Intangible Narratives;

An investigation on immersive architectural visualisation in VR.

By

Kar Wing Leung

A 120-point thesis
submitted to the Victoria University of Wellington in partial fufilment of the requirements for the degree of
Master of Interior Architecture

Victoria University of Wellington
School of Architecture

2018

ACKNOWLEDGEMENT

First and foremost, i would like to thank my family for their unwavering support for me through these five years.

To all my awesome friends, i wouldn't have made it without you guys. You guys are truly the best, residents and VR-room crew and all. Thank you for all the fun and cool bants over the years.

Lastly, a special thanks to my supervisor, Tane Moleta, who brang in his really fluffy samoyed that one time. Oh and for all his guidance, discussions and support over this past year as well.

Figure_1.
Final immersive environment screenshot

ABSTRACT

Within the current context of digital architectural construction and immersive representation exists a problem of 'ocularcentrism' as defined by Pallasmaa. Recent immersive developments such as Google Earth VR, or Realities.io, focus primarily in working within the tangible experience, purely emphasising on geometric forms and physical artefacts. They largely ignore the more experiential and intangible qualities of space, which are crucial elements in a real embodied physical experience of architecture. Phenomenologists such as Pallasmaa, Holl, and Zumthor expand on this, identifying that architecture clearly exists as something beyond just the tangible. Architecture fundamentally is an experiential and spatial art, incorporating not just the geometric sense of space but also aspects of the intangible such as sound, movement, lighting and interaction. As a result of this tangible-bias, virtual-reality's current use within architecture as an immersive medium is largely limited. Most developments can be described as 'an immersive virtual photograph' of architecture rather than an experience of one.

This research is a response to studies that directly address the problem of 'ocularcentrism' while also exploring the methods and techniques that can translate intangible qualities into virtual architecture. Utilising a Real-Time Virtual Environment (RTVE) and Virtual Reality (VR) tool set, this paper virtually reconstructs the case study of the Kowloon Walled City. It proposes a novel working methodology for immersive architectural visualisation with VR and adds to the on-going research in the field of phenomenology within architecture.

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1.0

INTRODUCTION

1.1 Research Question

What are the design methods and techniques that can effectively engage experiential and intangible qualities to lead to a more immersive architectural representation?

1.2 Scope

This thesis does not sit in the topic of critiquing architectural-visualisation in terms of conceptual applications such as pen and paper. It is addressing distinctly the problem of architectural-visualisation within the realm of immersive technologies (such as AR/CAVE, and more specifically VR). It looks at VR and RTVE's as a medium that has the potential to facilitate completely new immersive user experiences within the virtual, and how to unlock that potential. Even though the thesis reconstructs a built-environment, a 'final building' is not the end goal of this thesis. This thesis distinctly looks at novel methods and techniques that can utilise a RTVE and VR platform to create embodied architectural experiences. As a result, the output of this thesis is a working methodology or research about the viability of certain toolsets and techniques within that idea of immersive embodiness. In short, it is how to transpose a 'Pallasmaa' model of plasticity within a virtual experience of architecture.

1.3 Preposition

Architects and interior architects are masters within the domains of physical space. Architecture is a spatial art the engages the totality of the human senses, thinking and existential experience within the physical realities of the built-environment. Film, or narrative placemakers are masters of virtual and imaginary space. Interactive media excels in the submerging of our psychological state into other realities, with such a control over our feel of interaction, immersion and presence. In the advent of the contemporary, and as a result of new technologies, real space is moving towards becoming more virtual (augmented-reality/big data), and virtual space towards becoming more real (virtual-reality), creating a new mixed-reality paradigm. Architecture and interactive media, which once largely sat outside of each others canvas of design is quickly coalescing to inhabit the same space of mixed reality.

As a result, architecture seems to be at a point where immersion, atmosphere, narrative and presence are quickly becoming a central focus for design, within the built and virtual (Castle, 2014). Likewise, as the medium changes from screen to a mixed reality, interactive media is quickly realising this need to design space with the entire bodily experience in mind. This thesis therefore hopes to sit somewhere at the intersection between both of these disciplines, not traditionally in one or the other but as a hybrid of a mixed paradigm. It explores the methods and techniques used in interactive media for creating immersive experience and postulates how they can add to the discipline of architecture and vice-versa. As the relevance of new immersive technologies (VR and AR) become increasingly prevalent within these practices, a novel design method, one that incorporates techniques and thinking in a multi-disciplinary way is needed.

1.4 Problem Statement

Architecture is fundamentally the multi-sensory experience of space. Inhabitation of space is not just about the engagement of of sight, but also of the haptic, acoustic, tactile, and intangible. In "Sensing Spaces" Kuma writes, "All the senses are important in our experience of space. It's not about engaging individual senses but more about the whole atmosphere you want to create. ... It's the opposite idea from the building as an object, which to me means the kind of architecture that has been designed to look spectacular in photographs! Photographs can only capture a fixed visual image, whereas for me architecture is about the whole experience of space. This can include touch or smell - anything that offers a special connection." (Kuma, 2015). Mark Wigley (1998) also proposes in "The Architecture of Atmospheres", that the central objective of architecture could possibly be to create atmospheres rather than objects. He states that, "...in the end, it is the climate of ephemeral effects that envelops the inhabitant, not the building. To enter a project is to enter an atmosphere. What is experienced is the atmosphere, not the object as such." (Wigley, 1998). As a result, architecture arguably is and should be, designed around experience and the intangible consideration. According to Rasmussen (1962) in "Experience Architecture", he describes that "the true qualities of architecture are not geometric and formal, intellectual or even aesthetic, as they are extensional, embodied and emotional experiences that come from an individual's existential encounter with the material Rasmussen, 1962)." "By common consent, the Parthenon is a great work of art. Yet it has aesthetic standing only as the work becomes an experience for a human being … [A]rt is always the product in experience of an interaction of human beings with their environment (Rasmussen, 1962)."

Yet within the contemporary and in the advent of modernist culture, architecture in its built-environment and virtual condition, is a practice that has become dominated by a reverence for the ocular and tangible form, often undermining the more sensual and intangible aspects of architectural experience. In his text "The Eyes of The Skin", Juhani Pallasmaa (1996) writes about this phenomena:

In his text “The Eyes of The Skin”, Juhani Pallasmaa (1996) writes about this phenomena:

“The Ocular bias has never been more apparent in the art of architecture than in the past 30 years, as a type of architecture, aimed at a striking and memorable visual image, has predominated. Instead of an existentially grounded plastic and spatial experience, architecture has adopted the psychological strategy of advertising and instant persuasion; buildings have turned into image products, detached from existential depth and sincerity.”

This problem in particular can be seen perpetuating within the digital and virtual contemporary of architecture. The emergence of new technologies such as RTVE’s and VR , have enabled the potential to engage with architecture in a highly-immersive experience. However, most of these virtual experiences [Fuzor/Google Earth VR] fall well short of this potential as a result of an ocular and tangible fixation. As Pujol (2012) outlines in the context of virtual-architectural heritage:

“According to recent definitions (Papeet al. 2001, Roehl 1997, Roussou 2002), experts in virtual heritage had–until quite recently–established the reconstruction of tangible elements (artefacts, buildings and landscapes) as the principal aim of virtual heritage. Yet this takes into account only a small portion of human culture, and ignores the expressive and interpretative potential of VR as a form of interactive digital media. “

Recently however, there has a been a new realisation that architecture is a form that facilitates not only functionalism but, importantly, also engages on a sensual and intangible level; a relationship between our bodies and the surrounding space. As outlined by Philip Ursprung in the book “Sensing Spaces (2015)”, “It seems we are becoming aware once more that the relationship between ourselves and buildings can no longer be merely visual. We are not just a pair of eyes floating through space; we have bodies, senses, emotions, expectations and memories (Ursprung, 2015).” As a result of this new realisation , it has become apparent that there is a want and a need for architecture and ergo for architectural visualisation to become a more intangible, immersive and holistic representation of an embodied experience. .

CHAPTER

2.0

THEORETICAL CONTEXT

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2.1 Introduction

This literature review identifies what the key intangible and experiential qualities are within architecture, and how people experience them. It also identifies why the consideration of cultural design intent and narrative design are crucial in the creation of immersion, presence and an embodied architectural experience.

2.2 What is 'Intangible Experience'

It is difficult to define the meaning of 'intangible experience', a plethora of well-established theoretical topics already cover similar ideas in depth - phenomenology, ma, spirituality, affect. Atmosphere is also a commonly used word to describe this phenomenon. However unlike atmosphere with its etymology within physics, or any other term, 'intangible experience' perhaps best describes in clarity the phenomenon that this thesis seeks to represent - in short, the resonance of something metaphysical that evokes a visceral bodily connection to space.

So what is this something, what is this intangible experience in architecture? Fundamentally, it can be dissected as two key mechanisms - the identification of the former, the 'intangible' (what does the intangible refer to?), and the definition of the latter, 'experience' (what does experience mean?). The third mechanism is the relationship between the two. This is critically important as well. Similar to the Japanese concept of wabi-sabi, one concept can not exist without the other. There needs to be something there to create experience, likewise the intangible needs the former, a body, a container, to observe it.

2.2.1 The First Mechanism; Defining the intangible

Intangible according the oxford dictionary is defined as :
" 1. Unable to be touched; not having physical presence.
1.1 Difficult or impossible to define or understand; vague and abstract."

By its very definition, the word is highly ambiguous and subject to personal opinion and subjectivity. It is therefore perhaps better to think of intangible as not a word that can pertain to a singular meaning, but as a larger idea and concept of thought. Wigley discusses this, identifying the intangibilities of space as a multi-faceted object/concept rather than a singular paradigm, "It is some kind of sensuous emission of sound, light, heat, smell and moisture (Wigley 1998)". In a more explicit breakdown, Zumthor (2006) in 'Atmospheres' also identifies the intangible in a similar vein - as something more than a sum of its singular parts. He proposes that there are nine key operators within architecture that make-up the intangible.

The first is titled **"The Body of Architecture".** The material presence of things in architecture, its frame. This is geometry or form within architecture. The second is "**Material Compatibility"**. This is the relationship of how materials relating to one another can create something unique. The third is "**The Sound of a Space"**; the acoustic resonance of architecture. Fourthly is "**The Temperature of Space"**, the endo/exothermic reaction of the body to space. The fifth operator is titled "**Surrounding Objects".** Zumthor defines this as the relationship of our body to others and the sense human activity in space. The sixth item is named "**Between Composure and Seduction".** It has to do with the way architecture involves movement. It identifies how architecture is a spatial and temporal art, one that importantly involves the aspect of time.

The next is "**Tension between Exterior and Interior"** - these are the thresholds that exist between spaces in architecture. In this operator however, there is an ar-

-gument that rather than just simply thresholds, Zumthor is alluding to something far greater - the idea of interaction in space. Thresholds are inherently actions of doing and are unable to exist without states of transience - a state of before and after and the perception that a change has happened. This change can't happen unless an action has been taken. The action can be physical however, - "The way architecture takes a bit of a globe and constructs a tiny box of it. Suddenly there's an interior and exterior" (Zumthor, 2006), or it can be metaphysical, like the despotic ring of a door bell sound. As Teysott (2005) describes, the threshold is a zone. Change, passage, and ebb and flow are embedded in the word schwellen ['to swell']. Therefore in the same way, you can argue that within architecture, thresholds are simply the result of interaction occurring - whether it be when you turn a door handle, or cross a boundary, thresholds are ultimately just devices that the body uses to create a sense of change within space.

The eighth operator is "Levels of Intimacy", in which Zumthor speaks about the resonance of mass, size and gravity within objects and their relationship to the body. Finally, Zumthor speaks in depth about light and shadow, with his chapter titled"The Light on Things", which simple describes the way light falls, reflects and moves across a building.

The key operators of the intangible, or what intangible is, could be identified as this: [Geometry, Material, Sound, Temperature, Inhabitation, Movement/Time, Interaction, Scale, and Light.] Mood and emotion in space are also aspects that are often brought up when atmosphere or the intangible are described. To add to a .

The eighth operator is **"Levels of Intimacy",** which speaks about the resonance of mass, size and gravity within objects and their relationship to the body. Lastly he speaks about light and shadow, titled simply as **"The Light on Things"**; the way light falls, reflects and moves across a building.

Therefore, the key operators of the intangible, or what intangible is, could be identified as this: [Geometry, Material, Sound, Temperature, Inhabitation, Movement/Time, Interaction, Scale, and Light.] But what about mood or emotion in space? These are aspects that are often brought up when atmosphere or the intangible are described. To add to a pre-position, while mood and emotion could well be classified as an intangible of spatial experience, it perhaps sits more in the other

2.2.2 The Second Mechanism; Perception and Experience

Within architecture, there are perhaps two key parts that make up what 'experience' means. Firstly, it is the question of how we experience, and secondly are the mechanisms to which we use to experience. To extrapolate, the former can be explained as the way of how experience occurs, or the act of perceiving space and cognition. The order in which the moments of perception happen can be proposed as occurring within four stages - 1. The preemptive expectation of a space, 2. The initial impression of the space, 3. The conditioning/affirmation of the space, 4. The memory of the space [Fig 2].

Figure_2.
Diagram showing how humans experience space.

Architect's are overtly aware of this link between the different stages of perception - "If you put students in a certain type of space they will be expected to be fed, if you put them in another kind of space they will expect to be challenged. Space prepares you to receive or respond" (McNamara, 2014). Zumthor also talks about these moments of perception in the context of architectural experience, "I enter a building, see a room, and - in the fraction of a second - have this feeling about it" (Zumthor, 2006). The second part of experience can be

explained as the tools which we use to perceive. Traditionalism suggests that humans use five main senses to perceive space - the ocular, the acoustic, the haptic, the sensation taste and the sense of smell. But as Pallasmaa discusses, it is often just the ocular that is considered within architecture.

The problem is the relationship between the two, of how we perceive and what we use to perceive that has become fundamentally broken within architecture; that while architects are keenly aware of the differing stages of perception within space, there is a lack of consideration for how the other senses can contribute to cognitive perception and immersion. According to Pallasmaa, the lost occupation of creating meaningful connections within architecture outside of visual considerations has lead to a loss in plasticity within the discipline as he defines it (Pallasmaa, 1996).

2.2.3 The Third Mechanism; Immersion and Presence

Immersion and presence within architecture can be defined as the sum result of the former two mechanisms and their relationship. It is the cognitive understanding of a human having an awareness of their own surroundings. To say something is immersive, or to feel present, is to say that an intangible experience or atmosphere has been created/perceived. The difference between a low level of immersion and a high level is how connected that person feels towards a space. This is what Kuma perhaps refers to when he states his architectural objective is creating ‘a special connection’ within his work (Kuma, 2015). As a concept, presence comes from the the term ‘telepresence’, and has been typically defined as the capacity to which an environment has in making the user feel transported into another place and be able to efficiently interact with it. As a result, presence is a very complex and even ambiguous construct, Riva describing that it is a product of an individual’s mind, and as a result highly likely to vary depending on an indi-

-vidual's perceptual-motor, abilities, mental states, traits, needs, preferences and experience (Ijsselsteijn, Riva, 2003). Like Kuma, Slater simply defines the term ambiguously, as a notion of 'being there' (Pujol, Champion, 2010).

Therefore, while mechanisms of the intangible and perception serve in the creation of a complete embodied architectural experience, how immersive that condition is, highly depends on subjectivity and is largely ambiguous. That is not to say that designers and architects don't have an ability to influence this. Coming back to the idea of controllable qualities, while personal feeling and emotion is something largely outside the control of designers, design intent and the representation of cultural considerations is not. Culture can be said to be another intangible quality of space, however unlike emotion or feeling, how designers choose to represent culture; whether through light, form, interaction or acoustics, are aspects that can carry a designed intent. Mantovani and Riva discuss this, proposing that culture and the representation of culture in mediums has a significant effect in the creation of immersion and presence. Within this view, experience, presence and telepresence does not depend so much on the faithfulness of the reproduction of 'physical' aspects of 'external reality' as on the capacity of simulation to produce a context in which social actors can be communicated (Mantovani, Riva, 2000). Ijsselstein and Riva in the paper "Being There: The experience of presence mediated environments" conclude that success of creating presence lies within cultural codes of social interaction, explaining why even poor-sensory environments such as text-based virtual environments, such as MUDs (Multi-User Dungeons) or novels can still speak to creating a sense of immersion and presence (Ijsselstein, Riva, 2003).

