MASTER'S THESIS: **MASTERS OF DESIGN INNOVATION**
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CONSIDERING A **CINEMATIC FRAMEWORK** FOR **360 VIRTUAL REALITY VIDEO**

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Considering a Cinematic Framework for 360 Virtual Reality Video
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Appendix: Accompanying this thesis are test cinematic VR experiences and one final cinematic VR experience. Ideally, these are viewed through installing the WondaVR app (https://play.google.com/store/apps/details?id=com.wondavr.wonda.android&hl=en) to a capable smart phone. Then, copy the experience into the WondaVR file. Open the app and follow the instructions provided (A google cardboard or Gear VR is recommended).

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ABSTRACT

The sales of 360 cameras are estimated to increase by 7800% over the next six years (Ukonaho, 2016), while companies such as Google and Samsung continue to develop better and more affordable technologies for viewing and creating cinematic virtual reality experiences (cinematic VR). The VR medium offers new ways to communicate information and tell stories but we do not yet know how to tell those stories. The formal rules and understandings have not yet been defined. This research establishes ways that cinematic VR can appropriate techniques from cinema and game design. First, we explored a range of common cinema and game design techniques within the cinematic VR paradigm. Then, we analyzed four techniques, aperture/depth of field, 3D gifs from cinema, basic collision boxes and loading area screens derived from game design. Lastly, the most successful techniques are applied to a final short film experience in order to contribute to storytelling and communication through this medium.

CHAPTER 1 **INTRODUCTION**

Cinematic Virtual Reality (Cinematic VR) is one of the emerging mediums alongside Virtual Reality (VR) and Augmented Reality (AR) with the production of more advanced head mounted displays (HMD) Headsets and 360 cameras. It can be argued that Cinematic VR and VR are the same medium, both utilising virtual environments (VEs) and HMD headsets with the major differences being primarily in interactivity. Cinematic VR draws heavily from the film industry while VR draws from the games industry. This thesis is focused specifically on Cinematic VR but Cinematic VR and VR will be treated as offshoots of the same medium, similar to how animation and live action are both considered mediums of film. The formal language and techniques associated with either medium have not yet been fully defined. Therefore the purpose of this thesis is to establish ways in which Cinematic VR can appropriate established techniques from cinema and game design. Visual techniques from cinema will be analysed, including: aperture/depth of field and white bar optical illusions, while interactive techniques from game design will be explored including: movement and object interaction. Each technique has a specific role in either cinema or game design. This thesis will take a general look at each technique in relation to narrativity, presence, immersion, vividness, interactivity and suspension of disbelief in order to understand their purpose and how they can be transmuted to Cinematic VR.

THE GOALS OF THIS THESIS

The context for VR technology, content and taxonomy have largely revolved around the technological aspects of VR (Ryan, 1999); there are still technology and production challenges to be overcome. “What this community desperately needs is for content developers to understand human perception as it applies to VR, to make experiences that are comfortable (i.e., do not make you sick), and to create intuitive interactions within their immersive creations” (Jerald, 2015). This thesis is not about technological advances; instead it is about utilising the best tools at the current time to develop a foundation for content creation. Content should be created with a purpose that adds value, otherwise, there’s little reason to produce it (Highton, 2015). In both cinema and game design, techniques have been developed that add specific intuitive value to a body of work. Therefore, “a systematic exploration of the potentials, possibilities, advantages and constraints of Cinematic VR now needs to be carried out in relation to different types of functionality and application” (Aylett & Louchart, 2003, p. 2) in order for cinematic VR to develop these intuitive rules.

The overall goal of this thesis is to utilise existing techniques for cinema and game design and adapt them to Cinematic VR experiences to add value to the content. My personal interest is focused around communicating effectively through a range of digital media including film, games, graphic and interaction design. Investigating a medium where the formal techniques of communication have not yet been defined instantly appealed to me. Cinematic VR is also very close to the medium I am most fluent in: film. Where films work within a rectangular space, cinematic VR instead works within a full spherical 360 degrees of space. The change of the format opens countless new possibilities to add new value to an experience. This thesis explores the technical conventions that assist communication in Cinematic VR. To achieve this my thesis follows three distinct aims:

1. Investigate the current state of Cinematic VR. Then analyse how technical and narrative conventions of cinema and film can be appropriated by Cinematic VR. This is the textual aspect of my thesis and is achieved through conducting a literature review and textual analysis.
2. Design, build and test Cinematic VR experiences which showcase the appropriated cinema and game techniques from Aim 1. This will be achieved by a series of short Cinematic VR test experiences which illustrate specific textual or narrative aspects.
3. Design, build and test a final Cinematic VR short film experience which utilises the appropriate techniques to communicate a short narrative.

From these three aims the final outcomes for this thesis will be a final short cinematic experience, supporting documentation, and test Cinematic VR experiences.

CHAPTER 2 **DEFINING VR**

The relationship between VR and Cinematic VR is a highly discussed and contested one, with conflicting definitions over what can be categorised as VR. For the purpose of this research VR and Cinematic VR are considered different sub-mediums of the overarching VR medium. Firstly, an analysis of the conflicting views is conducted. Followed by a justification of the benefits of this research.

