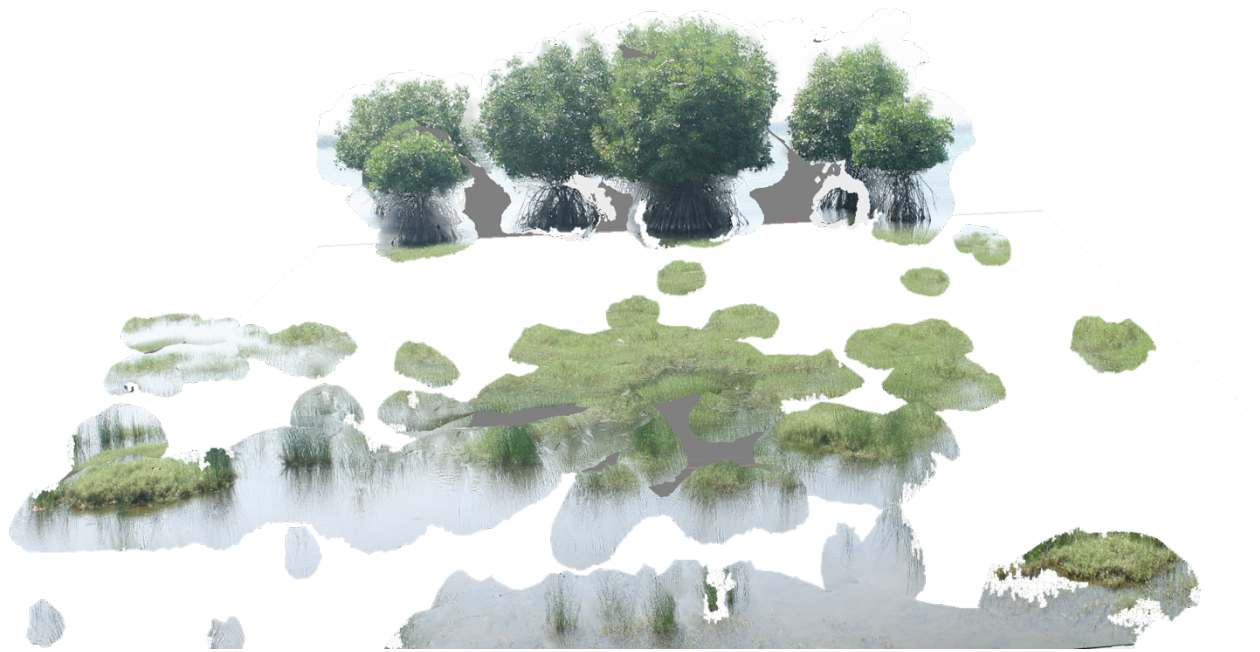


Figure 25. Original photogrammetry model of lagoon trees in memory scene

Unity's material manipulation affordances also helped present the sensuous nature of embodied knowledge based on sensory perception. Drawing on what Scotus (quoted in Heim, 1993) considered the 'virtualiter' qualities of a thing, beyond its empirical attributes, this sensuous aspect of urban spatial experience with animate elements is intentionally materialized. This is done through the use of shaders and animations, and present the essence of embodied experiences that transcend the base attributes of any objects materiality. The ethereal texture of 3D point cloud data meshes caught my imagination when exposed to the LIDAR camera models presented in the Interactive Architecture Lab's 'The Palimpsest' VR experience. To me it is a visualization of the essence of matter, and its animation presents the agential nature of matter this project investigates. The opening scene of *bodies-cities* uses a similar visual treatment of the Main Scene (see Fig.27), to present a world that is commonly perceived to be a public park site. In this work, the nature of matter I perceived in the point cloud mesh is inverted to present the base experience of matter as it manifests in an urban site. As the user steps into the

park, the visual treatment of the scene changes. The shader coding that enabled this treatment was provided through an online forum by J. Roman(2012)