2.2.3b Culture; Subject vs Object

As established previously, the two mechanisms of the tangible/intangible, and perception,, work to create an embodied architectural experience. However, the question of which aspect, the subject[perception] or the object[intangible/tangible] is the centric mechanism within this relationship, is vitally important in the context

of design intent and culture and ergo immersion. To extrapolate, the question is whether it is the intangible experience[atmosphere] that exists first, then it is perceived by a person[object-centric], or if it vice versa, that the intangible is created after perception[human-centric]. The answer is important in the context of architectural construction and representation, and from a standpoint is largely culturally dependent. For example, in Western culture, in face of modernism, the former of the object-centric is the dominant culture. Modernism as described by Eisenman was an attempt to create separation between the subject/object relationship and "have the object refer not to a reading subject, but to its own condition of being." (Eisenman, 2007). Wigley when he refers to the creation of atmosphere also proposes the object-centric, "it surrounds a building, clinging to the material object. Indeed it seems to emanate from the object….the atmosphere of a building seems to be produced by the physical form." (Wigley, 1998)

However, within Eastern cultures, or specifically the cultures of Japan and China, the opposite is true; the human centric ideal being the main cultural psyche. For these two cultures, the idea of architecture as a mode of a human experience, is far more ingrained within their architectural roots, and vernacular traditions. Nowhere is this more exemplified than with the Japanese concept of 'Ma', meaning space or sense of place in Japanese. As explained by Kengo Kuma, "In traditional Japanese architecture the most important space is the void. We call that kind of void space, the void 'Ma'. In the void we can feel the change of light, the change of time, the change of smell, the change of temperatures….void is a sensor. The void and the human body are working together to feel something. In my architectural design, I always think - where is the 'Ma'? Where is the void? And if I can create void in my project, then the project is successful (Kuma, 2015)." Professor Thompson outlines, in his essay on 'Ma', that the idea of life and living being a flow of a changing paradigms, as ebb and flow, as a continuum, is key in understanding how the Japanese understand space. For the Japanese, the way they perceive space is in an almost primal sense, directly linked to the deeper tradition of how they understand life and how they understand living. "Life is seen as a process of ebb and flow, rather than as a series of events, it changes metaphorically just as nature does from season to season, age

to age, birth to death, in endless rhythms of renewal." Japanese ma, or space-time is not fragmented, labelled and contained like space in the West, but rather is an emptiness or void that gains its form only in relation to the unseen boundaries created by the activities that performed in it (Thompson, 1998). Likewise, Chinese culture too similarly echoes these ideas of ebb and flow within their understanding of space in architectural traditionalism, as exampled by Li Xiaodong,

"Chinese architecture develops from the idea that the building is something to be experienced from 'within'.....Space in Chinese tradition has been articulated within a defined framework that allows for reinterpretation in different contexts through the use of the imagination rather than logic….For the Chinese, an artificially created space is first of all cosmological and should be in harmony with the order of nature…. So within Chinese tradition, architecture is less about individual building forms than about how space is defined by the structures that surround it. It's a concept articulated by the ancient Chinese philosopher Lao Zi, who said that what is important is what is contained, not the container (Xiaodong, 2015)."

As a result, the idea of cultural appropriation is an important consideration within this thesis. The creation of immersion, presence and, ergo, the success of an intangible experience, within architecture and virtual representation, can be heavily influenced by cultural codes. This is not just the consideration of physical or social factors of presence such as forms, cultural clothes or interactions, but also the appropriate cultural design intent - this can arguably be seen as the most important factor. As the case study site (Kowloon Walled City) is within a Chinese antiquity, would a human-centric approach be more culturally appropriate? Or would an object-centric design intent be more suited because its a Western demographic?

"No doubt the way westerners think of space is different from the way we see it. When we speak about space maybe we mean only the perception we Japanese have of the western notion of space. We have the impression that for them what has been hollowed out of a rock, while for us it means emptiness, vacuity. It is what exists between two columns, the void to which multiple relationships can be agended. It's an empty space, a vacuum, nothingness (Ito, 2001)"

2.3 Narrative Design

The criteria for judging how successful each proposed design exploration will come from their ability to contribute to the creation of environmental immersion and presence as it was discussed previously. Film and cinema have had a long history in the creation of presence and immersive media, and one critically important design method that is often used within that is storytelling or narrative design. Joe Rohde, the Senior VP & Executive Designer, creative division at Walt Disney in his paper "Creating Narrative Spaces (2010)" calls this intersection of story and physical environments within space as 'narrative placemaking'. Like culture, the art of storytelling and the narrative design approach has always been tied closely to immersion. Janet Murray in her book "Hamlet on the Holodeck: The Future of Narrative in Cyberspace (1997)" proposes that the very definition of immersion is something that is distinctively narrative in nature, by stating that:

"A stirring narrative in any medium can be experienced as a virtual reality because our brains are programmed to tune into stories with an intensity that can obliterate the world around us…. The experience of being transported to an elaborately simulated place is pleasurable in itself, regardless of the fantasy content. We refer to this experience as immersion. Immersion is a metaphorical term derived from the physical experience of being submerged in water. We seek the same feeling from a psychologically immersive experience that we do from a plunge in the ocean; the sensation of being surrounded by a completely other reality….that takes over all of our attention" (Murray, 1997).

Within architectural theory, the relationship between architecture and the narrative aspects of storytelling and language has already been well established, with many key influential texts referencing this idea of a "poetry of space". These texts include Gaston Bachelard's "Poetics of Space (1957) ", Junichiro Tanazaki's "In

Praise of Shadows (1933); Alvar Aalto in his analysis of Fra Angelico's Annunciation in the essay 'From the Doorstep to the Common Room' (1926); and in antiquity, Vitruvius as he saw architecture's origins as the result of a social exchange of speech ("Questions of Perception; Phenomenology in Architecture", Gomez, 1994). aspects of storytelling and language has already been well established, with many key influential texts referencing this idea of a 'poetry of space' - Gaston Bachelard's Poetics of Space; Junichiro Tanazaki's In Praise of Shadows; Alvar Aalto in his analysis of Fra Angelico's Annunciation in the essay 'From the Doorstep to the Common Room' (1926); and in antiquity, Vitruvius as he saw architecture's origins as the result of a social exchange of speech (Gomez, 2014).

2.4 Conclusion

In conclusion, a holistic embodied architectural experience can be described as the intersection of two key operators:

1. Intangible experience. This is created from two working mechanisms, the defined tangible/intangible and the perceptive body that experiences. The intangible aspects of space can be defined as [Geometry, Material, Sound, Temperature, Inhabitation, Movement/Time, Interaction, Scale and Light.]. How we experience these intangible operators is through all our senses and through different moments of perception.

2. Presence and Immersion. This is a quantifiable effect that can measure the success of an intangible experience, or how connected a person feels to a space. To have a high level of presence and/or immersion is to have a highly successful and embodied intangible experience. This is highly subjective, and subject to personal opinion.

If judgement of proposed design iterations is going to be based off immersive performance, there needs to be a set method or techniques that can effectively do that in the face of subjectivity. As discussed above, the mediums of cultural design intent and narrative language could possibly be one effective way of doing this.

CHAPTER

3.0

CASE STUDIES

3.1 Sensing Spaces

Kate Goodwin, Kengo Kuma, Grafton Architects, Li Xiaodong, Pezo von Ellrichshasen, Diebedo Francis Kere, Eduardo souto de Moura, Alvaro Siza.
Royal Academy of Arts, 2014.
Installation/Exhibition

Sensing Spaces is an architectural exhibition conceived in 2014 by the Royal Academy of Arts in London. It tasked seven architects to reawaken visitors sensibilities to the space around them, and bring to fore the experiential qualities of within architecture. Through installation each architect explored what it meant to create a special connection to space. As Kate Goodwin (2015), the exhibition curator transgresses - "We often have a visceral response to architecture, perceived through the body and senses before uits rationalised by the mind. This response cannot be captured through a magazine cover or a single photographic image or text; we encounter a building in its setting, we move through it, we feel it, we inhabit it, alone or with others. Being physically, emotionally and psychologically aware of spaces that surround us and of our place within them could be described as having a sense of presence....The heart of the this exhibition is the interaction between three factors: the nature of physical spaces, our perception of them, and their evocative power."

While this thesis deals with material in a virtual realm rather than physical installation, the design intent and concept of thought is not unsimilar. The exhibition sought to create presence and a sense of immersion through architecture, an awareness towards a more holistic embodied architectural experience. "Today they[buildings] are created as a practical and rational response to a brief….But, arguably much of the richness of architecture comes from the multifaceted what our senses respond to it, from the way it catches our imaginations, and from its emotional impact on us. (Goodwin, 2015)". Within the exhibition, each architect used distinctively different tools, intangible and tangible to create their installation. Some focused on the use of light, others on scale and form, some held a reverence

Figure_3.
Kengo Kuma's installation piece in the "Sensing Spaces" exhibition

to touch and smell. What is truly remarkable, however, about this case study is that the architects featured are not only known for their prowess in engaging with the tones of the intangible and sensual, but they are also all from varying cultures and countries. Each installation differs from one another and each work shows a large influence from that architects culture. As prefaced in the literature review, culture seems to be a significant part of shaping design intent in the context of how each architect reacts to the brief of creating immersion, and a present engagement with space. For them, the most effective way to create a special connection to space was to seat the design upon their own cultural roots. For example, Kuma's installation clearly references back to the Japanese cultural ideas of ma, ebb and flow. The installation as he describes is experienced within two distinct stages, the first as the 'architecture of reality', then second as the 'architecture of the void'. "The sequence is important. When the visitors first enter the space, they can't understand it, but step by step they begin to grasp what is happening. (Kuma, 2015)". While for Diebedo Francis Kere, who originates from Africa, his installation reflects the culture of community. "Through architecture the whole community came together to share ideas and to help….I also wanted people to experience the installation collectively, to have a sense of flowing from a vast space. (Kere, 2015)."

3.2 Evaluating Presence in Cultural Heritage Projects

Laia Pujol, Erik Champion, 2012.
Interactive Media/Published Study

Erik Champion is an academic that specialises in the research of cultural and digital heritage within the virtual. His research engages heavily with the ideas of creating presence, immersion and engagement with culture and digital historical architecture. While there has been a significant amount of study, research and ground-work already surrounding the creation and what presence/immersion is within virtual environments, there has been little within the context of architecture. Champion's work is an intersection that sits between three mediums, the historian, architecture, and the virtual. As this thesis closely aligns to much of Champion's work, this thesis could be seen as an iteration or different approach that builds upon the large amount of groundwork Champion has already done in the field (relating to the use of immersive visualisation in an architectural context). One paper in particular that offers great insight is "Evaluating Presence in Cultural Heritage Projects" (Pujol, Champion, 2012).

Within this paper Champion and Pujol present three case studies of virtual heritage experiments. In context to them, they propose recommendations for how to conduct experimental design solutions and evaluation for virtual architectural content. They recommend that presence/immersion shouldn't be an end goal of design but just as a means of measuring design. "The primary goal of desigers is not to measure presence, but to depict, communicate and afford the experience of some (virtual) content through increased presence (Pujol, Champion, 2012)." When it comes to a method of evaluation, Pujol and Champion suggest that both quantitative and qualitative techniques are required. "For the purpose of evalua-

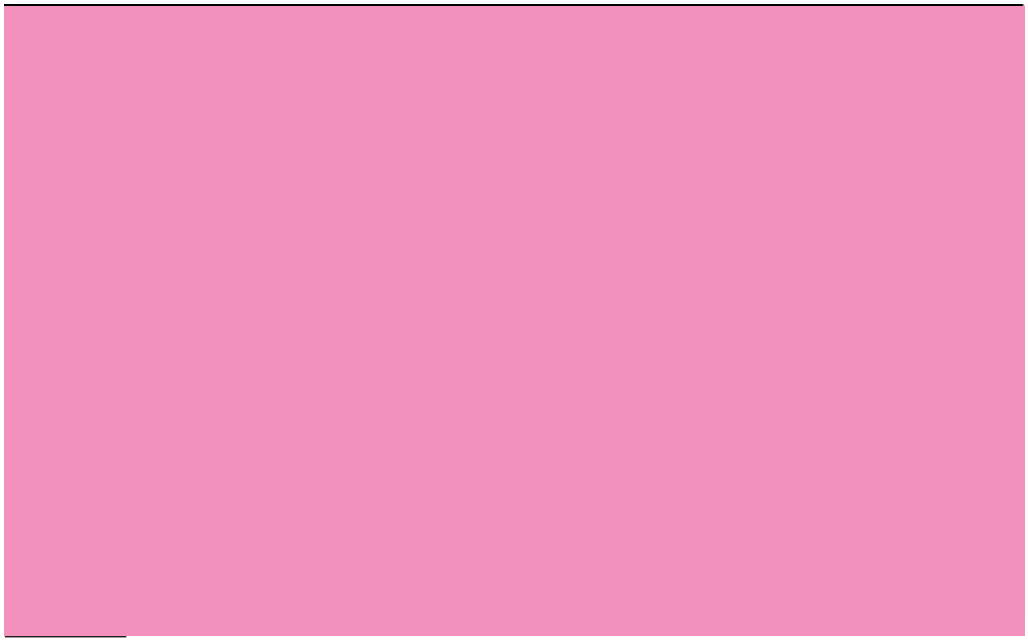


Figure_4.
Case Study 3, the virtual reconstruction of Rome.

and qualitative techniques are required. "For the purpose of evaluation, establishing a clear hypotheses on explicit quantitative data is needed...Both discrete and gestalt factors should be evaluated, as well as demographic details as pre-experience can be a powerful confounding factor (Pujol, Champion, 2012)." - This references back to the questions of cultural appropriation and a set narrative established in Chapter 2. And in terms of qualitative data; interviews, questionnaires and observations are recommended to be developed, combined with statistical and pattern data analysis.

3.3 Google Earth VR/ Realities.io

Google/Realites.io, 2017
Interactive Media/VR

Google Earth VR and Realties.io are two recently released immersive RTVE VR environments that engage heavily within the representation of architecture. Both environments utilised a 3d-scanning technique called photogrammetry to produce the interactable content. These two programs begin to show the power of a RTVE and VR environment in the realm of virtual architectural visualisation. They show that through the use of photogrammetry and 3d-scanning, combined with a RTVE and VR media, there is great potential for this technology to be used in the virtual preservation/reconstruction of built-architecture. However, while from a technical standpoint, both works show the immense potential of photogrammetry as a geometric and material creation tool for visual immersion, it falls short within the realm of creating an embodied architectural experience within their environments. As established in chapter 2, the creation of an embodied experience requires the consideration of multiple facets - these current environments focus purely in the creation of form and material to create immersion. They lack considerations of narrative, cultural intent, other sensual aspects such as sound and haptics, as well as other intangible operators such as movement, interaction and inhabitation. As a result, this thesis hopes to build upon Google Earth VR and Realities.io's proof of concept for VR and RTVE's being a viable immersive architectural tool.

Figure_5. (top)
Picture showing the Google Earth VR virtual environment.

Figure_6 (bottom).
Picture showing inside realities.io VR environment.

CHAPTER

4.0

METHODOLOGY

4.1 Aims and Objectives

A1. To aid in the understanding of immersion and presence within architecture with the use of intangible and experiential qualities.

A2. To explore a design framework and design methods that can effectively represent and engage people with the intangible and experiential qualities of architecture.

O1. To establish an effective working design method for virtually representing each specifically chosen intangible/experiential qualities.

O2. To identify criteria and establish a process that can evaluate the effectiveness and success of the explored design methods via immersion and presence.

O3. Begin to understand the relationship between architecture, immersion, phenomenological ideas, and new digital technologies.

4.1 Methodology

The major aim of this thesis is to explore whether certain workflows, design techniques and tools are effective ways to translate intangible aspects into the virtual. The desired outcome, therefore, is to propose a novel working method that can be either used a baseline for informing future designs or as a re-creatable workflow. This working method will include details of, a) a proposed workflow for designing, and b) a list of techniques and tools that are effective in creating intangible operators.

Fig 5. outlines the proposed workflow that is tested within this thesis. Within the context of this thesis, this workflow is named the **'intangible narrative approach'.** As shown, it outlines that once a context for virtual design/construction is chosen (in this thesis the case-study of the 'Kowloon Walled City' is used), the use of a narrative approach to define variables and criteria for design performance is then established. Once established, the design iterations are then created based off these variables and criteria. For this thesis, the narrative criteria set were real-life accounts, in-text citations and interviews from residents that lived within the Kowloon Walled City.

The next stage is to evaluate the design iterations against the narrative criteria set. This is accomplished through user-feedback. The technical knowledge of immersion and presence are used as the criteria to pull qualitative and quantitative data from. Qualitative data in the form of observations and anecdotes, quantitative in the form of statistical patterns. This gives some objective data that allows the designer to then feed input back into the 'intangible narrative approach' loop and make the appropriate design changes, or judge whether the design is successful.

The chosen digital medium used to test the research with is Unity3D and the HTC-Vive VR HMD.