WHAT IS VIRTUAL, WHAT IS REALITY

To understand the various definitions of VR, an understanding of what constitutes as virtual, and what constitutes as reality is essential. The *Virtual Reality Society* (2015) defines 'virtual' as near, and `reality` as what we experience as human beings, so the term 'virtual reality' basically means 'near-reality'. This could, of course, mean almost anything but it usually refers to a specific type of reality emulation. The intention is that the subject matter is either actually present in reality, or the subject matter is synthesised by computer and is virtual instead. Simple clarifications are not always sufficient in virtual reality. Complications arise such as "whether particular objects or scenes being displayed are real or virtual, whether images of scanned data should be considered real or virtual, whether a real object must look 'realistic' whereas a virtual one need not, etc." (Milgram & Kishino, 1994, p.1324). An existing object can be observed in reality and can also be captured and resynthesised via a display device. For the purpose of VR we can define reality as anything that has an actual objective presence and virtual as anything that exists in essence or effect, but not formally or actually.

VARYING DEFINITIONS

Academics, bloggers and creators all have different opinions about what VR is. Their viewpoints vary based on whether they come from technological, cultural or philosophical perspectives. “Virtual reality (VR) is typically defined in terms of technological hardware” (Steuer, 1993, p. 2) as described by these definitions: One, “Virtual Reality is electronic simulations of environments experienced via head mounted eye goggles and wired clothing enabling the end user to interact in realistic three-dimensional situations” (Coates, 1992, p. 4). Two, “Virtual Reality is an alternate world filled with computer-generated images that respond to human movements. These simulated environments are usually visited with the aid of an expensive data suit which features stereophonic video goggles and fiber-optic data gloves” (Greenbaum, 1992, p. 4). Three, “Jaron Lanier, CEO of VPL, coined the term virtual reality in 1989 to bring all of the virtual projects under a single rubric. The term therefore typically refers to three-dimensional realities implemented with stereo viewing goggles and reality gloves” (Krueger, 1991, p. xiii). Technology is not, however, the only context which VR is discussed.

Other definitions discus VR from more psychological or cultural viewpoints. One, “The conventionally held view of a Virtual Reality (VR) environment is one in which the participant observer is totally immersed in, and able to interact with, a completely synthetic world” (Milgram & Kishino, 1994, p. 1321). Two, “VR is an alternate world filled with computer generated images that respond to change in motion based upon the human present in that environment” (Ebersole, 1997). Three “virtual reality is defined as a real or simulated environment in which a perceiver experiences telepresence.” (Steuer, 1992, p. 7). Each definition is relevant within the context in which they have been utilised. There are also definitions which explain VR on a scale and analyse ‘how much’ content is VR.

VR AS A CONTINUUM

The definitions of VR so far have been clear cut, something either is or is not VR. On top of these definitions multiple authorities have proposed continuums where something may be VR to a degree. Two examples are Fumio Kishino & Paul Milgram's A *Taxonomy of Mixed Reality Visual Displays* & Maria Sanchez-Vives & Mel Slater's *immersion continuum in From presence to consciousness through virtual reality.*

FUMIO KISHINO & PAUL MILGRAM

A TAXONOMY OF MIXED REALITY VISUAL DISPLAYS

Kishino and Milgram proposed the virtuality continuum in 1992 "which connects completely real environments to completely virtual ones" (Milgram & Kishino, 1994, p. 1321). This continuum is a excellent way to visualise the difference between a real environment and a virtual environment and, under the correct circumstances, is extremely informative. Cinematic VR does not, however, have a clear cut standing anywhere within this spectrum.

MIXED REALITY (MR)

PHYSICAL **REALITY**

AUGMENTED **REALITY**

AUGMENTED **VIRTUALITY**

VIRTUAL **ENVIRONEMENT**

MARIA SANCHEZ-VIVES & MEL SLATER

FROM PRESENCE TO CONSCIOUSNESS THROUGH VIRTUAL REALITY.

In 2005 Maria Sanchez-Vives and Mel Slater proposed a three part continuum based on the level of immersiveness that each device's technical capabilities provide. Immersion is another contested term but the authors of this continuum define it as the "technical capability of the system to deliver a surrounding and convincing environment with which the participant can interact." (Sanchez-Vives & Slater, 2005, p. 333). Immersion is the physical inputs that are provided to a participant's main six senses and the less known senses such as balance to create the strong illusion of reality. VR "relies on perceptual stimulation in particular, visual cues, sounds, and sometimes touch and smell – to trigger emotional reactions" (Diemer, Alpers, Peperkorn, Shiban, & Mühlberger, 2015). Sanchez-Vives and Slater propose that the more senses a device caters to, the more immersive and the closer to true VR it is.