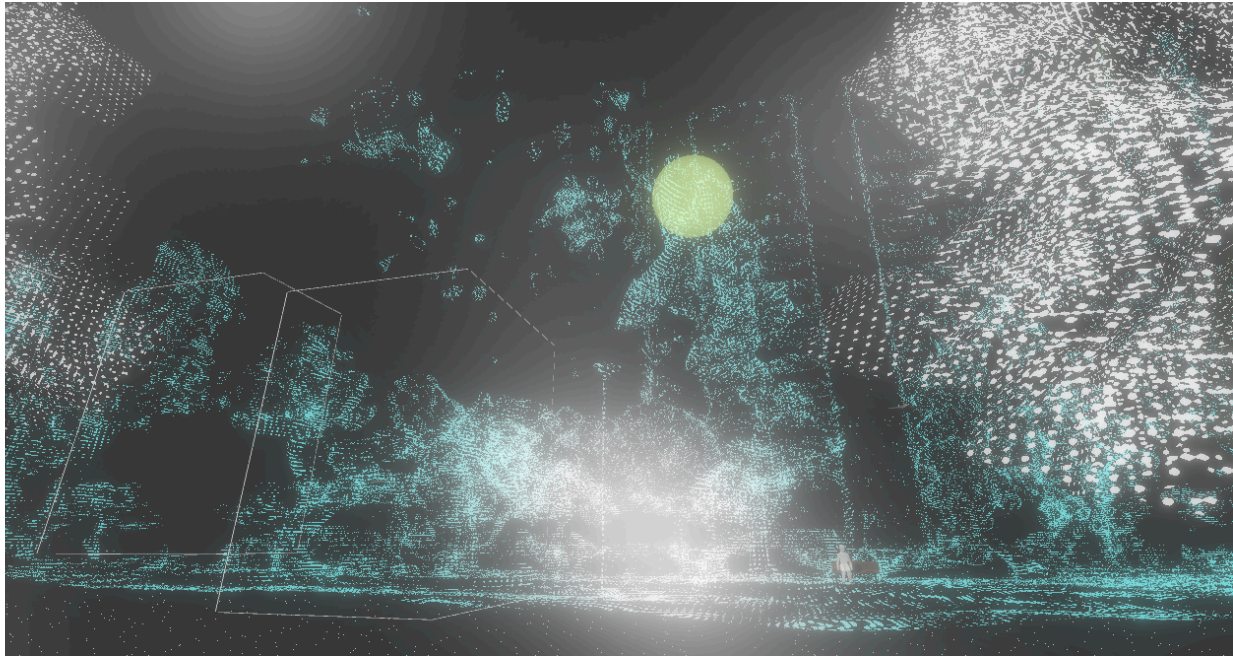


Figure 26. Visualizing the perceived uniformity of space

First sensory layer: Animations of the animate sensuousness of grass, soil and trees simulate the sensations experienced in the first level of embodied knowledge. This knowledge came as Viji and I took our first walkabout in the neighborhood to places she enjoyed, or not; the soil and grass come alive as the user steps in to the park. The green web of fresh breeze experienced in green spaces spreads out from the user's body to the trees around the park.