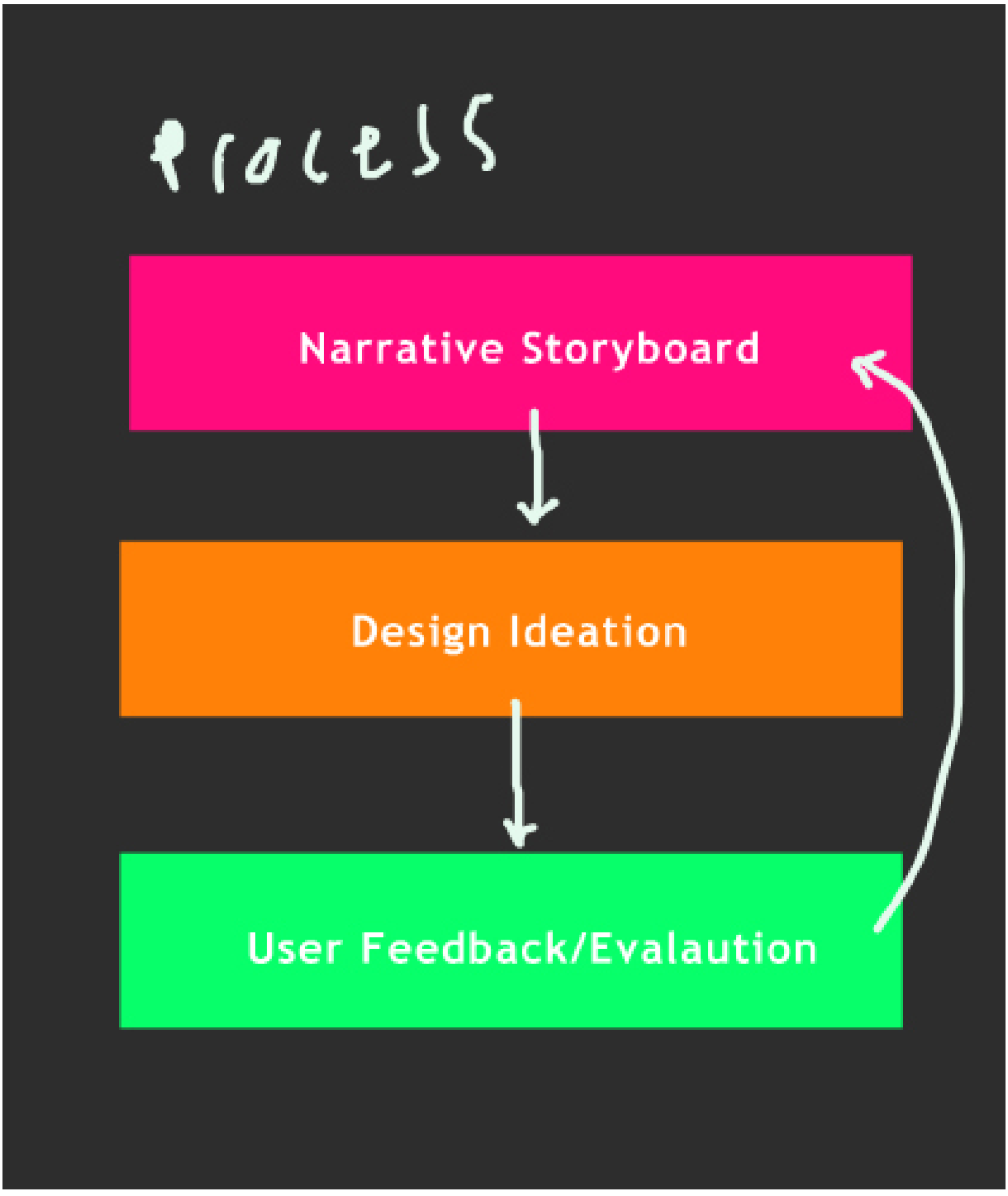


Figure_5.
Diagram showing the 'intangible narrative' workflow.

CHAPTER

5.0

DESIGN EXPLORATION

NARRATIVE STORYBOARD

The case-study for this thesis was the 'Kowloon Walled City' located in Hong Kong, China. Demolished in 1993, the city was a large slum and was once the densest place of population on earth.

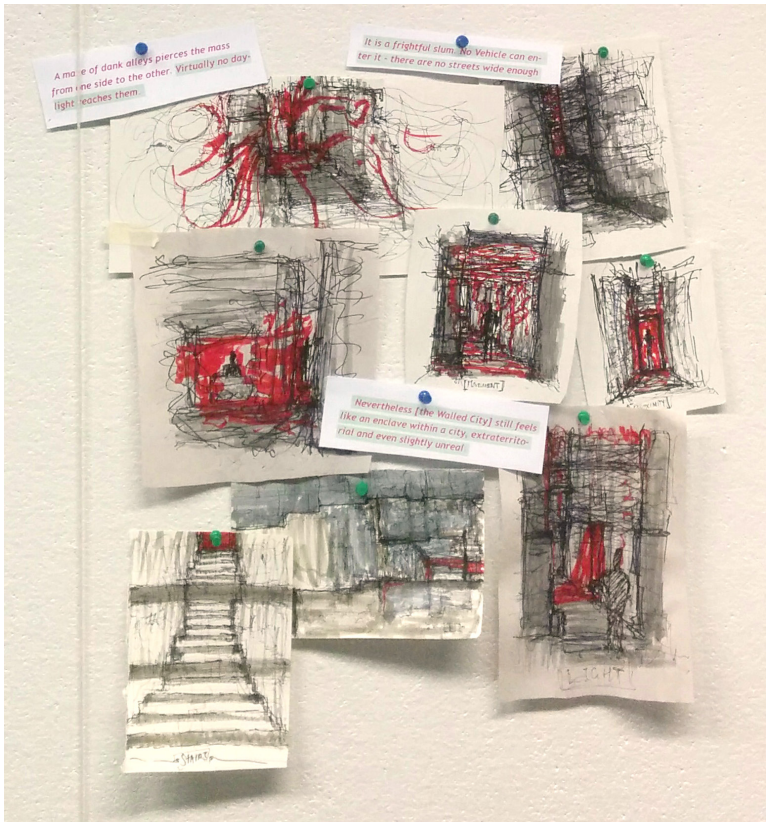
The case-study was chosen because of the sites more ephemeral characteristics. Although the case-study does have very interesting structures and formal typologies, it is often the more sensual and intangible qualities of the space that give it its reverence.

A storyboard of drawing investigations was laid out. This was based off images from the site as well as descriptions, the drawings were to represent the space in a way that it would've been seen in the perspective of an inhabitant of the space. In the context of and consideration of culture, the storyboard takes on the role of a Chinese viewer, so from the perspective of the human-centric.

The design investigations follow this storyboard narrative that has been developed. The ideations, work to describe the in-text citations found in the book "City of Darkness", a book that has real-life interview and accounts of how inhabitants that actually lived there describe the space.

Figure_6.
Images of the case-study, "Kowloon Walled City".

Figure_7.
Narrative storyboard criteria drawing investigations.


A maze of dank alleys pierces the mass from one side to the other. Virtually no daylight reaches them.
It is a frightful slum. No vehicle can enter it – there are no streets wide enough.
Nevertheless [the Walled City] still feels like an enclave within a city, extraterritorial and even slightly unreal.

" ...and its buildings, rising sometimes to 10 or 12 storeys, are so inextricably packed together that they seem to form one congealed mass of masonary, sealed together by overlapping structures, ladders, walk-ways, pipes and cables, and ventilated only by fetid air-shafts."

Geometry + Material

5.1 GEOMETRY AND MATERIAL

Initial formal investigations explored four proposed methods:

5.1.1 Physical modelling + photogrammetry,
5.1.2 Physical modelling + 3d-scanning,
5.1.3 VR/digital modelling,
5.1.3 Real world asset generation via photogrammetry.

Material investegations involved two proposed methods:

5.1.4 Photgrammetry real world textures,
5.1.5 PBR/Unity texturing.

Decisions were made to actively try and abstract the geometric forms. Not strictly making them low-fidealty aesthetically, but low fidealltical in the context of mirroring common built-enviornment realistic forms. This was to try and limit the ocular-bias that might occur at the later stages of expiermental data. There would be a strong chance that people would be too focused on the forms/materals looking realistic that it would dilute the data, and limit the understanding of how important/ effective the other elements (ie, sound, interaction) are towards creating an immersive reconstruction.

The process followed the proposed narrative-lead working method outlined in chapter 4. As a result, reconstructing the site (Kowloon Walled City), formally and materially was based upon the way the site has been described in text and interview by inhabitants rather than image or visual refrences.

Figure_8.
Geometric explorations showing photogrammetry vs 3d-Scan mesh.

5.1.1a CASE STUDY ONE : PHYSICAL MODEL + PHOTOGRAMMETRY

PROCESS:

1. Physical Model ---2. Photograph Compositio---- 3. Autodesk Remake (Photogrammetry) ----4. Autodesk Maya (Mesh Cleanup)

The process as described above focused on the creation of abstract meshes and forms that described the narrative description. As a result, initial testing involved the use of rudimentary materials such as cardboard and masking tape, experiments with wire was also conducted. Several sketch models were created out of differing types of cardboard and other material, from a low complexity to a high complexity. The physical sketch models were then photographed and input into Autodesk Remake to generate a photogrammetry 3D Mesh. Following that, the mesh is then taken into Maya for cleanup or digital alteration.

RESULT:

The working method of 5.1.1a shows great promise as a way for creating geometries. The process creates near identical 3D mesh representations of its physical counterpart. Initial investigations, however, have highlighted some considerations that have to be made when using this method (of physical modelling + photogrammetry). Photogrammetry offers very good results as long as there are the right conditions. Various experiments highlighted that the fidelity of mesh creation is highly dependent on several factors - the material used in the physical model (white vs brown card), good lighting with little harsh shadow, and a large amount of photographs input to the software. As a result, it can be very time-consuming to get a high-fidelity result with when it comes to more complex models or certain materials. There is little control over the fidelity of the 3D mesh outside of these key parameters. Whereas other methods for modelling allow for this control.

Figure_9.
Physical model of the narrative geometry

Figure_10.
Photographic composition.

Figure_11.
Autodesk Remake output photogrammatrey mesh.

5.1.2b CASE STUDY TWO :
PHYSICAL MODEL + 3D-SCANNING

PROCESS:

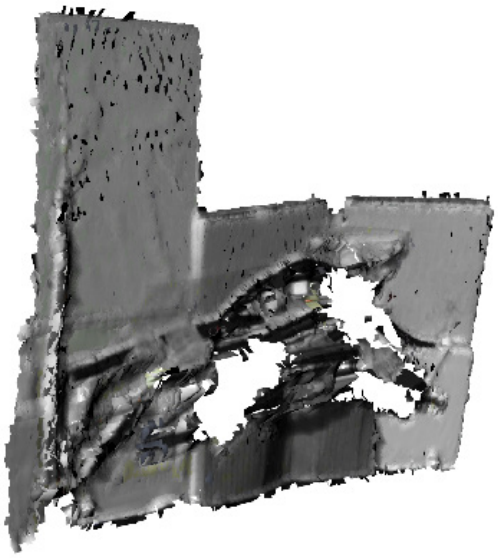
1. Physical Model ---2. 3D Scanner

This process utilizes a hand-held 3D scanner rather than using photogrammatrey for formal creation. The proccess is far simplier than 5.1.2a but leads to mixed results.

RESULT:

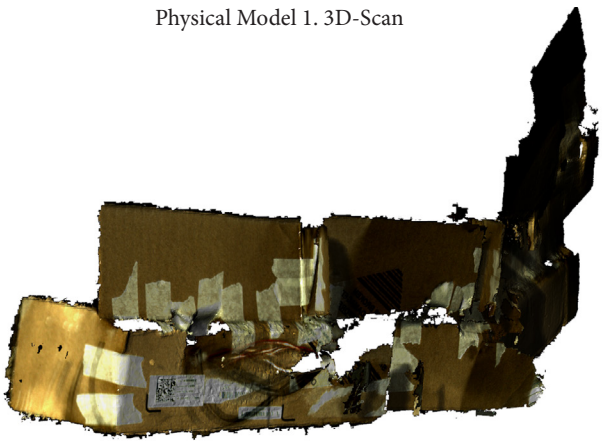
While the process for digital mesh creation is far simplier than 5.1.2a, the resulting mesh is also far less accurate. Problems also occur capturing some of the geometry and holes also are more likely to appear. The scanner has trouble picking up reflective materials and also materials that are either black or white in colour. However, compared to the proccess of 5.1.2a there is a lot more control here. While this proccess would be bad for accurate mesh creation, for more low-fideality and abstratc forms it has potential. There is ability to purposely create 'glitch' architecture. By using certain materials in the sketch model proccess, it can inform where holes within the mesh are created.

Physical Model 1. Photogrammetry



Physical Model 1. 3D-Scan

Physical Model 2. Photogrammetry



Physical Model 2. 3D-Scan

Figure_12.
Comparision between photogrammetry and 3d-scanned meshes.

5.1.2c CASE STUDY THREE: DIGITAL VR MODELLING

PROCESS

1. VR HMD----2. Google Tiltbrush

Architecture within the digital has always used axis-based modellers such as Revit, Rhino and Sketchup to create forms. As a result, and as a way to try to steer away from traditional toolsets, and ergo ocularcentric workflows, an experimentation of using Google Tiltbrush as a form creation tool was investigated instead. Google Tiltbrush is a novel modelling tool that creates meshes as the user virtually paints within a VR environment. The meshes can then be exported out as .fbx files ready for implementation into Unity or another program.

RESULT:

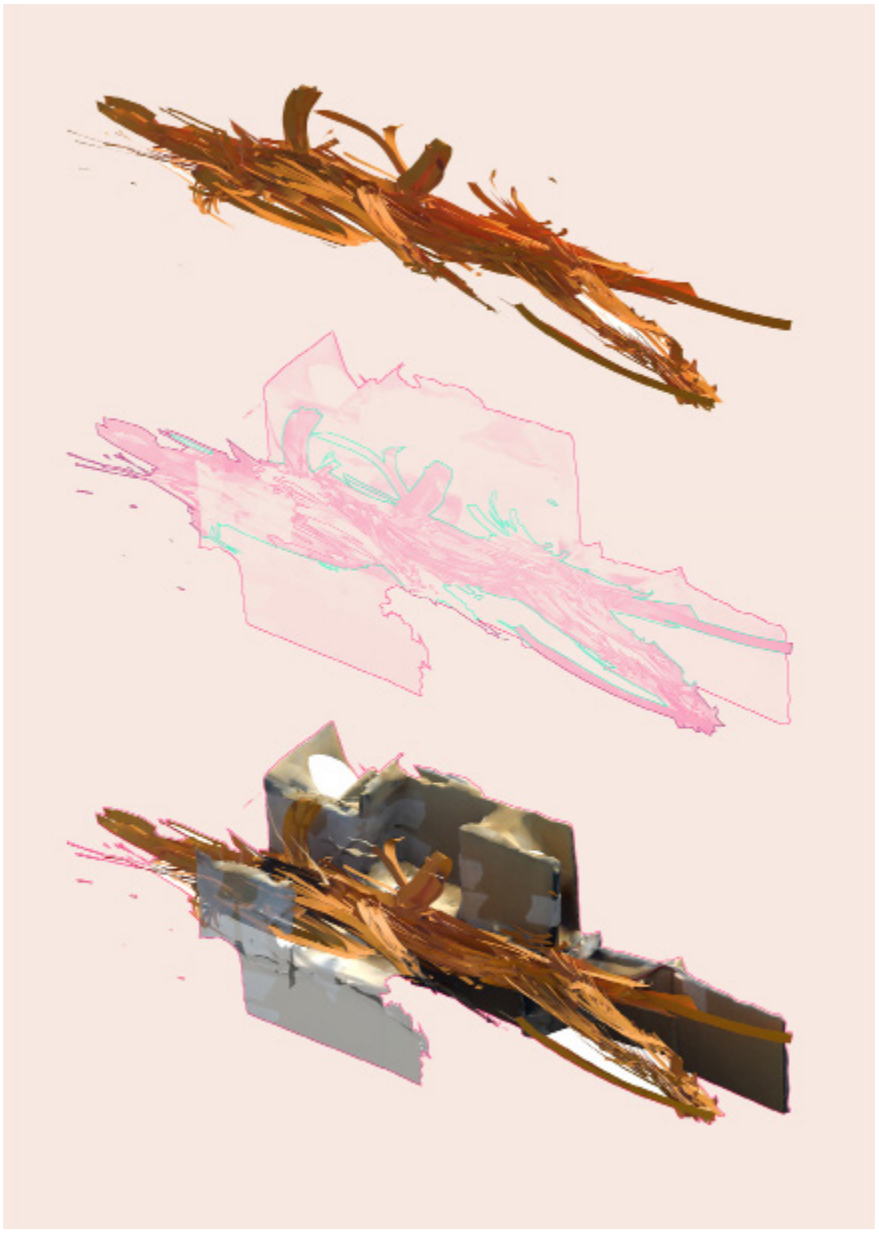
Tiltbrush, because it is akin to freeform painting, offers immense potential as a formal ideation tool. Abstract forms and interperative gestures that would take traditional modelling programs hours to do is done within a matter of minutes instead; which offered a completely new level of creative flexiablity. This meant that 5.1.2c also had the greatest uptime for creating quick formal iterations. Forms generated in tiltbrush implemented seemisly into any proposed workflow as they output .fbx files. In the context of this thesis, pipes, lights, wires and cable typologies were explored and created with tiltbrush, and offered great/interesting results within a short amount of time.

Figure_13.
Process showing the use of tilt brush to generate forms.

Figure_14.
Showing how the generated tiltbrush geometry implements into workflows.


Tilt Brush


Tilt Brush



5.1.2d CASE STUDY FOUR: REAL-WORLD ASSET GENERATION

PROCESS

1. Real-world object----2. Photographic Composition--
-3. Autodesk Remake----4. Autodesk Maya

The workflow of this method is very similar to 5.1.2a. It utilises photogrammetry (Autodesk Remake) to generate geometries, the difference being the subject of reconstruction in this case.