At the lowest level non-immersive VR systems or desktop VR involve looking through screen(s) and interacting with applications. "A user can then interact with that environment, but is not immersed in it" (Mandal, 2013, p. 3), for example desktop or mobile computer games. The second level, semi-immersive or fish tank VR, are systems that support head tracking to improve the sensation of being inside the experience. "They still use a conventional monitor (very often with LCD shutter glasses for stereoscopic viewing) but generally do not support sensory output."(Mandal, 2013, p. 3). Cinematic VR traditionally falls under this category. Cinematic VR can be viewed and the illusion of interactivity presented but an image is only a 2D representation of a three-dimensional space (Jayaraman, 2009) and therefore cannot truly be interacted with. Finally, immersive systems are the most developed VR systems in terms of immersion. "They let the user totally immerse in a computer generated world with the help of HMD that supports a stereoscopic view of the scene according to the user's position and orientation" (Mandal, 2013, p. 3). Game or CGI VR experiences where the user can move through and interact with the environment are examples of immersive VR. By these definitions all desktop applications are a form of VR and Cinematic VR is categorised as 'part VR' or 'semi immersive'. Like many of the definitions proposed, this one looks at VR from a technology viewpoint over any other.

VR, A TECHNOLOGY FOCUS

Most popular definitions of virtual reality make reference to a particular technological system (Steuer, 1993). They focus on how the technology meets particular standards and specifications with references to computer generated and mediated environments, wired gloves, position trackers and head-mounted stereoscopic displays. This makes sense as VR technologies must meet a certain level of competence to create a consistent experience. The content for VR cannot be successfully viewed if for example, every participant gets sopite syndrome (motion sickness) from the experience. These technological barriers need to be overcome before mainstream content can be invested in and produced, hence the history of VR has primarily been about the technology and overcoming said barriers. Back in 1993 Jonathan Steuer from Stanford University concurs that the focus of VR is technological, “the locus of VR is a collection of machines and such a concept is useful to producers of VR related hardware” (p.3).

A device driven definition is unacceptable to anyone who is looking at VR from a non-technological angle, including software developers, policy makers and media consumers. A technology-driven definition fails to provide: insight into the processes or effects of using these systems, a method for consumers to express their experiences, an aesthetic form from which to create media products or a conceptual framework. “Stop focusing on primarily technical implementation and start focusing on these challenges that offer the most value to the VR community of the present day” (Jerald, 2015). As this thesis is centered on content creation and accessibility over technology development, these same limitations have presented themselves.

Writers from news/blog sites such Wired, UploadVR and Realvision argue that Cinematic VR is not VR at all. For one thing, it does not give the user complete freedom of movement and interactions as it is only a 2D representation of a three-dimensional space (Jayaraman, 2009, p.1). Secondly for this thesis we argue that that a filmed VE is still a virtual representation of reality but there is argument for this constituting reality. Multiple definitions also claim that VR must be computer generated that would also imply that Cinematic VR is not actually VR (Smith, 2015).

There are two main arguments, the purists arguing that if an experience does not meet all VR criteria then it is not VR while pragmatists argue that any experience viewed in 360 degrees is VR. Regardless of the validity of either approach this thesis is about learning how to communicate through the medium. From these arguments it can be concluded that for this thesis VR is “a real or simulated environment in which a perceiver experiences telepresence” (Steuer, 1993, p. 7). Regardless of whether you subscribe to the purist or pragmatist view this thesis adopts this definition for the framework it provides. This definition moves away from the technical definitions by referring to an experience over machines and therefore moving from a particular hardware package to the perceptions of an individual. This definition creates a concrete unit of analysis for VR, a means for examining VR in relation to other types of mediated experiences and a set of dimensions over which VR can vary. It ensures that newly developed technologies can be examined in relation to other media technologies. Therefore Steuer’s definition of VR in terms of presence/telepresence creates a sound framework. This definition is still imperfect and purists would argue it’s far too broad. But the definition is only based on what is most applicable to this study.