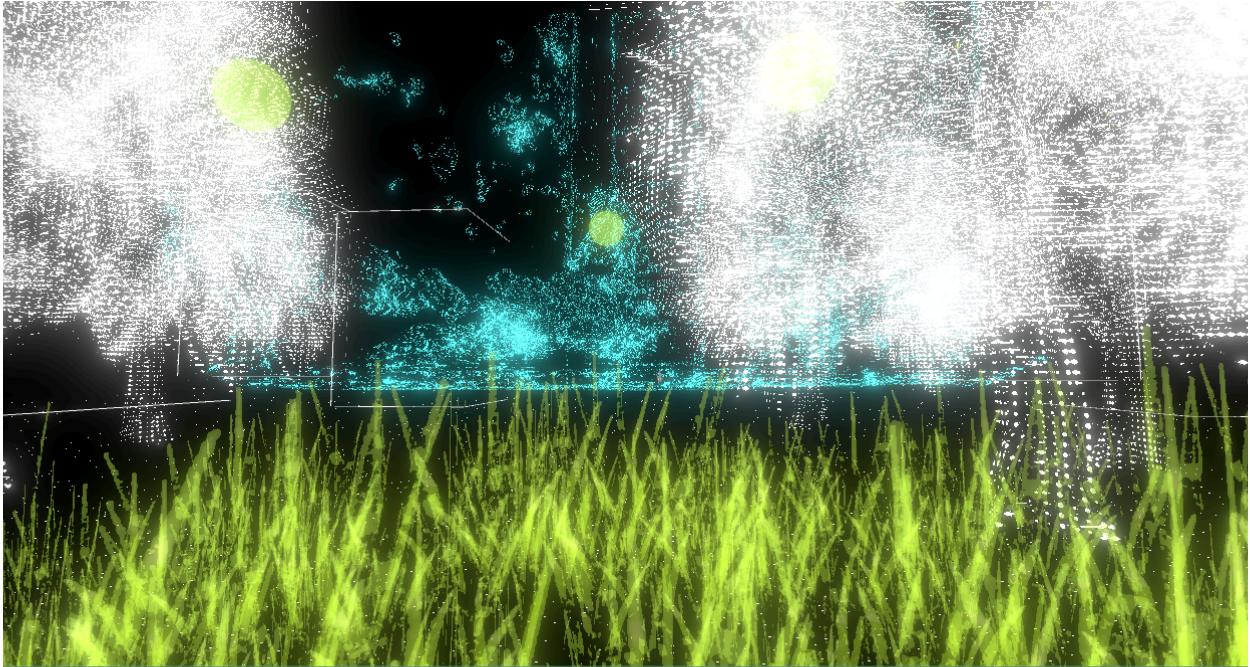


Figure 27. Sensory animations in Layer 1

Second sensory layer: The multisensory sensory systems that Viji referred to when describing her preferences for areas of the site span a few senses. Drawing on the film montage work of Chris Marker, Rachel Thompson (2017) uses horizontal montages as the 'glue' that holds together 'disparate elements' that create relational meaning. Her experiments in visual anthropology are placed, as mine are, between the presentation of material agency through specific methods. Embodied knowledge is a set of disparate elements. Viji travels in her mind through her exposure to other cultures. Viji travels in her mind through her exposure to other cultures. I used similar audio-visual mixed montage to present the re-configuring of space across the Toronto site and that of memory in Sri Lanka. These overlay the scene the user is within, only partially so as to not completely leave the Toronto site. When Viji hears the accents, and sees her Ethiopian friend walking through the park, the scene fades into an Ethiopian landscape (reference to graphic used can be found in Appendix E) and sounds of the language spoken (Amharic) by a resident who offered to share the audio. The significance of direct access to the park is a link to her life in rural Sri Lanka with easy access to green space at home and in nearby environs. When the user

follows Viji to the tree, the scene uses the audio-visual montage effect to transition partially to the scene of Sri Lanka as seen in Fig.29.