RESULT:

Results of 5.1.2d were reasonably successful. Like 5.1.2a, it suffers from many of the same drawbacks as a result of the photogramamtery software. These include the need for good lighting conditions and some materials don't pick up as well. A series of tests were conducted on which type of real-world object works well with this proccess, and in conclusion , objects that had a range of different colours and textured non-shiny materials perfomed the best. The meshes that were created also held an accurate resemblence to their real-world physical counterparts. As a result however, this limits the creative felxiablity of this proccess as a design ideation tool, as comapred to 5.1.2a which has a large degree due to the physical modelling element. This proccess therefore was used heavily in helping to create the intangible operator of 'inhabitation' within the proposed thesis immersive environment.

Figure_15.
Board showing different 5.12d photogrammetry explorations.

Figure_16.
Photogrammetry mesh of a workshop bench area.

5.1.2e CASE STUDY FIVE: MATERIAL GENERATION.

PROCESS

1. Photographic Composition--- Photogrammetry---Texture
2. Unity3D---Shaders---Texture

The workflow of generating material was handled in two processes. The first was using digitally created materials via shaders. Shaders are how computers are told to render materials. Within unity there is the ability to edit this and tell the computer to render textures/materials in different ways. This gives the designer an ability of control outside of traditional softwares where this is preset. A range of shaders were tested, from unity-standard shaders to PBR (physically-based-renderer) ones. The second method was to utilise real-world assets to generate textures and materials via photogrammetry. This process involved photo composition of textures found in real physical space, ie a concrete texture and then transposing it within the environment. A side experiment was conducted to alter these textures within photoshop to generate abstract textures on objects.

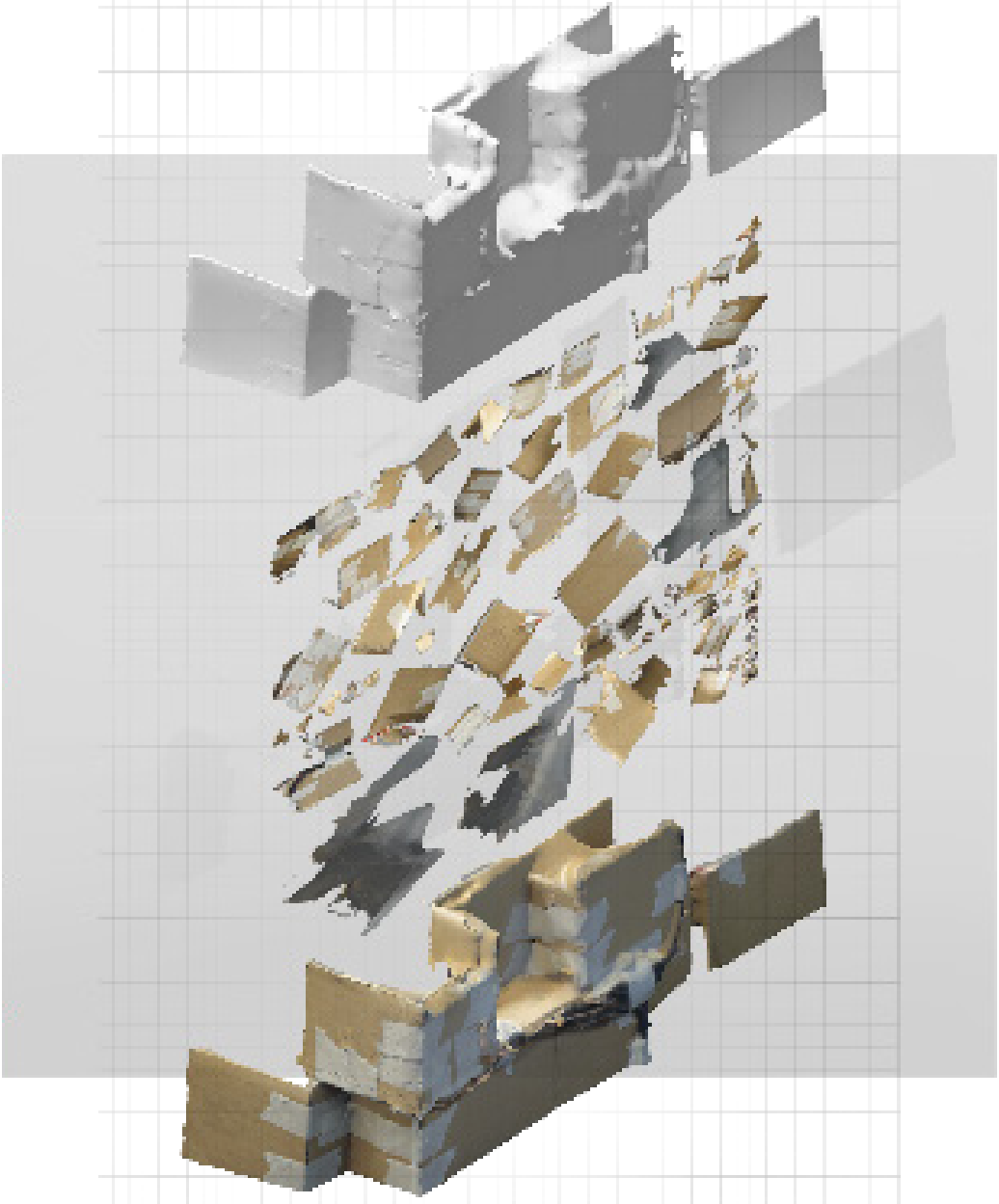


Figure_17.
Axonometric showing the mesh with no material and then photogrammetry generated material applied.

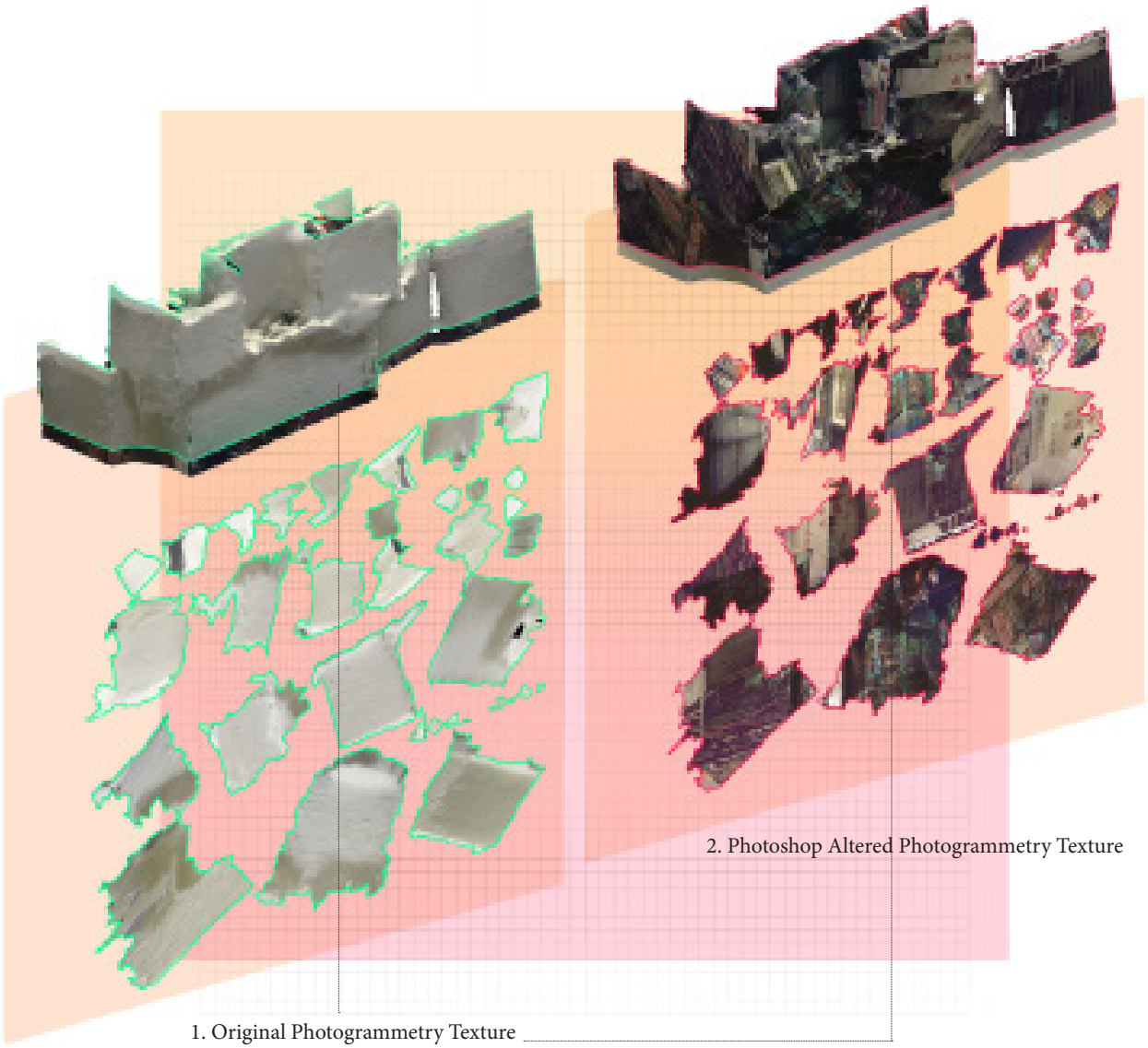


Figure_18.
Showing the process of altering photogrammetry texture image files.

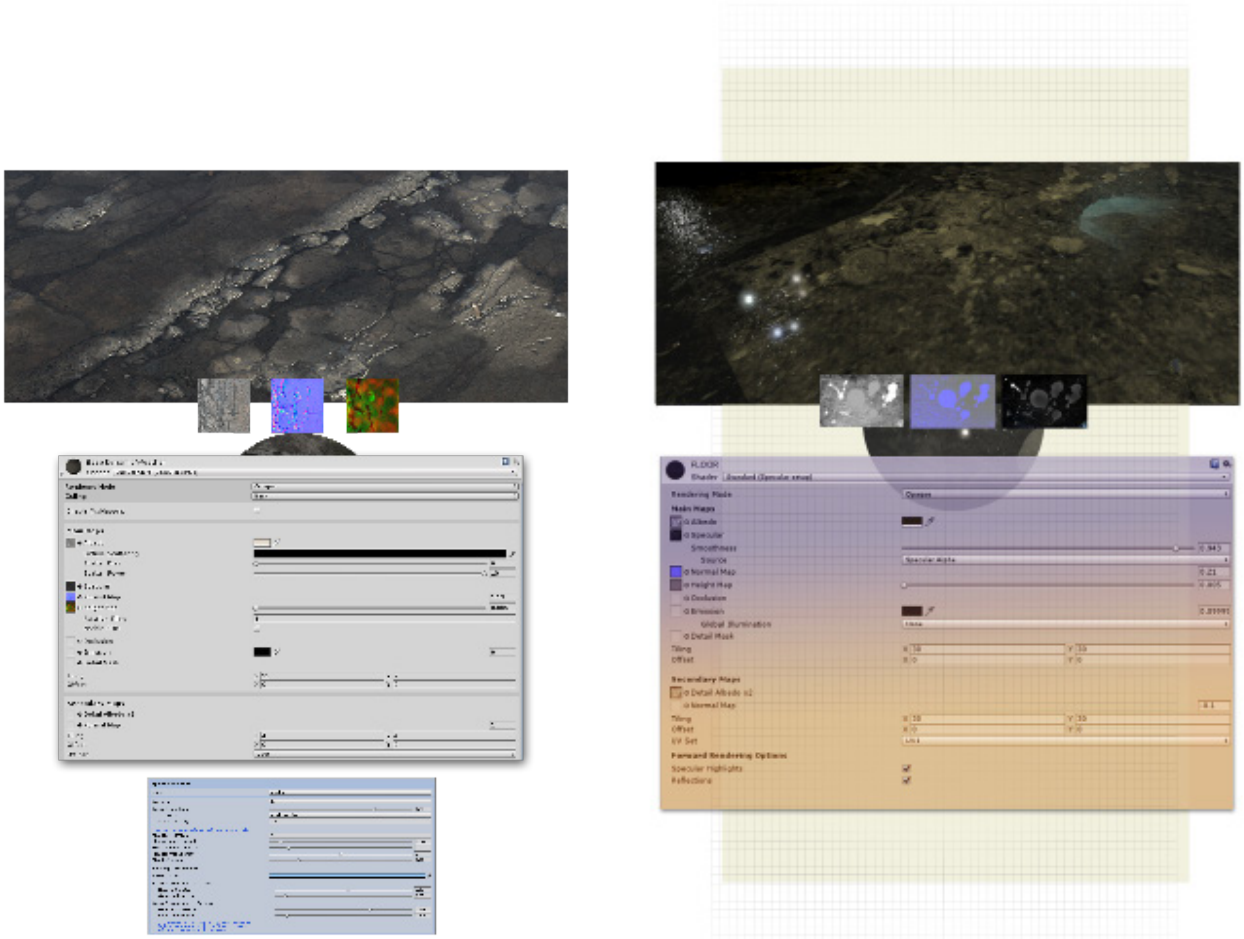


Figure_19.
Inside Unity3d, shader texture information of unity-based shader system and the PBR shader system.

" Often fetid and dank, with water permanetly dripping for maekshift pipes overhead, the alleys were an obstacle courses of delivery trolleys, broken concrete and sodden rubbish"

"At ground level was a narrow network of 30 or so streets and alleysways, some no more than a metre across. No vehicle can enter it - there are no streets wide enough."

Movement

5.2 MOVEMENT

Movement within a VR HMD environment can be tricky and needs to be carefully considered. Within the medium there is a well known fact that locomotion and movement within a VR HMD experience can cause nausea and severe motion sickness if not done correctly. In particular, a forward continious movement within the environment has been identified as being motion-sickeness inducing. As a result, most VR HMD environments utilize a teleportation system rather than a continous movement locomotion system as to not induce motion sickness.

However such a system is far from ideal from an immersive standpoint. Teleportation although inhibits nausea, is not very close to how we move in reality within the built-environment. The teleportation effect also proves to be quite jarring as a result, in relation to creating an immersive embodied virtual experience.
Therefore, this thesis explores two proposals for locomotion movement systems:

1. Teleportation system.
2. Contiuous forward movement system.

Experiments and explorations were done to try and posulate if there was a method to either a) get the teleportation system to feel more like an embodied movement system, or b) to get the forward movement system to not cause any issues of nausea or sickness.

There were also explorations into other aspects of movement also. Movement in space doesn't just include the linear sense of movement, it also includes vertical movement (stairs) and influnced movement of spatial arrangement (obstacles and tight or large spaces). As a result there were method explorations that investigated these ideas also.