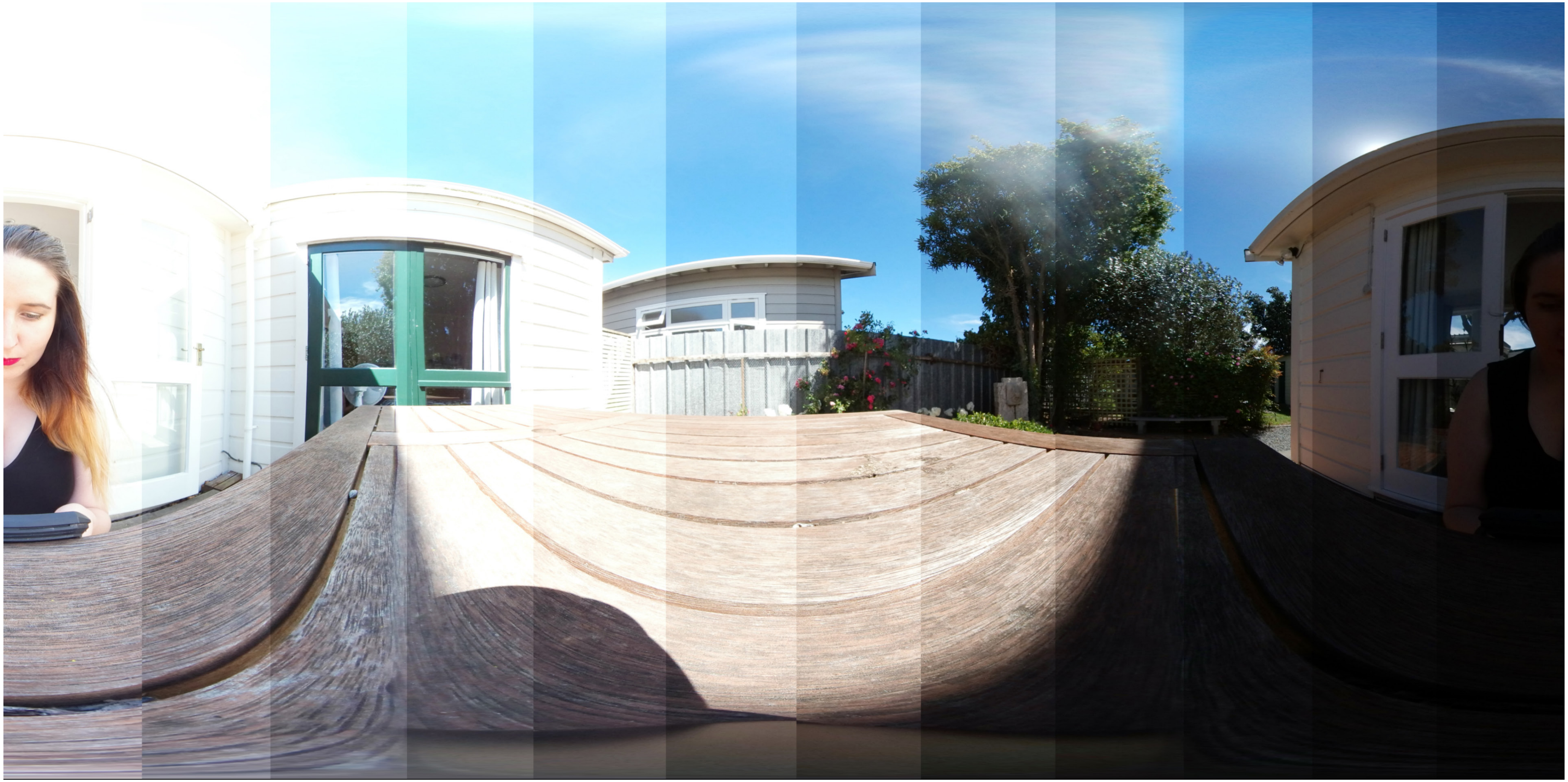

Figure 1. 360 Testing conposition shot, exposure

CINEMATIC VR

Technically Cinematic VR is panoramic videos captured through a 360 degrees video camera (Parisi, 2015). This thesis has defined VR and Cinematic VR as sub-genres of the same medium where VR draws heavily from the games industry and Cinematic VR draws from the film industry. Until this point we have primarily discussed VR and Cinematic VR in general terms but the focus of this thesis is cinematic VR. Cinematic VR is viewed through the same mechanisms as traditional VR but it varies in multiple key areas that create unique challenges for creators.

360 VR DEFINITIONS

For footage which encompases a 360 degree field of view there is no current consensus on the taxonomy. Instead there are multiple labels that mean the same or similar things. Cinematic VR labels include: immersive videos, 360° videos, spherical content/video/film, stereoscopic video, live action VR, 360 experience and cinematic VR. Another question is whether 180 degrees viewing in an HMD headset is VR at all? Regardless of the answer there is another range of terms for 180 degree content and often they are labeled as VR anyway. This creates a confusing array of terminology when referring to 360 experiences. Some have no obvious differences in meaning. While others could be likened to live action and animation, both are considered film where one is computer generated the other filmed, but live action can also have animated aspects. The Cinematic VR director Patrick Meegan (2016) describes Cinematic VR to mean "you're capturing the real world and putting it into a VR headset to make the person feel as though they are really experiencing this world that you have captured". This thesis uses Cinematic VR over any other terms for several key reasons.

First, the Cinematic VR definition is relatively broad and can be used to address all the alternative terminologies within this medium. Cinematic VR can be based on computer graphics animation, or they can be captured from real life using spherical cameras (Parisi, 2015). Therefore, animations can be termed Cinematic VR which many of the other definitions exclude.

Secondly, the term cinematic implies a certain level of consideration in the production of any given experience. The term gives emphasis to storytelling and the application of cinematic principles and conscious use of techniques while still including other areas such as amateur videos and vlogging. Although anyone with a 360 camera can make a 360 video, Cinematic VR implies narrative, an emotion, a message to impress upon an audience and therefore it is important to prioritise meaningful experiences rather than spending time and money simply pursuing the latest trends. For visual storytellers it is not enough to document a subject or simply create a beautiful image (Highton, 2015).