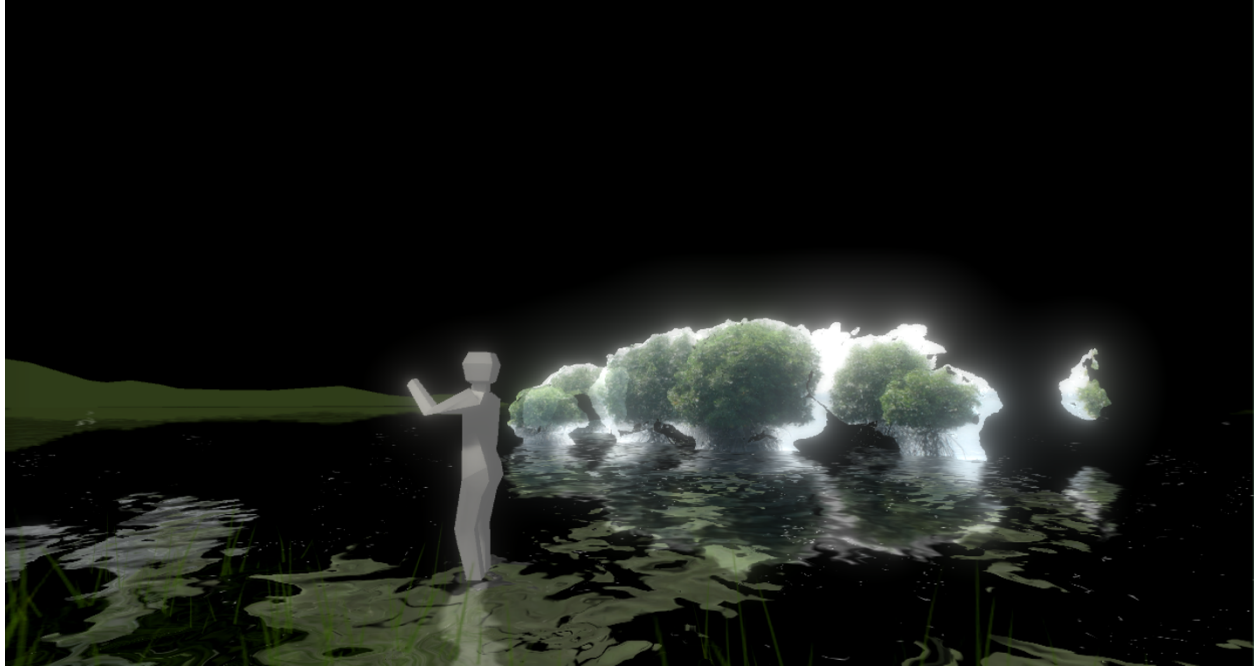


Figure 28. Scene montage effect for layer of related site memory

Mapmaking

The embodied mapmaking process is tested in this iteration of the prototype by generating a symbolic map as users navigate the world, unlocking sensory triggers through attention and respectful engagement with the knowledge producer's virtual selves, and spending time on certain VR world elements. As a layer of interactivity, this version is a test of functionality and not the precision and relevance of the mapping mechanism in a potential design tool.

Reflections from this development stage, and learnings to be applied, are shared in the Conclusion and Future Directions.

Phase III: Testing and Evaluating

User testing was limited to two sessions with Viji and one with Elder Gary.

Testing with knowledge producers

The VR experience was first presented during the early stages of design to check on the presentation of embodied knowledge as techniques of sensation and memory. Viji did not have specific feedback but it gave an opportunity for her to provide more knowledge of how she notices smells and tactility of grass and soil at certain times of the year. These resulted in the changing of the grass to an animated version seen in the final prototype. The knowledge on use of smell will have to be incorporated in future iteration of the VR experience that can include olfactory devices as part of the installation. It was in through this consultation that Viji and Elder Gary stated how they wished their avatars to interact with users in the VR experience.

Testing conducted with a small group of OCAD students and Faculty resulted in changing elements that enhanced the presentation to VR layers to match the material treatments and symbolic meaning across the three layers of the experience, and incorporated other feedback such like the optimal placement of the user as they are introduced to the scene and inclusion of more audio sequences from the actual real world site.

Conclusion

This research creation project materialized from my interest in understanding the significance of embodied urban site experiences to public architecture. What I found most interesting was the realization that designing with a complex organism like the human body requires a complex

entanglement of perspectives and methods that have the potential to veer off into thread of new research and design explorations.

The research journey in to sensory ethnography deepened my awareness of the link between my intuitive awareness of my environment and how this awareness manifests in neighborhood choice. I began to understand the hyperreal entanglement between the inner world created by my senses and outer environments that echoed my experiences and vice versa. Other knowledge sharers from the St. James Town community had similar experiences and those drove their choice to live in and interact with their urban environment in specific ways. Each stage of research deepened the realization of how much our sensing bodies entangle with the external environments we inhabit through routines, preferences and activity in neighborhoods. This experience led to my choice of project title, *bodies-cities*, as a direct reference to Grosz's (1993) reference on how human bodies, and the cities they inhabit, reflect the each other in a tangle of lived experience and spatial patterns.

Answering my research questions deepened my awareness on topics related to my research questions such as understanding the fluid boundaries and multisensory workings of the human body, mapping as an embodied process, and virtual reality as an evolving design space.

Answering my research questions led to the discovery of a linkages and entanglements of knowledge across disciplines that seem to be necessary when attempting to design for the complex demands of an organism like the human body. The design of the VR experience and the ethnographic process were influenced by work in neuroscience, dance therapy, cartography, adapted quantum theory and urban theory.

New materialist theory, with the specifically feminist intra-active approach Barad proposed, expanded my understanding of the relationship between the body and urban architecture, and

allowed for an ethical approach to sensory knowledge gathering and presentation in VR space. Agential realism as a theoretical framework deepened this approach to include respectful knowledge seeking practices that allowed for sensitive knowledge to emerge and influenced how the knowledge should be shared with strangers in an embodied design space like VR where the direct violation of the embodied experience of others is a simulation of the injustice imposed on those whose concerns are marginalized such as Indigenous communities, immigrants and the lower income households struggling to co-exist within the hegemonic social fabric of modern Toronto where they are considered to be Others who share experiences outside the preferred norm. The theoretical positioning and research discoveries in neurology, architecture, and studies on the body offered an approach to both defining the sensing body in a public spatial environment and informed how sensory knowledge was mapped through urban site use and preference, as well as its impact on emotional well being. The importance of functional and emotional linkages of the sensing body emerged from applying the theoretical approach to direct engagement of embodied mapping with residents. The process helped me develop a robust toolset that captured real world site data that mattered to residents through the photogrammetry technique, sense based knowledge, and spatial considerations that linked to the architectural sequence of morphological (associated meaning based) significance of the site. I hope future researchers will find it equally helpful.