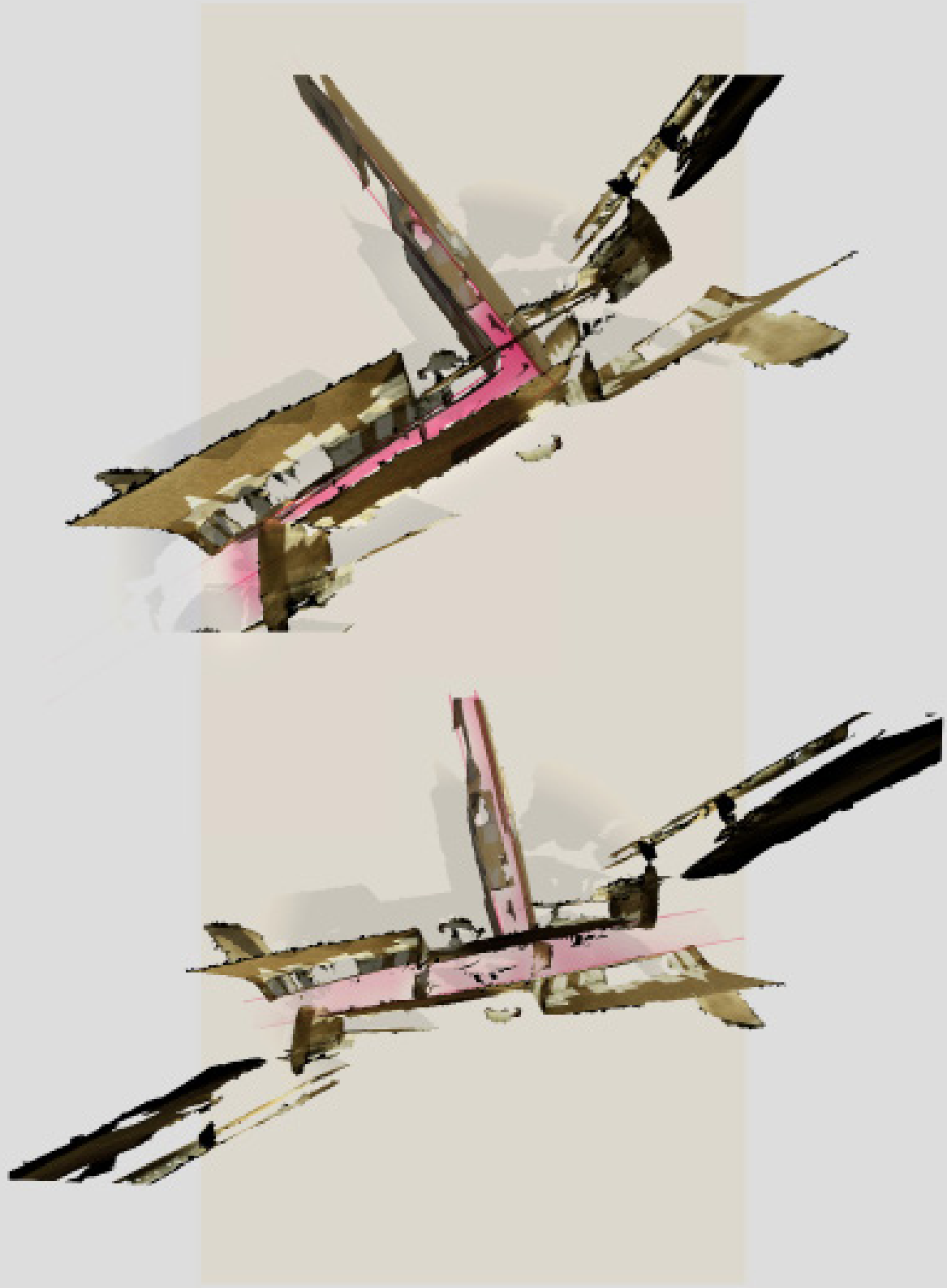
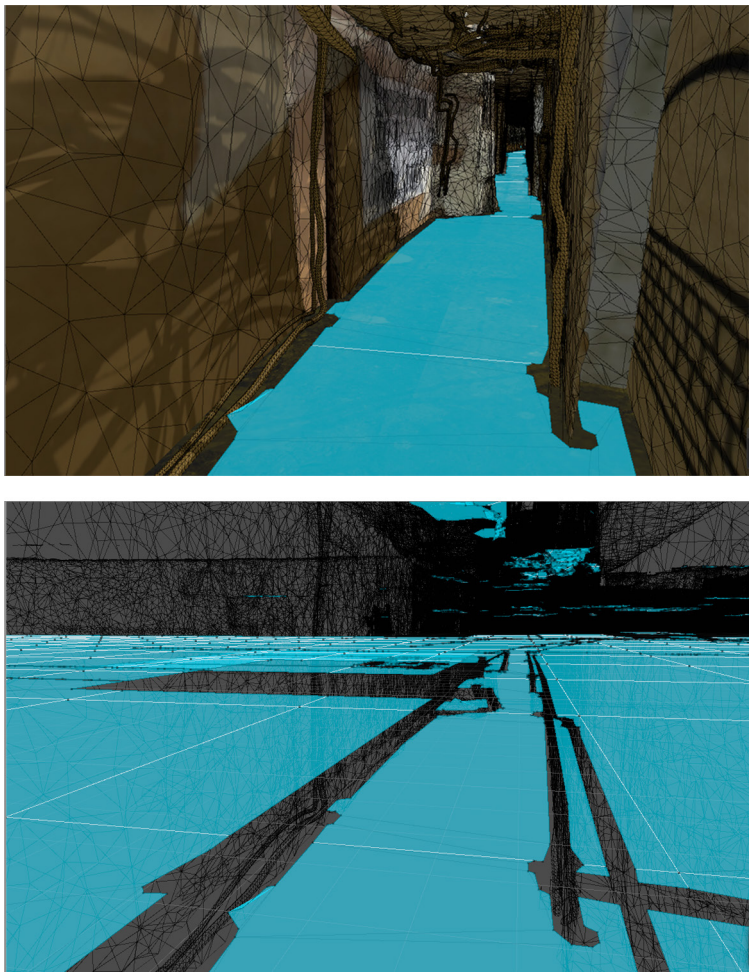


Figure_20.
The different spatial layout compositions.



5.2.1 CASE STUDY ONE: TELEPORTATION SYSTEM

Figure_21.
Navmesh map inside unity for teleportation.

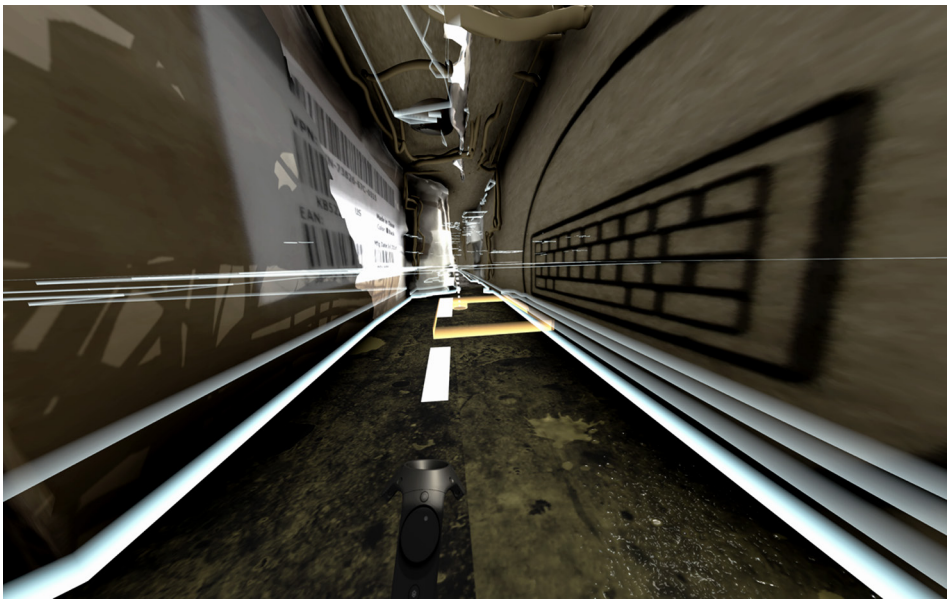
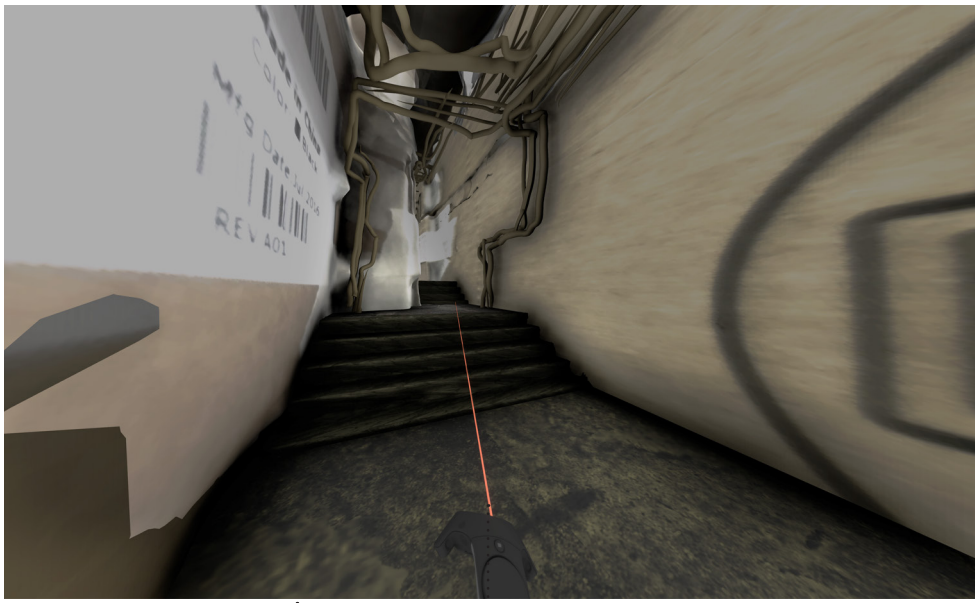


Figure_22.
Detailing in the environment, how the teleportation system works.

5.2.2 CASE STUDY TWO : CONTINUOS MOVEMENT SYSTEM



SPEED = 0.4f velocity

```
void Movement()
{

    if (moving == true && stair == false)
    {
        sound.SetActive(true);
        normMove = true;
        CameraRig.constraints = RigidbodyConstraints.
None | RigidbodyConstraints.FreezeRotation;
        CameraRig.useGravity = false;
        CameraRig.drag = drag;
        CameraRig.AddForce(Col.transform.forward *
CameraRig.mass * speed);
        CameraRig.maxAngularVelocity = 10;

        if (CameraRig.velocity.sqrMagnitude > speed-
Limit)
        {
            CameraRig.drag = 3f;

        }
```

Figure_23.
Showing how the forward continuos movement system works + the c# scripted code.

5.2.3 CASE STUDY THREE : VERTICAL MOVEMENT

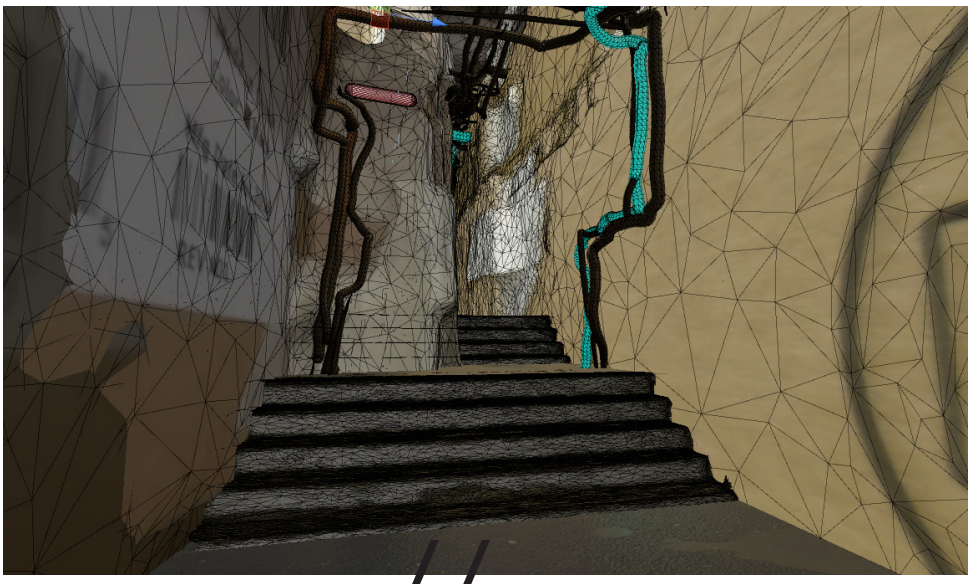
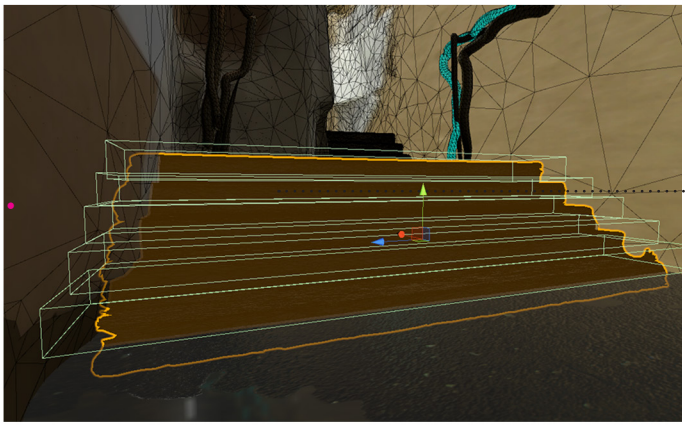


Figure_24.
The stairs where vertical movement was explored.

METHOD THREE: VERTICAL MOVEMENT

INTANGIBLE NARRATIVES



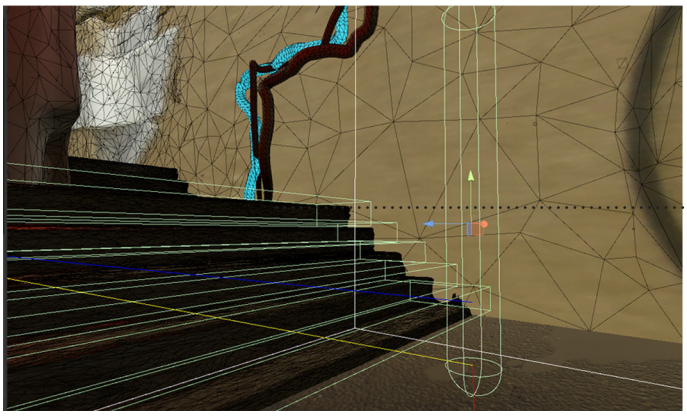


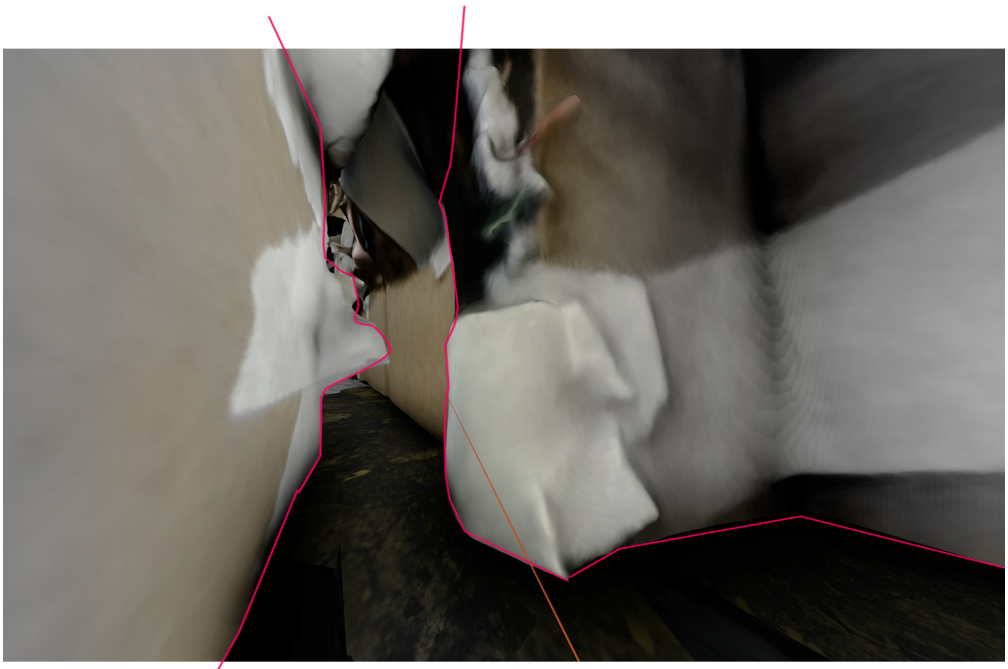
Figure_23. (top)
The stair box colliders that trigger the changing speeds of movement

Figure_24. (bottom)
The player capsule colider, raytrace and stair collider systems within Unity3d.

```
void stairUpRay()
  {
     float hitdist = 5f;
     float theDistance;
     Vector3 origin = Col.transform.position - new Vector3(0, ColDist2 + rayPos,
0);
     RaycastHit hit;
     Vector3 direction = Col.transform.TransformDirection(Vector3.forward) * 10;
     Debug.DrawRay(origin, direction, Color.green);

     if (Physics.Raycast(origin, direction, out hit, hitdist))
     {
        theDistance = hit.distance;

        if (theDistance < 0.12f && hit.collider.tag == stairGeo && stairUp == true)
        {
           CameraRig.constraints = RigidbodyConstraints.None | RigidbodyCon-
straints.FreezePositionX | RigidbodyConstraints.FreezePositionZ | RigidbodyCon-
straints.FreezeRotation;
           Vector3 target = new Vector3(Parent.transform.localPosition.x, Parent.
transform.localPosition.y + 0.65f, Parent.transform.localPosition.z);
           Parent.transform.localPosition = Vector3.Lerp(Parent.transform.localPo-
sition, target, Time.deltaTime * 1.1f);

        }
        else if (theDistance > 0.12f && hit.collider.tag ==  stairGeo  && stairUp ==
true)
        {
           CameraRig.constraints = RigidbodyConstraints.None | RigidbodyCon-
straints.FreezeRotation;
        }
     }
  }
```

Figure_25.
C# script detailing how the vertical movement up stairs works.

5.2.3 CASE STUDY FOUR : OBSTRUCTED MOVEMENT & SPATIAL DIVISION



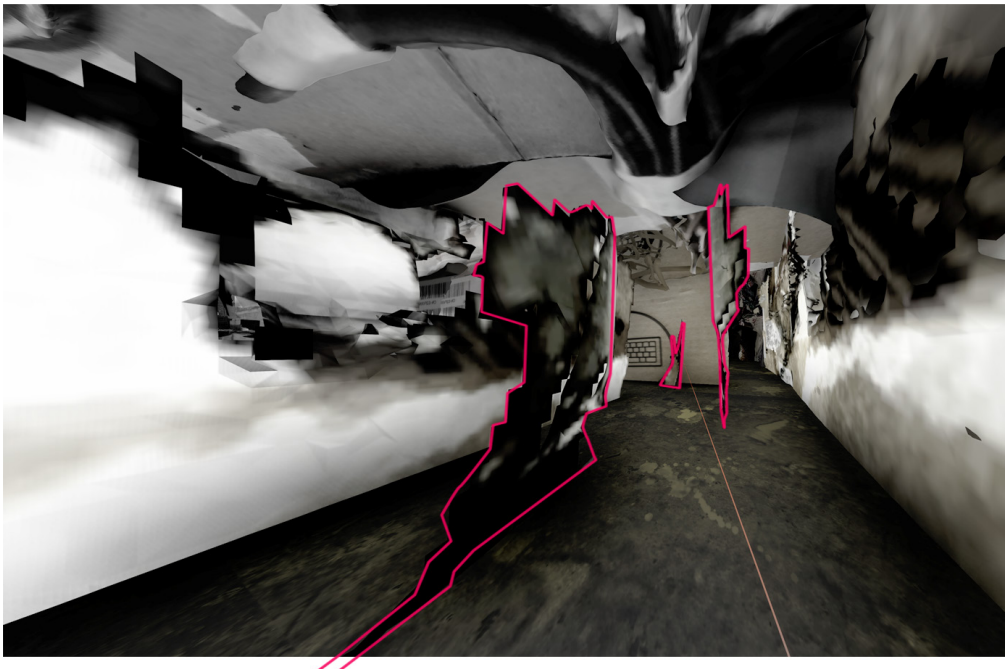


Figure_26.
Geometric placement creating influened movement down a narrow passage.