Lastly, the term cinematic, although largely applied to time based media is also used in the context of other media such as gaming. This opens the definition to including the grey areas between film, game, VR and AR. This is especially important as we are looking at interactive techniques from game design as well as visual techniques from film to utilise. It is predicted that the outcome of this thesis will be an interactive experience over a static video.

VR AND CINEMATIC VR

The main point where Cinematic VR differs from the CGI based VR is in how each type generates VEs. Either the experience is a 360 capturing of the real world or computer generated through programs such as Maya. The same difference lies between live action and animation films. Many definitions of VR are from a technology viewpoint that advocate for 3D computer model and real time control by the user. This encourages interactive navigation and manipulation with stylised often cartoon-like environments. Cinema is the opposite with little to no interactivity but, instead, photo-realistic imagery.

Most of the efforts around VR have originated from computer culture. Alternatively Cinematic VR also incorporates complementary efforts from cinema culture. We are looking at the existing storytelling conventions and what audiences have come to expect from all related media. "Engaging this cross pollination of communities is essential to discovering what this medium is all about" (Meegan, 2016). The challenge of Cinematic VR (and VR) is in the convergence of mediums like cinema, computing and theater (Naimark, 1998). We need to be good storytellers, photographers, filmmakers and game developers. Watching a movie or TV program has always been a passive activity. Audiences expect the story to unfold for them on a screen. As producers, we need to be willing to guide them through our panoramic movies by utilising both new and traditional filmmaking techniques. We need to prevent them from missing important moments because they are distracted or looking the other way in our VR environments (Highton, 2015). Alternatively, gamer culture encourages a more user lead experience with the user choosing where to look and how the game progresses. The challenge for Cinematic VR in this instance is the inherently static nature of recordings.

The pragmatist approach to the taxonomy and research surrounding VR in this thesis encourages innovation and the creation of unique experiences over a meaningless copy and paste from similar media. From here we will discus the importance of narrative and conventions. Then we will discuss and test cinema and game technique. Finally, we will explore the process used to create the final short film experience.

CHAPTER 3 **THE VR INDUSTRY**

BRIEF HISTORY OF VR MEDIA

A brief History of key historical moments in Cinematic VR, 360 Videos, Virtual Reality and cinema is worth considering. VR has been at the forefront of recent discussions with the release of a range of HMD headsets (Oculus Rift, Hololens), but 360 degree viewing also has a long history which has been documented by the Virtual Reality Society (2017).

1700'S PANORAMIC PAINTINGS

Panoramic Paintings were one of the earliest forms of media that created the illusion that a view is present somewhere the viewer is not. These 360 degree murals were intended to fill the viewer's entire field of vision. The Irish painter Robert Barker popularised Panoramic Paintings. Enormous paintings were displayed in purpose-built circular rotundas. Barker's Panoramas were hugely successful and spawned a series of "immersive" panoramas by other artists, which drew thousands of patrons to witness re-creations of exotic locations, nature and battle scenes. A phenomenon resulting from immersion in a panorama, called the "locality paradox", happened when people were unable to distinguish whether they were in the exhibition rotunda or at the actual location of a scene. Though popular, or maybe due to the attention they received, critics ridiculed Panoramic Paintings claiming they lulled viewers into lethargy, inhibiting their ability to imagine things for themselves.

1838 STEREOSCOPIC PHOTOS & VIEWERS

In 1838 Charles Wheatstone's research demonstrated that the brain processes the different two-dimensional images from each eye into a single object of three dimensions. Viewing two side by side stereoscopic images or photos through a stereoscope gave the user a sense of depth and immersion. The later development of the popular View-Master stereoscope (patented 1939), was used for "virtual tourism". In 1849 The lenticular stereoscope was invented by David Brewster and in 1939 The View-Master was invented by William Gruber. The design principles of the Stereoscope is used today for the popular Google Cardboard and low budget VR head mounted displays for mobile phones.

1897 PARIS EXPOSITION

The First cinema patent was awarded in 1897 for a process called Cineorama. Cineorama premiered at the 1900 Paris Exhibition, where ten synchronised 70mm projectors projected onto ten, thirty-foot high screens arranged in a full 360° circle. A viewing platform dressed like a hot air balloon, large enough to hold 200 people, was in the centre. The film was shot by locking a circular array of ten cameras to a central drive, putting them in an actual hot air balloon, and filming as the balloon rose more than 1,000 feet above Paris. Cineorama's only public viewing was short lived. It closed after three days for safety reasons, due to the extreme heat from the projectors' arc lights. The virtual experience was more dangerous than the actual reality.

1929 LINK TRAINER THE FIRST FLIGHT SIMULATOR

Edward Link created the "Link trainer" (patented 1931) as a commercial flight simulator, which was entirely electromechanical. It was controlled by motors that linked to the rudder and steering column to modify the pitch and roll. A small motor-driven device mimicked turbulence and disturbances. Such was the need for safer ways to train pilots that the US military bought six of these devices for $3500. In 2015 money this was just shy of $50 000. During World War II over 10,000 "blue box" Link Trainers were used by over 500,000 pilots for initial training and improving their skills.