The theoretical findings helped me position this work in the evolving medium of VR, within the context of larger trends. Understanding posthuman perspectives (Barad, 2007), and particularly about how tools evolve with human bodies (Hayles, 1996; Morie, 2007) brought my choice to work with VR as an embodied medium, into alignment with the research in to the human body relating to its environment. It was the moment where I found resonance between my own research and design passion and the social and technological environments that we as designers are now trying to understand. An environment where digital tools we create draw on

hidden or emerging perspectives that as designer psyche and tools seek to co-exist. Do the tools demand new ways of creating or the experience we seek demands new tools? or is it some mix of both? The answers lie in the journey.

The sensory ethnography practices presented a variety of knowledges 'cut's that redefined the experience of the urban site: multisensory drivers like visual-proprioceptive-olfactory modules that signify the necessity of trees and grass, visual-cognition dominated knowledge triggers like sense of belonging created by seeing other people of color in the area, and much more found in Chapter 3. In a design context, the way in which the knowledge emerged through knowledge producer sharing demanded that the conceptual design reflected the ethical handling of knowledge sharing and the complexity of the mind-body-environment dialogues of becoming. Ethical design of VR is a currently debated in academia and practice, and I hope this example can inform way future design of VR spaces.

Using sensory ethnography to capture the nuanced and elusive nature of embodied knowledge was challenging because some knowledge producers tended to avoid articulating knowledge of the sensing-body, diverging instead to logical analysis of situations and social dynamics. This is an unsurprising reflection of how dualist patriarchal influences work and promote the logical mind vs the feeling body. We are often discouraged from using their bodies to communicate or gauge experience, and listening to emotions is not always acceptable in social and professional contexts. These norms still prevail in parts of most societies today. My use of body centric methods that expected knowledge producers to visualize, feel or name bodily sensations made some of them self-conscious. Further reflection on phasing this type of body work in to research practice would be interesting to explore in future work.

Reflecting on what Hayles (1996) refers to as the posthuman challenge of merging of wetware and science/logic worlds of technology, the sensory ethnographic process revealed that, in some ways, this trajectory in experiential design is a return to remembering the body of the past - how the body through history developed in symbiosis with the environment it inhabited (Abram, 1996). Pre-Anthropocene practices that hold value in Indigenous traditions the world over, where the body is used as a richly nuanced site of knowledge making, is coming back to the center of the design stage. This research led to identifying sensory categories that defy typical sensorial classification like the sense of linkage to spaces beyond the peripersonal space like 'feeling' the linkage to greenspace beyond sight gives a sense of contentment. These explorations of large scale body to space ratios can be explored in future research.

This reflection also raises questions as to what the posthuman body can evolve into as it entangles with immersive design spaces. This project used immersive and interactive virtual reality space as opposed to 360 video, resulting in my spending time with worldbuilding in the Unity's 3D environment and time spent testing the work in the immersed space of the VR headset. For me, this immersion in virtual design spaces, through the computer and the headset, influenced my motor skills after extended use. I found myself trying to access 3D views of 2D screen surfaces after I spent hours using the mouse to manipulate 3D models in Unity. My body was already responding to a perceptive shift and extended time using the VR headset while editing the scenes made me feel disoriented with the real-world for the first 20 minutes after a long development session. These observations point to the need to investigate how the body is managed after and before immersive tool use. They also hint at ways these interactions can be managed in mixed reality workspaces.

The experience of designing in virtual reality tested the medium's capacity to use this embodied presence as way of presenting embodied knowledge from one body to another. Materiality and

animation was designed to ensure the immersed environment reflected the sensuous and dynamical nature of embodied knowledge as its meaning shifted subjectively. The game mechanics enabled ethical knowledge sharing practices by creating access levels to users. This also reflects how the ethnographic research process is way to seeking access to intimate knowledges others hold. As a design process, the layers of knowledge were presented as layers of immersed sensitization on what matters to the embodied self in a spatial setting.

The design brought sensory knowledge into a digital design space, hoping to influence the perception of an urban site. From feedback from users, this immersive quality was powerful but further research with users could, and should, test the impact of presenting sensory knowledge.