Figure_27.
Geometric placement creating obstructions within circulation areas.

5.2.4 CONCLUSIONS & RESULTS

CASE STUDY ONE:

The results of a teleportation movement system proved to be unsuccessful. One main reason can be attributed for this. Anedotal testing suggested that the reason is because teleportation as a locomotive system is a very quick way of traversing space. There is an ability to move 2-200m within a few seconds rather than at a slow constant rate like in reality. This leads to a massive distortion in the sense of time and scale , which are crucial elements within an embodied experience. Users tend to traverse the environment very quickly, and rarely stop to focus their attention on the details of the other intangible aspects of space.

CASE STUDY TWO:

The continuos forward acceleration locomotion system on the other hand proved to be outstandingly successful. Problems of motion-sickness were mitigated through the use of two stratergies. The first was the implementation of inertia. Inertia can play a vital role in our feeling of movement in space, it gives a feeling of feedback or balance that you are actually moving. The second was the limitation of how quickly you can traverse. As discussed above, fast movement can distort the peception of time and scale, by slowing down the movement it forces users into having to find and percieve the ephemera surronding them. From testing, there seemed to also be a relationship between speed and motion sickness, ie faster movement would create more motion sickness.

CASE STUDY THREE:

Investigations of vertical movement were mainly conducted through the medium of stairs. In the proposed method, a constant foward motion is applied, when the user hits the start of the stair well they are pushed upwards and then forwards in a repeating ‘Z” looking type of movement. The exploration was widely sucessful in creating a real sense of immersion, as the sensation is very close to actual movement. This was accomplished by using a change of speeds as you traverse the stairs. As the user approachs the stairs, the speed of the user is forcably slowed down for a second. Then within the “Z” motion, upwards is fast, while the horizontal slower. This all works to create the feeling of moving up the stairs one step at a time.

CASE STUDY FOUR:

Spatial division and obstructions are also an important aspect of movement. In the narrative, and within text-accounts, the site was described as to have many narrow alleyways and items like shopping trolleys blocking circulation. This was emulated within the environment. Obstructions were created in the form of abstract geometry as well as photogrammetry assets. Alleyways vary in size, giving a sense of scale and allowing for bits of the enviroment to persaude users to move physically in reality.

" A maze of dank alleys pierces the mass from one side to the other. Virtually no daylight reaches them."

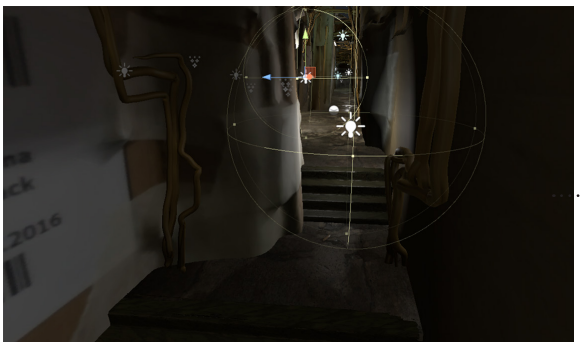
"The light was dingy at best, deep green; there was the endless splatter of water leaking on to stone. One particularly ghastly little ginnel - spongily wet underfoot, a big rat hopping off - brought you to the gate of the Tin Hau temple."

Lighting

5.2 LIGHTING

5.3.1 Case Study One :
STATIC LIGHTING PROCESSES

5.3.1a BAKED
POINT LIGHTING



5.3.1b REAL-TIME
POINT LIGHTING

5.3.1c VOLUMETRIC
AREA LIGHTING

5.3.1d VOLUMETRIC
TUBE LIGHTING

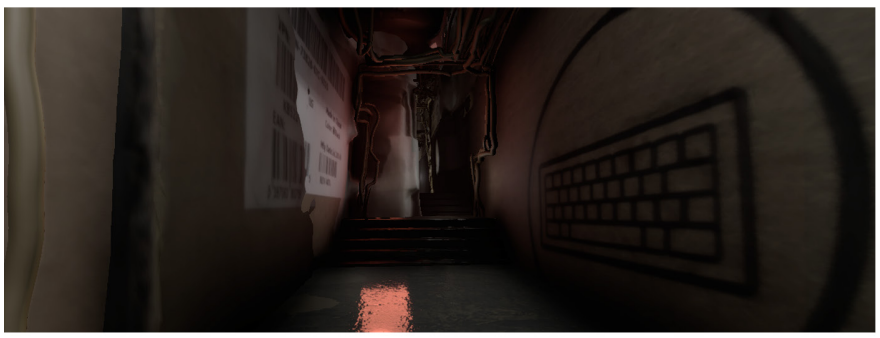
Figure_29.
A series of images showing the different static lighting processes used within Unity3d.

base

5.3.1a

5.3.1b

5.3.1c



5.3.1d

Figure_30.
A series of images showing the effect of incrementally adding more static lighting processes to the environment.

5.3.2 Case Study Two :
DYNAMIC LIGHTING PROCESSES

Figure_31.
The flickering light implementation inside Unity3d.

Figure_32.
Alleyway area without the flicking light on.

Figure_33.
Alleyway area with the flickering light on.

5.3.3 Case Study Three :
DYNAMIC EMISSIVE LIGHTING PROCESSES

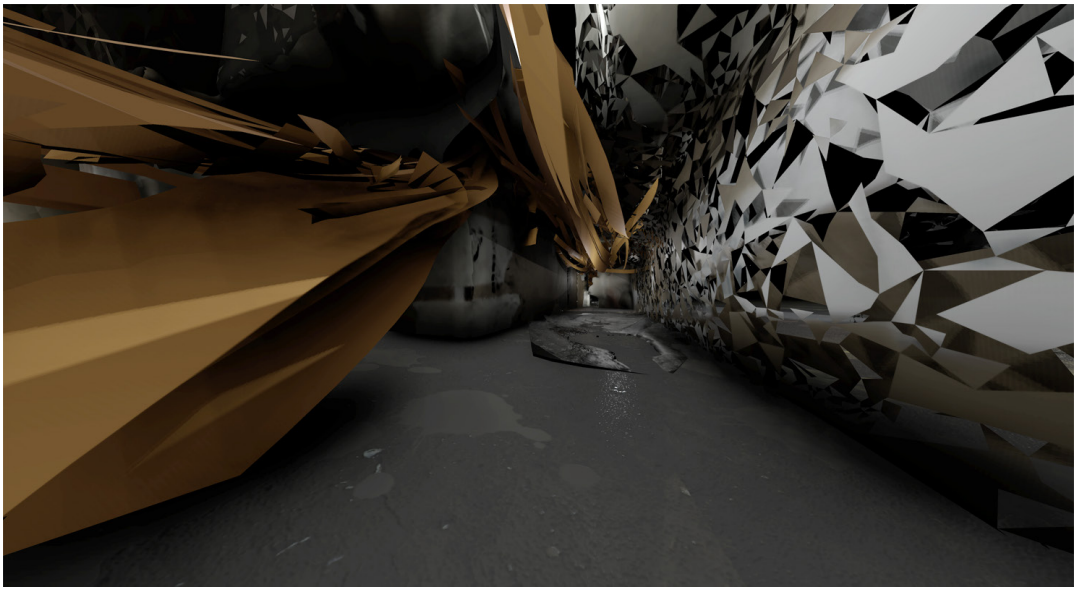


Figure_34.
The environment without dynamic emissive lighting.

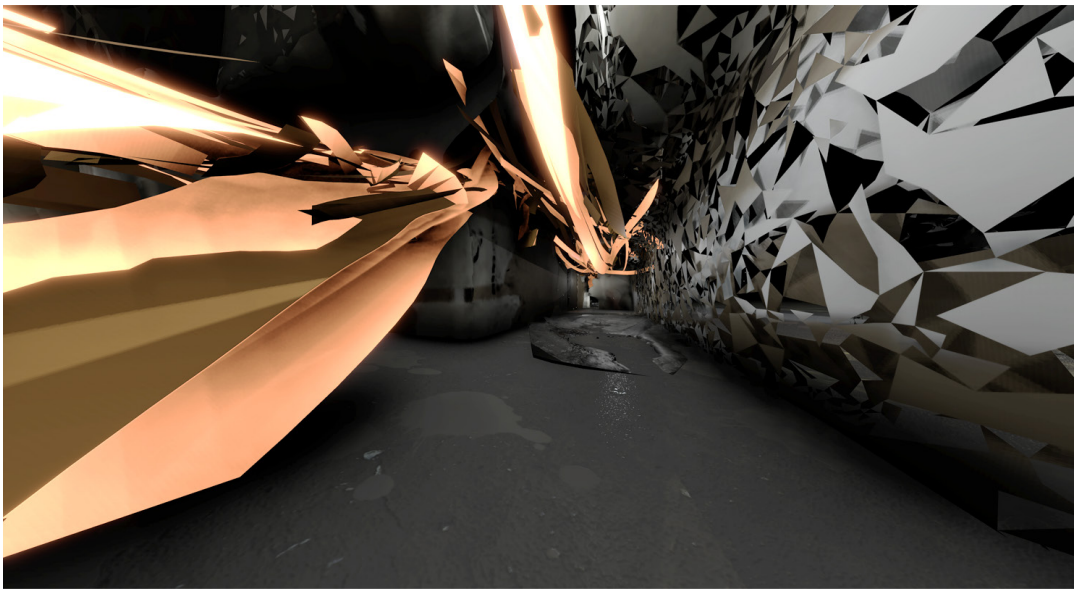


Figure_35.
The environment with dynamic emmisive lighting.

5.3.4 Case Study Four :
POST-PROCESSING STACK

Figure_36.
The environment without any post-processing

Figure_37.
The environment with post-processing (AO+AA+colour grading+bloom).

"Water was a constant problem for the inhabitants of the city. You had to make a daily trip to one of the two wells located in entire city."

Interaction

5.4 Interaction

Several different methods were tested to create a sense of interaction within the space. The first one (5.4.1) is 'actor within space'. This is the creation of a task or a role within the environment for the user. In this thesis, the role that the users were given were to be a water collector, or to find water and fill a bucket with it. The second, (5.4.2) is interactable objects. WIthin the environment, certain objects are intractable, as in they are able to picked-up, moved around and dropped. The third method (5.4.3) tested is the implementation of haptic feedback. Haptic feedback was coded to trigger within the VR HMD hand controllers when certain events of actions were taken from the user. This creates a physical sensory element within the environment.

RESULTS:

CASE STUDY ONE:

Very rarely do people in reality be present in space without an activity or something to accomplish. As a result, the integration of giving a role or activity within the environment has proved to be very successful in raising immersion and presence.

CASE STUDY TWO:

The inclusion interactable objects proved to be not as successful. This is due to the result of the narrative driven process. The narrative criteria outlined that most of the interaction of the space was in the form of movement through the space. As a result the implementation of interactable objects did little to resolve immersiveness.

CASE STUDY THREE:

The inclusion of haptic feedback within the controllers was shown to be a successful method for creating immersion. This was the result of the introduction of a physical sense of feedback to actions taken in the virtual environment. The process of when/what actions trig-

Figure_38.
Interaction and UI of picking up a bucket.

Figure_39.
UI as the bucket is picked up.

5.4.1 Case Study One :
ACTOR WITHIN SPACE

Figure_40.
Filling up the water bucket inside the environment.

Figure_41.
Interactable tap to turn on.

5.4.2 Case Study Two : INTERACTABLE OBJECTS

Figure_42.
Picking and moving the bucket around.

5.4.3 Case Study Three : HAPTIC FEEDBACK

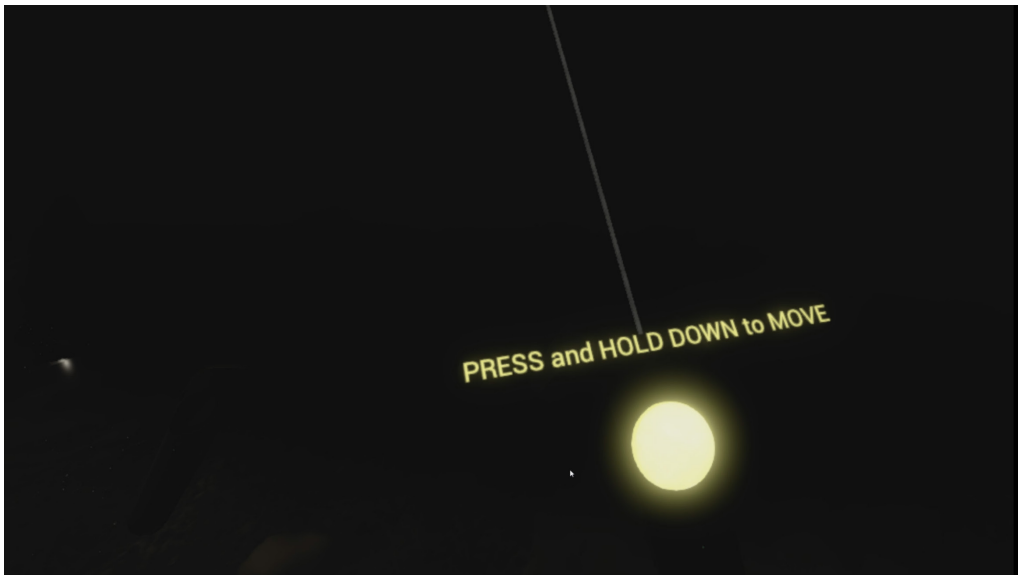


Figure_43.
Haptic feedback in response to actions taken in the environment.

" All this intensity of random human effort and activity, vice and sloth and industry, exempted from all controls we take for granted, resulted in an environment as richly varied and sensual as anything in the heart of a tropical forest. The only drawback was that it was obviously toxic."

Inhabitation

5.5 Inhabitation

The general design focus of implementing inhabitation was to try and create a sense of inhabitation without the fomal use of recognisable people. The narrative criteria and description describes not nesscierly the people in the space, but the ephemera and effect as a result of people in space. It was a focus to represent 'human activity' rather than humans directly. Three case-studies were investigated as possible working techniques to achieve this.

5.5.1 is the impletation of bodies within space. The bodies were purposely made just simple rectangular forms. The bodies then were scripted to try and mimick human behaviours of how people move around in space, moving at different speeds, stopping and interacting with one another. 5.5.2 is the creation of places. This case-study investigated the effect of adding in recognisable programs of activity within the environment. Two programs are implemented, a metal workshop and a retail shop. 5.5.3 explores how the implementation of realistic forms and regonisable human elements can help create a sense of 'human acitivity'. Photogrammerty of assets found in real site-locations was the process used for the generation. Elements included fans, rubbish bins, tables and benches amoung others.

RESULTS:
The implementation of people or 'bodies' in space was quite unsuccessful. While a lot of work went into refining the movement of the bodies in space, the impact of them to emulate the effect of people was unresolved. As a result, it is concluded that to implement people within virtual pace, actual forms of people might be needed. This is fairly time consuming and hard to achieve though.

Adding the programs of space seemed to be widely successful. The implementation of the workshop and retail space was the most successful method in creating a sense of inhabitation within the environment as ancedotal observations suggest.

Figure_44.
A metal workshop with people inside it.

5.5.1 Case Study One :
BODIES OF PEOPLE IN SPACE

Figure_45.
A 'person' walking down the alleyway.

Figure_46.
A person working within a shop.

5.5.2 Case Study Two : CREATION OF PLACES

Figure_47.
A workshop within the environment with photogrammetry-made geometry.

5.5.3 Case Study Three : REAL-WORLD ELEMENTS

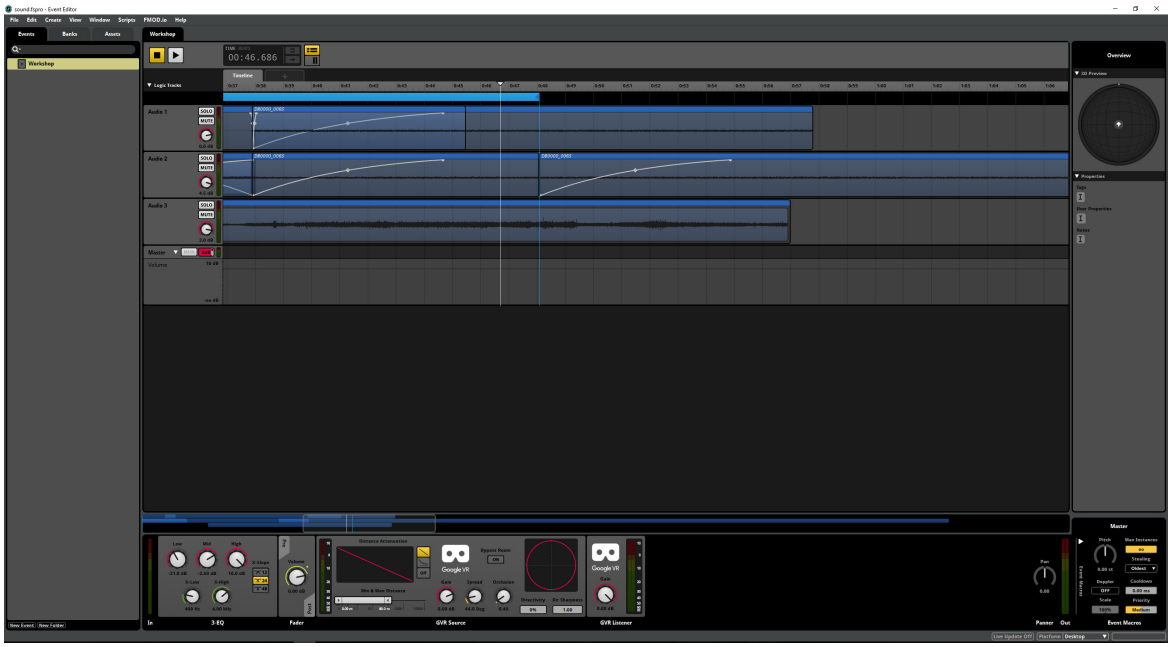
Figure_48.
Photogrammetry trash bins within the environment.