1930'S SCIENCE FICTION PREDICTIONS

In the 1930s a story by science fiction writer Stanley G. Weinbaum (Pygmalion's Spectacles) outlines the idea of a pair of goggles that let the wearer experience a fictional world through holographics, smell, taste and touch. Other predictions about the future of VR are made throughout 1900's science fiction media, including in 1966 the pilot episode of Star Trek.

1950'S MORTON HEILIG'S SENSORAMA

In the mid 1950s cinematographer Morton Heilig developed the Sensorama (patented 1962) which was an arcade-style theatre cabinet that would stimulate all the senses, not just sight and sound. It featured stereo speakers, a stereoscopic 3D display, fans, smell generators and a vibrating chair. The Sensorama was intended to fully immerse the individual in the film. He also created six short films for his invention all of which he shot, produced and edited himself. The Sensorama films were titled, Motorcycle, Belly Dancer, Dune Buggy, helicopter, A date with Sabina and I'm a coca cola bottle!

1960'S HEAD MOUNTED DISPLAYS

During the 1960's there was a rise in innovation around head mounted displays Morton Heilig's Telesphere Mask. Two Philco Corporation engineers (Comeau & Bryan) developed the Headsight as the first precursor to the HMD as we know it today. Then in 1965 Ivan Sutherland described the "Ultimate Display" concept: "The ultimate display would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal. With appropriate programming such a display could literally be the Wonderland into which Alice walked." – Ivan Sutherland. This was followed in 1968 by Ivan Sutherland and his student Bob Sproull creating the first VR / AR head mounted display (Sword of Damocles).

1987 VIRTUAL REALITY THE NAME WAS BORN

Jaron Lanier, founder of the visual programming lab (VPL), coined the term "virtual reality". Through his company VPL research Jaron developed a range of virtual reality gear including the Dataglove (along with Tom Zimmerman) and the EyePhone head mounted display. They were the first company to sell Virtual Reality goggles (EyePhone 1 $9400; EyePhone HRX $49,000) and gloves ($9000). A major development in the area of virtual reality haptics.

1990S, 2000'S HEADSET RELEASES

The next 20 years showed the occasional release of films predicting the direction of virtual reality, or early VR technologies that had varying degrees of success. 1991 – Virtuality Group Arcade Machines, 1992 – The Lawnmower Man, 1993 – SEGA announce new VR glasses, 1995 – Nintendo Virtual Boy, 1999 – The Matrix ("Virtual Reality Society", 2015).

VR CONTENT

In the entertainment industry there is VR content currently on the market. Mostly the industry is populated with games, films and experimental art. Invasion (Darnell, 2016) is an static animated short cinematic VR 'pixar styled' piece about the humorous interaction between a rabbit and aliens. This short used audio to draw the user's gaze and predominantly utilised the front 180 degree of the experience for the narrative. Jurassic World: Apatosaurus (Felix and Paul Studios, 2015) is also an animation focussing on scale by placing the user next to a huge dinosaur. Notes on Blindness (ARTE Experience, 2016) is an experimental piece that depicts an animated world based on a blind man's interpretation of reality. Furthermore, there is a section on steam dedicated to VR content. Youtube and facebook have dedicated 360 viewing platforms for vloggers and ameture filmakers to upload their content. New Zealand is also participating in VR with companies like 8I and installations like the green fairy; a exhibition aimed at young children. The standard of the content being produced varies. Games like temple run has been appropriated to the VR space and cause motion sickness or are unplayable for various reasons. While indie work is being produced companies such as Google and Samsung are also investing in technology and content in this medium.

VR CURRENT MARKET AND PROJECTIONS

The sales of 360 cameras are projected to grow over 7800% over the next six years with rapid growth for semi professional grade cameras aimed at prosumers. The professional grade cameras will also see growth as more established Hollywood studios begin offering 360 movies (“Global 360 Camera Sales Forecast,” 2016). The popularity of 360 cameras is driven by the sales of VR headsets. The market for VR related technologies is accelerating, expanding and offering new innovations at a rapid pace with a $120 billion AR/VR forecast for 2020 (Rosiński, 2015). Between 1990 and 2010 there was a small range of VR related technology released for commercial use. At present, companies like Steam, Google, Oculus and Samsung are putting lots of resources into tools for experiencing and creating VR, including VR headsets, 360/dual lens cameras and specialised haptic feedback controllers.

The games and film industries have already proved that there is a lot of money to be made from merging stories with technology (Glassner, 20`01, p. 51). There are still numerous technical, price and content challenges that need to be overcome. Despite this, VR is now a functional system adopted as part of the new media landscape by numerous magazines, newspapers, TV shows, TV ads, feature films, marketing campaigns, and social media platforms. (Mathew, 2014, p. 898).