Challenges of the VR medium

Though the VR medium lends itself to the presentation of embodied spatial knowledge, in this stage of development is not a fully accessible technology platform. Designing interactive VR experiences like *bodies-cities*, and its future iterations which require more complex layers of tool-like functions, requires a level of coding knowledge that requires time to acquire or financial resources to access. Without this knowledge, the presentation of embodied data that has spatial significance becomes limited to individual or emerging designers or smaller teams. The medium of VR has few templated applications that can be accessed by designers new to the medium and those that do not have computing capacity within their teams. This is a limitation that can benefit from work on developing accessible VR storytelling and design tool templates, or more collectives of artists and designers working with those who possess computation skills.

For the presentation of knowledge in a participatory manner, the limitations of using specific computers that can handle VR equipment is gets in the way of flexible time management

between community knowledge producers and designers, and restricts the flow of the design process. Ideally a participatory design process within VR would be ideal for the materializing of embodied site knowledge with the VR design space. VR's tendency to cause dizziness and nausea gets in the way of full participation by all participants, and though this did not occur with the two participants in this study, it may place limitations on further research with a larger research sample.

The cost of equipment can also be a limitation that impacts experimentation during the design process and access to the medium in general. Access to computers that are compatible with VR headsets, which need higher computing capacity, is costly and there are few spaces in Toronto where emerging artists and designers can access equipment for reasonable costs, or any cost at all.

Based on these reflections and discoveries, I hope to explore some of the future research and prototype development pathways explained in the next section.

Future Directions

The work completed in this thesis is one phase of work within a research pathway for integrating embodied urban spatial knowledge to design inclusive urban spaces.

Improving the Current Prototype

To enhance the effectiveness of the prototype as it relates to public architecture, I plan to expand the experience to include the embodied experience of two other residents and work on the related changes to the VR design space. This includes consolidating the embodied

knowledges into spatial use patterns that relate to a larger geographic range beyond the St. James West Park, and to include new layers to include the experiences of two other residents. The work will also require a conceptual res-design of virtual interaction based on what an architectural sequence would typically 'draw' when conducting site analysis. I also intend to experiment with spatial audio in the prototype to increase the immersive experience. The embodied mapmaking function currently maps the location of the user's body in VR space but I hope to get the map to present patterns that indicate the duration of time spent, and allow for feedback in VR on why they spend time in that part of the VR space. This can lead to other explorations for using VR as a spatial quality measurement that can help designers gauge urban resident preferences.

VR tools for conservation and immersive therapy

Beyond this enhancement of current work, the future research pathway can evolve in a few other ways number of ways. One options is to create virtually immersive greenspace or memory spaces that users can enjoy as immersive virtual therapy. This would require a detailed photogrammetry layer that can replicate real world green space that reflects the real world experience of flora and fauna. There is also the potential to use the techniques of photogrammetry and immersive experience design for conservation of ecological sites we may lose to climate change and urban development.

VR tools for human experiential data in generative design

Another area I may like to explore is a research creation pathway that incorporates embodied site knowledge into a tool that can aid the design of public architecture with emphasis on sensory design factors. With the increasing interest in generative design where algorithms, fed by

multiple spatial design factors, generate multiple design options (Gerfen on the work of David Benjamin and The Living, 2018) it would seem important to understand where and how the embodied experiences can be included in such workflows. For this, the research pathway may have to take into account the types of tools that exist with similar intent, such as VR-EP Dementia - Virtual Reality Empathy Platform (2017), and other tools that may exist in architectural design houses as aids to sensory architecture practice. This research pathway also allows for experimenting with other ways of presenting architectural sequences that relate to urban sites in modern cities. In my case, I am interested in integrating the design knowledge related to human need for flora and fauna, and for sensory stimuli emerging from public spaces and architectural structures. This pathway also requires an investigation into conceptual template creation within VR design space, focusing on how they can include community participation and replication of VR design concepts without reliance on a team of technical experts that modify work at each stage of a process that continuously translates embodied user knowledge into public architectural design stages. Studies on creating ready-to-use conceptual models in VR environments (Troyer, O, Kleinermann, F, Pellens, B, Wesley, 2007) have explored what challenges lie in templating VR environments but I would like form a partnership, with an architectural research or design house, to explore how that kind of conceptual templating can work for embodied knowledge in sensory public architecture, in ways that allow flexible ways of working with emergent knowledge like that of sensing bodies in urban contexts.

With 2018 set to witness the launch and growth of mobile VR devices that offer spatial planners more freedom to design onsite with local stakeholders, and offsite, and with research underway to include other Big Data and IoT in VR (Chaos Group Report, 2017), the development of tools that can be with for greater stakeholder involvement in experience based design space ripe for exploration.

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Appendices

Appendix A: Glossary

Affordances: the qualities or properties of an object that define its possible uses or make clear how it can or should be used.