" Sometimes you seem to be all alone, with every door locked around you. Sometimes the lane is suddenly bright with lights of a laundry or a sweatshop factory, and loud with Chinese music"

Acoustics

5.6 Acoustics

There were two main focus areas for implementing acoustics within the virtual environment. The first was an investigation on implementing object-specific acoustics. This is sound coming from objects, ie fans. The second was an investigation on ambient sound. This is a general noise of sound in the background. These two were then combined to inform an overall spatial sound for the environment. The process for creating acoustics was to record the acoustics from real-world physical space, mix them in a digital editor and then place and layer them inside the virtual environment.



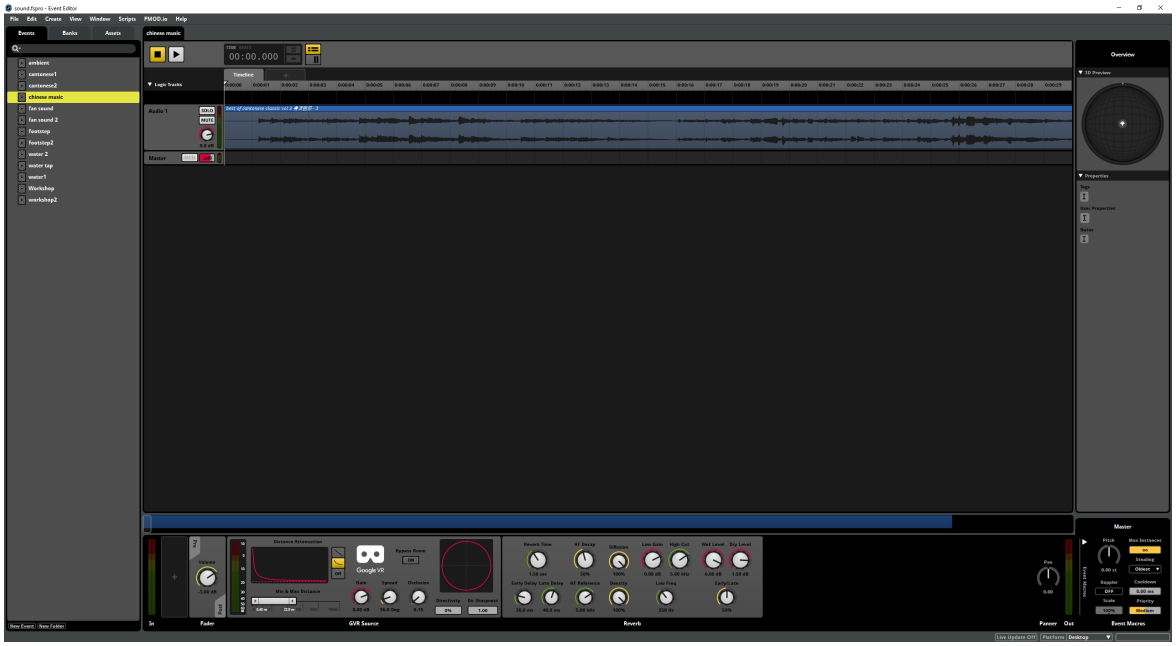
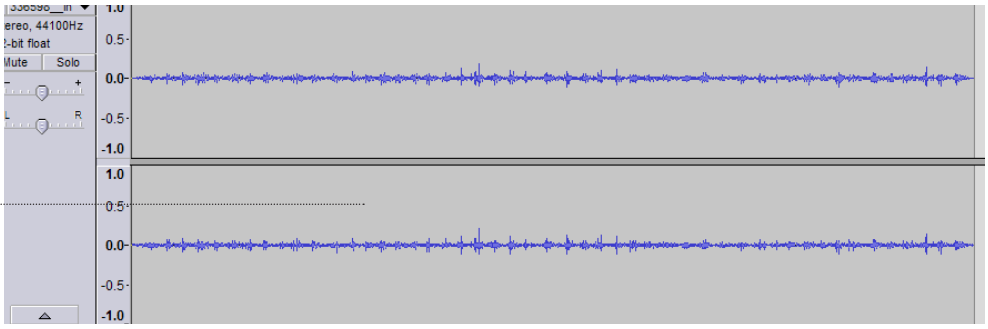


Figure_49.
Workshop sound creation in FMOD.

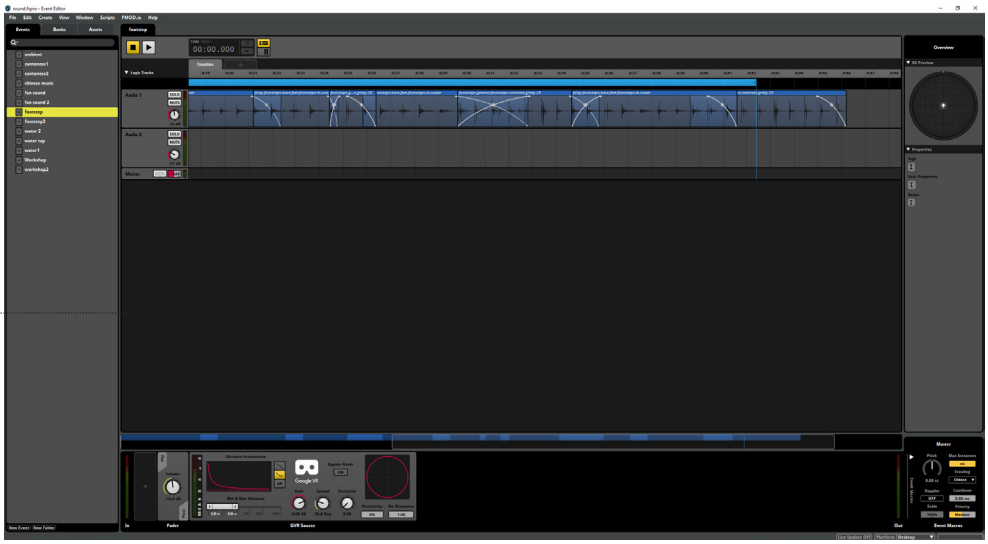
Figure_50.
Chinese music sound editing in FMOD.

5.6.1 Case Study One : SPATIAL SOUND.

1.RECORD SOUND



2. EDIT/MIX IN FMOD



3. IMPLEMENT IN UNITY 3D

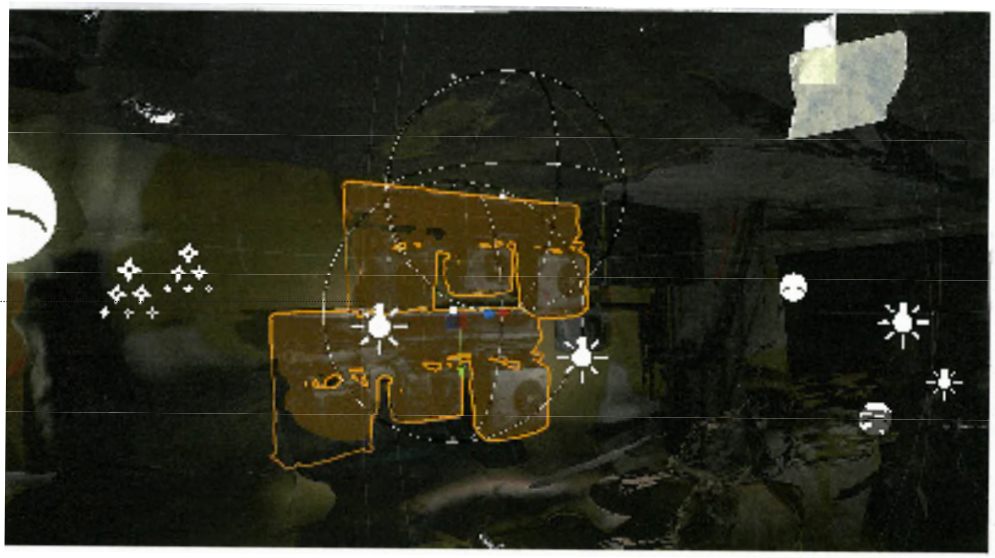


Figure_51.
The process that is undertaken to create spatial sound.

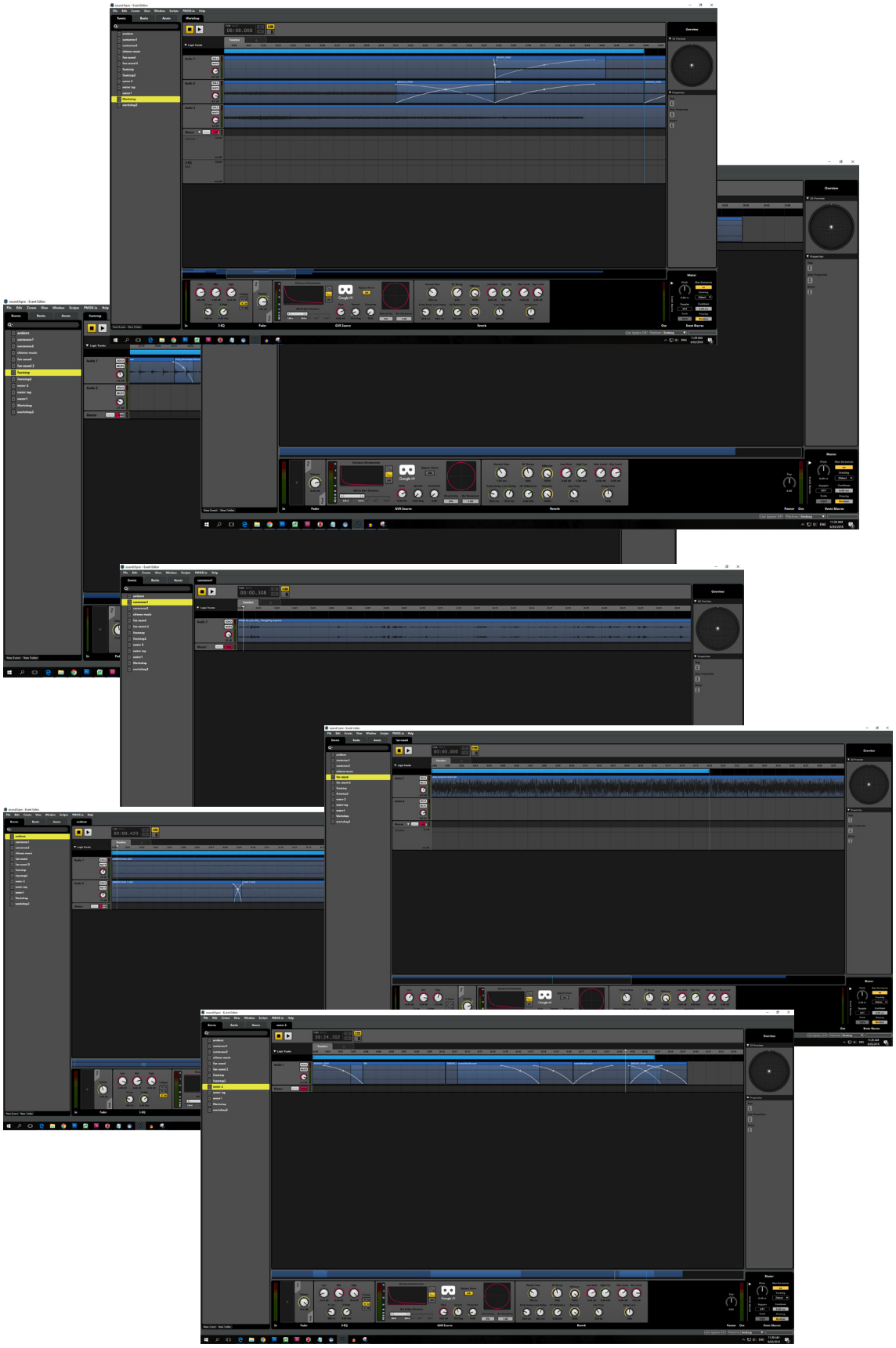


Figure_52.
The process that is undertaken to create spatial sound.

CHAPTER

6.0

DEVELOPED DESIGN

6.1 Developed Design

The developed design incorporates the lessons learned from the initial design testing. It utilises the techniques and tools identified to create an immersive embodied virtual experience of architecture. To see videos of the final developed environment scan the QR code.

Figure_53.
Corridor area within the developed design environment.

Figure_54.
QR Code linking to a web-page with videos that showcase the developed design environment.

6.2 User Evaluation

A user-lead qualitative experiment was carried out to pull out statistical data from the proposed developed designed environment. It was designed to make conclusions about two aspects of this thesis. 1. The experiment was split into seven parts for the seven intangible operators outlined in the design methodology chapter. They were seperated into:

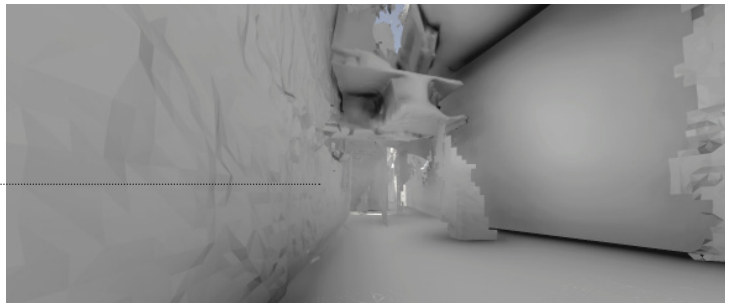
1. Geometry 2. Material
3. Movement 4. Lighting
5. Interaction 6. Inhabitation
7. Acoustics

Each operator had their own corresponding base environment. Starting from environment 1. (Geometry), other intangible elements were sequentially added. So for example, at environment 2, the aspects of material are added along with geometry. At 4, geometry, lightning, movement and material are all present, however interaction, inhabitation and acoustics are still removed. Each corresponding environment has a seperate group of user participants.

Using a test group of 21 people, the experiment sought to test how immersive each environment had relative to one another. This is to aid in analysing how successful the proposed design iterations, techniques and methods have been. If they have been effective in translating intangible qualities into the virtual environment, then the qualitative data should reflect that.

Figure_55.
The seven different environments for used for user-testing.