VR'S IMPACT ON OTHER FIELDS

The primary industry focus of this thesis is the entertainment industry, but there's also potential for impact in arts, military, business, communication, design, education, engineering, medicine and many other fields (Mathew, 2014, p. 894). Across many industries, VR can be utilised as an innovation tool that creates a visual and interactive VE in which the user can be fully immersed. "VR is considered as a way to trounce limitations of ordinary human computer interfaces. Thereby this technology cumulates the use of complex and highly integrated interfaces to yield solutions to new applications" (Mathew, 2014, p. 895). Across many industries VR is a solution for when something is too dangerous, expensive or impractical to achieve in reality. VR allows for virtual risks to be taken while still gaining real world experience. ("What is Virtual Reality?," 2015).

The price of VR technologies is predicted to drop, become more accessible and more mainstream over the next 10 years. This is illustrated by Oculus Rift dropping the HMD headset and controller price by $200 in march 2017 (Mitchell, 2017). The lower the price tag the more VR will be utilized. For example, the military's main interest in VR is to save lives (Mathew, 2014, p. 897). Many injuries are induced while training. VR can simulate training scenarios like parachuting, shooting and urban combat in order to greatly reduce the risks to soldiers. There is also opportunity for advanced training with realistic environments, better operational awareness and cost savings. In architecture, architects can also construct virtual tours to help customers visualise construction. While in medicine, VR helps in the docking of molecules using visual and auditory displays (Mathew, 2014, p. 897). "Education, telepresence and professional training will likely be the next industries to take advantage of VR in a big way" (Jerald, 2015). Therefore, VR has applications across multiple industries.

WHY VR MEDIA IS ADVANCING

The commercialisation of VR is contributing primarily to the advancements in HMD headsets, 360 cameras, and real-time rendering engines such as Unreal and Unity. Matthew concurs that “VR had its breakthrough with innovative applications like its high technology system which correlates with the display technology, simulation technology, network technology, sensor technology artificial functions as well as computer graphic technologies” (2014, p. 896). The technological advancements have gained commercial interest which created a cyclic event. Money is used to fund new VR technology which in turn generates more money and interest to spend on more advancements.

That’s not to say VR doesn’t still have technical and commercial challenges to overcome. VR is subject to the ‘Uncanny Valley’ phenomenon coined in 1970 by Masahiro Mori to describe the human reaction to things that appear almost human, but somehow miss the mark in a manner humans are instinctively repulsed by (Weschler, 2012). The challenge of VR is that when making sense of an experience, users assume it follows the same rules and mechanisms as everyday life (Diemer, Alpers, Peperkorn, Shiban, & Mühlberger, 2015). The virtual environment (VE) needs to look, act, sound and feel real because even if it is slightly off the participant can sense it. This does not necessarily mean it needs to look realistic but it does need to behave in a manner the user intuitively understands. For example, the human visual field is approximately 180 degrees and although we are not always consciously aware of our peripheral vision we notice when it is removed (“What is Virtual Reality?,” 2015). It is also noticed by the user if the resolutions of the VE are poor quality. There could be lag between the user’s movement and the visual response causing dizziness. Cinematic VR and most VR technologies at this stage do not allow for tactile feedback (Matthew, 2014, p. 898). VR has been likened to microcomputers in the 1970's which, after much development, overcame their respective challenges. Many tech companies (such as Google and Oculus) are concentrating on creating mobile solutions which is why VR can be expected to follow the trend set by microcomputers.

The commercial interest in HMD headsets and related VR technologies is derived from existing commercial success from earlier human computer interfaces such as desktops/ laptops, mobile devices and tablets. Existing human computer interfaces including desktops are widely used. Human computer interfaces are limited to the virtual environment display and the illusion that the user is managing, interacting and altering physical objects. Through these displays only limited information can be shared about the three-dimensional world, which usually provides the user with a lower level of sensory feedback. The key difference or selling point of VR is it can "include additional depth information which can be induced by forming a prototype model of heterogeneous instance, thereby making it more complex. New interfaces and devices enable users to work in such environments" (Mathew, 2014, p. 895). An example is that VR is not limited to the rectangular construct and instead there is 360 degrees of space and the scale of objects is then altered accordingly.

FUTURE OF VR

"VR in no way comes close to reaching its full potential. Not only are there many unknowns, but VR implementation very much depends on the project. For example a surgical training system is very different from an immersive film"

(Jerald, 2015).

Is VR/AR here to stay? Or is it a passing fad? Whichever belief you subscribe to, big companies are investing time and money into overcoming the challenges this medium presents. This thesis is designing for the present and future VR content creation. At the 2016 GDC conference Professor Jesse Schell from CMU predicted potential developments for VR over the next 10 years: By 2018 Schell expects eye tracking VR headsets will be available, and by 2020 he expects at least 10 virtual reality reality shows and foveated Rendering (Only render where the eye is looking) will exist. By 2025 VR Schell predicts home movies will be treasured possessions where users can relive important events and VR feature films will become social experiences in order to be most effective.

Current advances in digital imaging, computer processors, mass storage devices, image compression and efficient archiving enable the retrieval and extraction of more useful information from images (Jayaraman, 2009, p.X). This will help in the creation of more sophisticated 360 camera technologies. Two applications for these advancements are light field technology and volumetric video. Currently both methods exist in some form but are not accessible price wise nor are they fully serviceable.