Agential realism: Agential realism reformulates "agency" and "realism" to understand the dynamics between human and nonhuman factors in the production of knowledge. Agency is the enactment of iterative changes across matter that creates what we perceive to be 'real' (Barad, 2003).

Cartography: Practices, processes, and discipline concerned with transforming and representing a real world in a mapped form (Perkins, 2009).

Corporeal: having, consisting of, or relating to a physical material body.

Embodiment: the integrated relationship between mind, body and environment

Intra-action: Intra-action refers to how each relata (subject or object) are defined by the dynamics among them (there can be more than two). Intra-action differs from inter-action by not assuming the properties/boundaries of each relationship is determined prior to the intra-acting (Barad, 2003, 2007).

Matter: commonly considered a substance but in this thesis, matter is performative. It (re)produces itself through (intra-active) dynamic relationships (Barad, 2003).

New materialism:

Performance: Doing action and work.

Performativity A non-foundational approach to the production of identity, grounded in action and practice (Perkins, 2009).

Phenomena: ontological units that are building blocks of reality; these units intra-act to create reality or the real world as we understand it. Phenomena are dynamic topological reconfigurings/entanglements/relationalities/(re)articulations of the world.

Place: the perception of a site created by emergent patterns of meaning. In this study, it is experience constituted through “a function of the performance of objects, not just of patterns of social behavior; it exists as a consequence of the entanglement of people, nonhumans, material objects, ideas, norms, and technologies.” (Lieto, 2017)

Real world: the non-technologically presented world.

Reality: is not composed of pre-determined understandings of things. Reality is composed of things-in-phenomena (see phenomena). Reality is (re) produced through intra-action (Barad, 2003).

Sensory ethnography: Qualitative methodology based on in-depth field-based contextual research (Pink, 2009).

Sensory: A sensory body is simply one that belongs to sensation.

Site: a physically marked section of a geographic region

Urban: of, relating to, characteristic of, or constituting a city. Also in this study it considered a process, not a form, that emerges as crystallizations of “temporary materializations of ongoing socio-spatial transformations” (Brenner and Schmid, 2015).

Virtual world: world simulated through technology.

Virtual reality: reality simulated through computation (Heim, 1993).

Appendix B: REB Invitation/Consent Form



November 23, 2017

Mr. Nick Puckett

Faculty of Liberal Arts & Sciences & School of Interdisciplinary Studies

OCAD University

File No: 101122

Approval Date: November 23, 2017

Expiry Date: November 22, 2018

Dear Mr. Nick Puckett, Ms. Manik Perera Gunatilleke,

The Research Ethics Board has reviewed your application titled 'A Sense of Place: Understanding the sensory entanglements that influence placemaking'. Your application has been approved. You may begin the proposed research. This REB approval, dated November 23, 2017, is valid for one year less a day: November 22, 2018. Your REB number is: 2017-53.

Throughout the duration of this REB approval, all requests for modifications, renewals and serious adverse event reports are submitted via the Research Portal.

Any changes to the research that deviate from the approved application must be reported to the REB using the amendment form available on the Research Portal. REB approval must be issued before the changes can be implemented.

To continue your proposed research beyond November 22, 2018, you must submit a Renewal Form before November 15, 2018. REB approval must be issued before research is continued.

If your research ends on or before November 22, 2018, please submit a Final Report Form to close out REB approval monitoring efforts.

If you have any questions about the REB review & approval process, please contact the Christine Crisol Pineda, Manager, REB secretariat.

If you encounter any issues when working in the Research Portal, please contact our system administrator.

Sincerely,

Nancy Snow

Acting Chair, Research Ethics Board

Appendix C: Sensory Ethnography Interview Questionnaire

Project: bodies-cities

Interview Questionnaire 2: Interview with knowledge producers on Site

Process Guide Notes

- a) This interview is conducted on site, with the knowledge producers(participants), after a walk-through areas lead the researcher through.
- b) This is a semi-structured interview and the following considerations will be taken into account:
 - Flow of information gathering may not be easy to control with a precise question flow, particularly given the entangled nature of the topics of social, perceptual, ideological, political and ecological implications.
 - Past experiences with similar communities and age group revealed that people are used to certain forms of storytelling and tend to take the narrative flow in certain directions that the knowledge producer prefers. Digging for more information must not interrupt the flow of the oral history.
 - Key points to be covered are addressed in the questions below.
 - Outreach Conversation 1, with the knowledge producer, established the identification of a site.
 - Review the use of simple language and explore the use of local language terms to define the key concepts of sense/sensory/emotion/affect/feeling.