1. GEOEMTRY

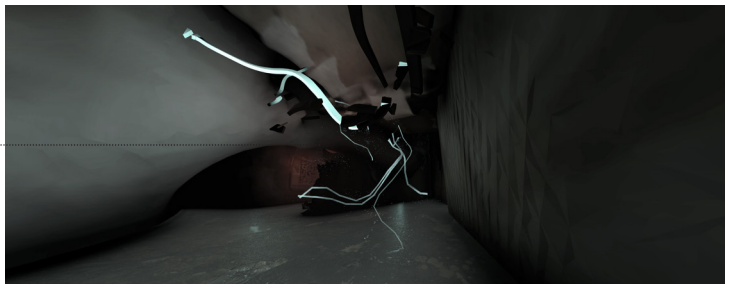


2. MATERIAL

3. MOVEMENT

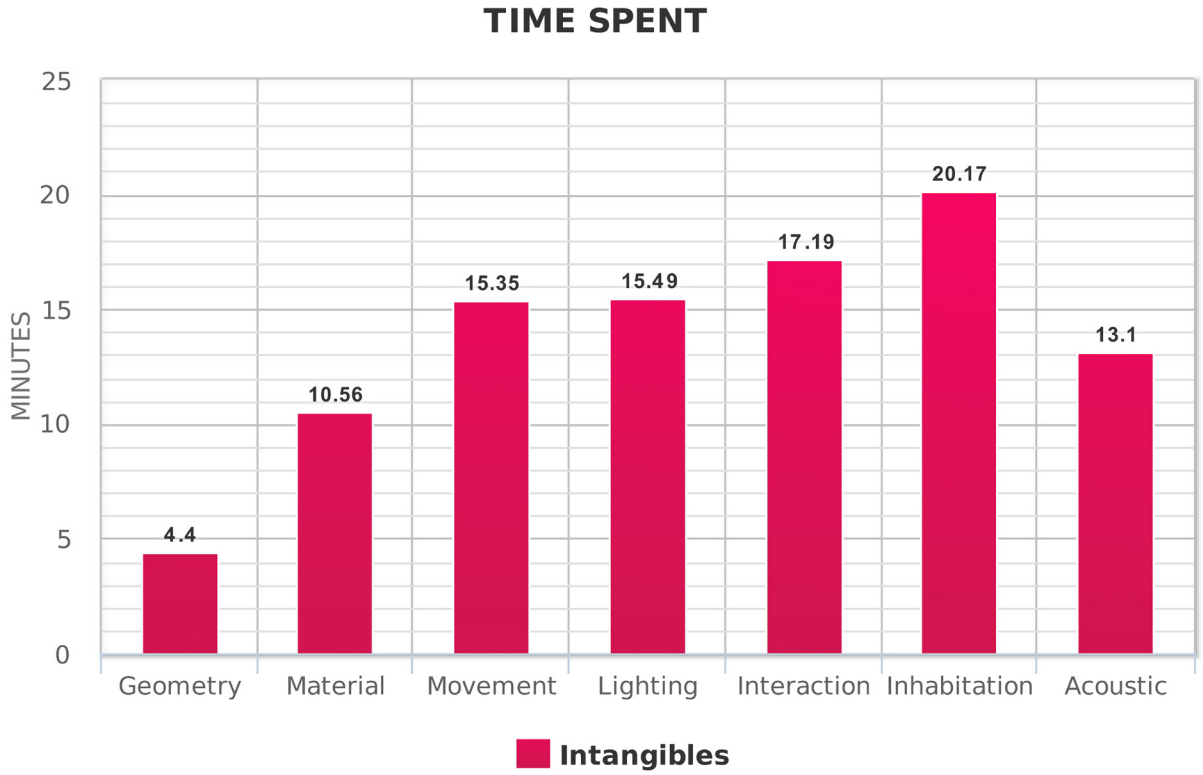
4. LIGHTING

5. INTERACTION



6. INHABITATION

7. ACOUSTICS



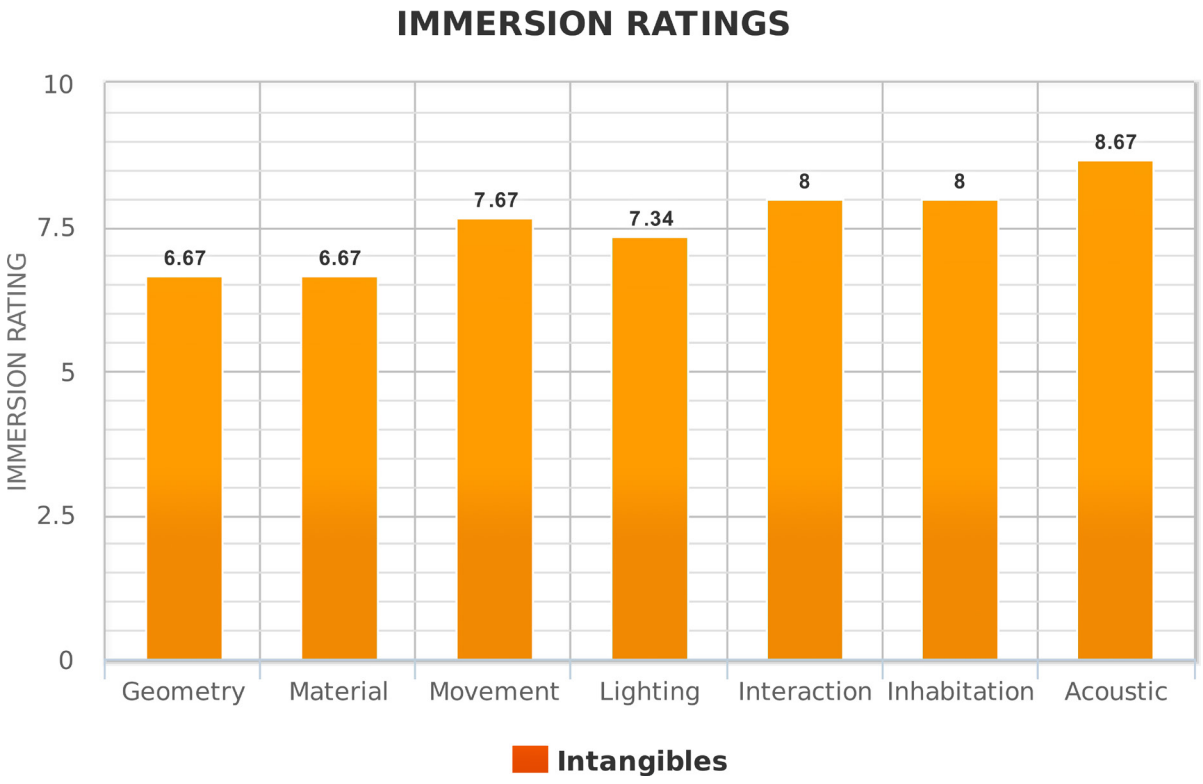


Figure_56.
Bar graph showing the immersion ratings of each test.

Figure_57.
Bar graph showing the time spent of each environment.

ORIGINAL DESCRIPTION (GEOMETRY):

".and its buildings, rising sometimes to 10 or 12 storeys, are so inextricably packed together that they seem to form one congealed mass of masonary, sealed together by overlapping structures, ladders, walkways, pipes and cables, and ventilated only by fetid air-shafts."

PARTICIPANT DESCRIPTION (GEOMETRY):

" A bright and desolate looking space. Seemed like a broken corridor. Lonely space, with many conjesting corridors leading to dead ends. Pipes and taps around every so often, like journeying into an abadonded/decrepit area."

Figure_58.
Word-cloud showing the density of words circled in the questionaire (geometry level)

Figure_59.
Descriptions of the environments, user vs inhabitant (geometry level).

6.3 User-Study Results

Experiment data was collected through the use of a questionnaire. Within the questionnaire users were asked to rate the immersiveness of their experience out of 10. Users were exposed to two environments to rate on the immersiveness scale, the base environment they were allocated to (1,2,3,4,5,6) and the final designed environment (7). The amount of time users spent in these environments was recorded as well.

Users were also asked to write a short anecdote describing their base environment, and also told to circle on a list of predefined words, which words best described the space.

The hypothesis is, that if the 'intangible narrative' workflow is an effective method of translating intangible operators into virtual space, then there should be an increase in the rating of immersion as more intangible operators get added, as well as the overall rating of the final developed designed environment should be rated highly. Likewise, the design iterations and techniques/tools used to create them are judged by the qualitative data. If they are successful, then there should start to be a correlation in the descriptions of the environments; that the user written descriptions should start mimicking the pre-established narrative criteria descriptions.

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As figure 56 shows, there indeed seems to be a positive relationship between intangible operators and immersiveness, that as more intangible aspects get added into the environment, the rated immersiveness trends upwards. Apart from acoustics, this trend seems to be also true of time spent. The most significant results were the the addition of movement (10% increase), acoustics (6.7%), and acoustics (6.7%). The one anomaly was lighting which saw a decrease in rated immersiveness. The overall immersion rating of the final designed environment was also on the higher end - 8.76/10. As a result, the data seems to suggest that the intangible narrative workflow has great potential as an effective way to create immersion.

For the qualitative data, the results varied much more significantly. Overall the data shows that throughout each of the environments, words or descriptors that described the space as narrow, dingy, dark and dense came up frequently. This suggests that the design processes and techniques undertaken in the creation of the geometry, materials and lighting and movement were successful. Lonely or desolate were words that also came up frequently throughout all environments. This suggests that the design of inhabitation was not as successful. Anecdotal evidence suggests that it was the poor implementation of people was the cause, as many of the participants said that the encounter with the realistic photogrammetry models made them feel like they were grounded in a place suddenly. For written descriptions, the user-generated descriptions did show a pattern of closely matching the narrative criteria descriptions as more the intangible operators were added, suggesting that overall, the techniques and methods used within the design process were effective.

CHAPTER

7.0

CONCLUSIONS

7.1 Discussion

The thesis sought to create a discussion around the current potential for VR and RTVE within architectural visulisation. Within the literature review there was an identification of three problems that currently stymie the use of these tools within architecture. The first was an idea of an ocular-bias, the second was the lack of representation of ephemeral and intangible qualities within VR experiences. And the third was the need to consider, on a more holistic level, a new design approach for mixed-reality. One that builds upon an amalgamation of architectural and film-narrative workflows and ideas. As a result the research question was:

What are the design methods and techniques that can effectively engage experiential and intangible qualities to lead to a more immersive architectural representation?

The proposed aims and outcomes of this thesis were to create a methodology and workflow that showcased which techniques and strategies designers could use that would represent intangible operators within virtual space in a more holistic and embodied experience. That holistic and embodied experience was identified to be linked very closely to a person's feeling of immersion and presence within space. As a result, the thesis progressed into focusing on the creation of immersion and presence within virtual space. This was to measure if the hypothesis of translating intangible aspects into space actually held any tangible evidence of making an experience of architecture more positive or embodied. Film was looked into heavily in regard to this. As established, film has a great knowledge of how to control our feeling of immersion within an inter-

-active virtual media. This thesis takes the narrative component that is critical within film and attempts to amalgamate it within a more traditional architectural design methodology. The end result was the proposal of a novel workflow called the “Intangible narrative” approach. It combines the narrative aspect for creating immersion, and the architectural workflow and toolsets that allow for the consideration of a body acting in space. This is the proposed holistic design approach for mixed reality space that was discussed earlier and is the first crucial part in answering the research question.

To test the effectiveness of the “Intangible narrative”, design ideations and potential techniques were investigated to translate intangible operators in space. This is the second part in answering the research question. Within the design explorations a range of different design tools and techniques were used as strategies to implement intangible operators in virtual space. The implementation of the design explorations within the final developed design environment reflects how successful the explored techniques are, and ergo the intangible narrative approach.

Evaluating the final developed design environment through the user testing suggest that the research question has been in some cases answered. Although the sample size was small, and further testing is needed to make an assertion, the data does point favorably towards the thesis’ proposed workflows of the intangible narrative approach and design techniques. It suggests that they could be an effective way of translating intangible operators into virtual space, and as a result create a more immersive architectural visualisation. The user-experiment conducted in this thesis also adds to the phenomenology position within the practice, reinforcing the ideas that as you shy away from ocularcentrism towards a more considerate/holistic approach of the body, and, inclusion of the intangible, the user immersiveness and bodily connection to a space increases.

7.2 Critical Reflection

There were obvious shortcomings with how the research progressed and was conducted. Firstly there was an establishment of how important cultural codes were towards the creation of presence and immersion, however outside of the initial site-context narrative storyboard, there were none-or little other cultural codes. This is because they were never established as criteria for the design explorations to meet at any stage, nor were tested. As a result, the research can be argued as being not a holistic approach or way of design. Another limitation and oversight was the assertion that the research could propose a truly holistic embodied experience within VR/RTVE. Although there is potential for these technologies to represent sound, sight and touch(haptics) within a virtual environment, they still fall well sort of being an embodied experience for the simple fact that the other sense we use to perceive, that of taste, smell and temperature are not possible with current technologies.

This insight meant that the research was always going to fail in this aspect. The research outcome, however, suggests that the designed VR immersive environment is at least, in a sense, more embodied than current rudimentary architectural VR visualizations. As a result, it is can be called a success in this regard. Another issue was the underestimation of the scope of the research. Within the design exploration stages, ideally there should've been a similar amount of case-study explorations aligned to each intangible operator. However, as it progressed, this was not the case. It was the result of an underestimation for how long certain aspects, techniques and tools take to use, learn and implement. For example, geometry had the most case studies, even though theoretically it should be the least important. Acoustics on the other hand had only one exploration. This is because acoustics, and inhibition were very lengthy process

to learn and learn how to implement. Sound engineers and 3d animators are professions in their own rights, and for an individual to try and implement those aspects, as well as the others was an oversight on scope.
From a technical standpoint, a significant amount of time was spent learning how to script c#. This didn't help to resolve the design explorations in a functional way, but i'd consider it a success. For myself, the output of skills learnt was as valuable if not more than the thesis research outputs.

This thesis accomplished answering the research question for the most part, it makes aware the potential for arch-vis within mixed reality, and in VR. Because of the hindsight in scope, there was a lack of clarity about the resolve of the explored design techniques and proposed workflow as being truly effective. As a result, this research is meant to be showcase a starting point to build upon. Future research could look more critically and in depth at the representation of specific criteria, with more in-depth test data.

Bibilopgraphy

Adabala, Neeharika, Naren Datha, Joseph Joy, Chinmay Kulkarni, Ajay Manchepalli, Aditya Sankar, and Rebeccea Walton. "An Interactive Multimedia Framework for Digital Heritage Narratives." Microsoft Research, October 25, 2010. https://www.microsoft.com/en-us/research/publication/an-interactive-multimedia-framework-for-digital-heritage-narratives-2

Bachelard, Gaston. "The Poetics of Space". Boston, Beacon Press. 1969.

Cameron, Fiona, and Sarah Kenderdine. Theorizing Digital Cultural Heritage, edited by Fiona Cameron, and Sarah Kenderdine, MIT Press, 2010. ProQuest Ebook Central, http://ebookcentral.proquest.com/lib/VUW/detail.action?docID=3338737.

Castle, Helen. "Empathic Space: The Computation of Huma-Centric Architecture. Architectural Design Magazine Vol. 84. 2014.

Champion, Erik. Critical Gaming: Interactive History and Virtual Heritage. Routledge, 2016.
———. "Defining Cultural Agents for Virtual Heritage Environments." Presence: Teleoperators & Virtual Environments 24, no. 3 (Summer 2015):

Champion, Erik, Ian Bishop, and Bharat Dave. "The Palenque Project: Evaluating Interaction in an Online Virtual Archaeology Site." Virtual Reality 16, no. 2 (June 2012): 121–39.

Champion, Erik, and Andrew Dekker. "Biofeedback And Virtual Environments." International Journal of Architectural Computing 9, no. 4 (December 2011): 377–96.

Dana POP. "Space Perception and Its Implication in Architectural Design". Acta Technica Napocensis: Civil Engineering & Architecture Vol.56, No2 (2013).

Eisenman, Peter. (2007). "Written into the void: selected writings", 1990-2004. New Haven: Yale University Press. 2017.

Goodwin, Kate, Ursprung, Philip. "Sensing Spaces: Architecture Reimagined". Royal Academy Publications. 2015.

Holl, Steven, Juhaani Pallasmaa and Alverto Perez-Gomez. “Questions of Perception: Phenomenology of Architecture. William K Stout Pub. 1994.

Rasmussen, S. E. (1962). Experiencing architecture. Cambridge [Mass.: M.I.T. Press, Massachusetts Institute of Technology.
Mcmahan Alison. “Immersion, Engagement and Presence”. Taylor Francis Group. 2003.

Murray, Janet. “Hamelet on the Holodeck: The Future of Narrative in Cyberspace. Cambridge MA: The MIT Press, 1997.

Pallasmaa, Juhani. “The Eyes of the Skin” Wiley; 1 edition. 1996.

Pallasmaa, Juhani. “Space, place and atmosphere. Emotion and peripheral perception in architectural experience”. University of Helsinki, Lebenswelt, 4.1. 2014.

Pujol, Laia, and Champion Erik. “Evaluating Presence in Cultural Heritage Projects.” International Journal of Heritage Studies 18, no. 1 (January 2012): 83–102.
———. “Evaluating Presence in Cultural Heritage Projects.” International Journal of Heritage Studies 18, no. 1 (January 1, 2012): 83–102.

Riva, Giuseppe & Davide, Fabrizio & Ijsselsteijn, Wijnand. (2003). ‘Being there: The experience of presence in mediated environments, ‘. Being There: Concepts, Effects and Measurements of User Presence in Synthetic Environments. 3-16.

Schnabel, Marc Aurel, and Serdar Aydin. “Decoding Kashgar.” 2015 Digital Heritage. Accessed April 5, 2017. http://www.academia.edu/17496410/Decoding_Kashgar.

Thompson, Fred. “A Comparison between Japanese Exterior Space and Western Common Place. Nordisk Arkitektuforskning. 1998 1-2.

Rohde, M, Joe. “Creating Narrative Space”. ICAM 15, Paris, session 4. 2 May 2010.

Zumthor, Peter “Thinking Architecture” Birkhauser Architecture; 3rd edition, 2010.

Zumthor, Peter “Atmospheres: Architectural Environments, Surrounding Objects” Birkhauser, 2006.

Image Sources

All figures not listed are of author's own work.

Figure 2.
POP Dana (2013). Cognition and perception diagram. Acata Napocensis: Civil Engineering & Architecture Vol 56, No 2, pg 213. Retrieved from: http://www.academia.edu/10935249/Space_Perception_and_Its_Implication_in_Architectural_Design.

Figure 3.
Harris, James (2014). Kengo Keuma Installation. Royal Academy of Arts. Retrieved from: https://www.royalacademy.org.uk/exhibition/sensing-spaces.

Figure 4.
Pujol, Laia, and Champion Erik. Virtual Rome."Evaluating Presence in Cultural Heritage Projects." International Journal of Heritage Studies 18, no. 1 (January 2012): 83–102. pg-95. Retrieved from: https://www.tandfonline.com/doi/abs/10.1080/13527258.2011

Figure 5.
Google (2017). Google Earth VR experience. Google. Retrieved from: http://store.steampowered.com/app/348250/Google_Earth_VR/

Figure 6.
Realities.io (2017). Realities.io VR experience. realities.io. Retrieved from: http://realities.io/