Before we start, I would like to remind you that:

This project is supported by the St James Town Community Corner and Wellesley Community Center, however, please be aware that this is a voluntary study conducted with your comfort in mind. We understand people can change their minds due to various reasons so please know that you are free to leave this project at any time. You only need to let me know and there will be not judgement or repercussions. We will ensure your data is removed from all project documentation.

All your information, other than what is included in the final work, will be deleted at the end of the project anyway.

A. Establishing a connection: reconnecting with the knowledge producers

- a) How are you today? Did you have any trouble getting here?
- b) Shall I share the plan for today again? (establish scope of today's work and recap the process so far)

B. Experience of a site

I. Perceptual Implications (we begin with how the site feels to the knowledge producer)

- a) How did you first find this place?
- b) What attracted you to it?
- c) What particular aspects make you enjoy/ like it more?
 - If they share particular details, ask probing questions related to any physical sensations experienced such as: How do you feel when in these areas? Can you describe them? What you like or do not like. Probe in the following areas if the knowledge producer is unable to articulate how they feel.

I. Related Ecological Questions

- a) Skin feel: air, touch sensations, any kinetic responses (how the body feels within the space)
- b) Visual: how the spatial dimensions influence how they feel, shape and texture of forms used, colors, relation of objects to space.
- c) Audio: sounds of nature and implications to the knowledge producer.
- d) Smells: the types of smells that they like/do not like in the areas they like/don't like
- e) Taste: do you feel there is any taste related associations with this activity/area?
 - ii. Why are these important to you?
 - iii. Do you know anything about the history of this area? Is it important, and if yes, why is that?
- f) How does it make you feel?
 - i. Emotions felt can lead to other details of sensory stimuli.(ask for details depending on clarity of answer)
- g) Does it remind you of any other place you enjoyed/was important in your life?
 - ii. How are they similar? (ask for details depending on clarity of answer, entry point to ask about the ideological, sociological, and political implications)
 - iii. How are they different? (ask for details depending on clarity of answer, ideological, sociological, and political implications)
 - iv. Why do you think that is?

II. Social Implication Questions

- a) Do you meet others here at the site? Are they from your community? Whether from within the community or not ask:
 - I. If so, did you expect to meet people here at a site in this manner?
 - II. Is it important to mingle with others?
 - III. Are there events here that you like and participate in? Are there ones you do not like?
 - IV. What do you like about it? What do you not like about it?
 - V. Do you think the way the site looks and feels makes a difference to these interactions with people?
 - What visual and layout aspects?
 - What feelings specifically?
- b) How does visiting this site make you feel about your place in the family / community?
 - a) Dig for more information based on answer, what events or people influence the:
 - I. possible tensions/ new experiences
 - II. gain of purpose/ loss or gain of status

III. Ideological and Political Implications

These can be related to the social questions above.

- a. How do you about community management processes, the role of the government, other influencers like urban developers (constructing new structures)?
- b. How you feel about changes in the area, city? Changes you wish to see?

Appendix D: Exhibition

Description

The *bodies-cities* virtual reality experience is an interactive multi-stage exploration of an urban site, the Western edge of St James Town in Toronto, including the park and relevance of surrounding areas. The experience uses an Oculus Rift headset to take each user, one at a time, on a short walk while immersing the user in the sensory embodied experiences of a resident/s who will share their experience if they pay attention to the sensory cues within the VR scenes.



Figure 29. bodies-cities VR exhibit at DIVERGE Exhibition



Figure 30 Visitors testing the VR prototype at the exhibition

Appendix E: Diagram References

1. **Diagram 23 image textures are sourced from free to use samples here:**

<https://www.pexels.com/search/space/>

<http://www.tourvideos.com/Images/maps-big/Holland/Holland.jpg>

<http://www.tourvideos.com/Images/maps-big/Holland/Delft.jpg>

2. **Ethiopian scene image bought through a subscription from Dreamtime. Receipt image attached below:**

My Invoices

This section provides details about the credits packages you acquired so far. Click the links under the Method column for printable invoices.

Date	Purchased Plan	Units	Package value	Payment Method	Invoice
03/28/2018 18:57	Subscription 5 images/month Mar 28, 2018 - Apr 23, 2018	1	CS\$0.00CAD	Credit Card	View Print

Showing 1 - 1 of 1 records