Light field technology is being explored by Lytro who have developed a range of light field cameras. Light field cameras use an array of small lenses to allow light to be captured from multiple vantage points. By calculating the intersection of light rays in the scene images are produced with both color and depth (Lytro, 2016). With Lytro you can edit the focus, shutter angle, frame rate and calculate each pixel's frame in space while in post-production. The 'Lytro Cinema' camera collects so much data that it comes with its own server. With traditional cameras, "light rays pass through the camera's lens and aperture, and then hit the sensor or film to form the image" (Lytro, 2016). Basically, light field technology utilises the information that multiple camera sensors placed beside each other reveal about the space.

Volumetric video is the process of taking enough simultaneous 2D images of an environment to create a 3D model. "Image-based rendering may fulfill a common dream in many VR circles: to wave a camera around an actual place and to end up with a 3D computer model" (Naimark, 1998). Companies such as 8I are investigating volumetric video. At CES 2017 Hype VR and Intel revealed that every frame of their volumetric video experience is 3GB big. This is far too large for consumer grade products to easily handle.

Light field and volumetric data enable a larger amount of control over the 2D image properties and help to extrapolate an accurate representation of a 3D space. The average consumer's computer cannot handle this data accurately. But if/when they do, there will be many more possibilities for interactive cinematic VR experiences.

CHAPTER 4 **MEDIA AND THE AUDIENCE**

The importance of media is in its ability to express, educate, persuade, entertain or otherwise communicate with users (Potter, 2012). The expression of ideas, information, stories and feelings etc. is produced uniquely within each medium. Either the most appropriate medium for the message is utilised or the message is adapted to suit the medium more accurately. Broadly speaking, books, cinema and theatre communicate stories; games and installations communicate experiences; while web pages and print media communicate information. VR is about "providing understanding - whether that is understanding an entertaining story, learning and abstract concept, or practice a real skill" (Jerald, 2015). VR experiences are specifically designed to be event-centric, personalised,

PRESENCE

“Presence is a physiological state or subjective perception in which even though part or all of an individual’s current experience is generated by and/or filtered through human-made technology, part or all of the individual’s perception fails to accurately acknowledge the role of the technology in the experience”

(“Presence defined,” 2009).

It is a state of consciousness; the experience of one’s physical environment as it exists in the physical world. Alternatively, it can also mean the perception of an environment as mediated by both automatic and controlled mental processes. The phenomenon of presence in a mediated sense (also referred to as telepresence) is defined as the sense of being in an environment and can be generated by natural or mediated means (Gibson, 1979). “Presence brings into play ‘natural’ reactions to a situation and the greater the extent to which these natural reactions can be brought into play the greater that presence is facilitated, and so on” (Slater, Linakis, Usoh, & Kooper, 1999, p. 4). The cognitive nature of presence – in that it is a subjective judgment – forms the core of our understanding of presence as it is usually conceptualised and assessed in its relation to immersion, stimulation, emotion, spatial presence, involvement and realness (Diemer, Alpers, Peperkorn, Shiban, & Mühlberger, 2015). Like any psychological construct, the definitions and measurements for presence are diverse (Baren & IJsselsteijn, 2004). Therefore, this discussion is limited to a general overview and information relevant to this thesis.

Willing suspension of disbelief' is a similar term coined in 1817 by Samuel Taylor Coleridge to discuss when a participant knows "that the world displayed by the text is virtual, a product of the author's imagination, but he pretends that there is an independently existing reality serving as referent to the narrator's declarations" (Ryan, 1999). Ken Pimentel and Kevin Teixeira confirm that this is the same feeling as when a reader is absorbed in a good novel, movie or game (1993, p. 15). "Presence is important because the greater the degree of presence, the greater the chance that participants will feel and behave in a VE in a manner similar to their behaviour in similar circumstances in everyday reality." (Slater, Linakis, Usoh, & Kooper, 1999, p. 4). An audience's emotional responses and reactions to experiences is most realistic when they feel as if they are really there.

Encouraging participants to suspend their disbelief is the outcome of presence. When participants are present in the environment it enables media to communicate most effectively. Each medium is uniquely equipped to elicit a sense of presence in a participant. "For centuries, books have been the cutting edge of artificial reality. You read words on a page, and your mind fills in the pictures and emotions—even physical reactions can result" (Ryan, 1999). Books create no physical manifestation of the experience but rely on the subject's imagination. Alternatively, cinema creates a static environment but no way to participate, while games create an environment where you can control the experience but you are still physically separate. Each medium differs from reality as the participant is not physically present within the experience. By producing visceral reactions media induces stronger emotional responses (Jerald, 2015). Each medium encourages participants to 'willingly suspend their disbelief' and become immersed in what the creator is communicating.

Presence and suspension of disbelief in VR also behave in this same manner. As early as 1992, presence and VR, was discussed by Sheridan and Furness in: Presence, Teleoperators and Virtual Environments (Mantovani, Agliati, Mortillaro, Vescovo, & Zurloni, 2006, p. 6). In Cinematic VR the subject observes and performs the actions of reality within the virtual space. Creators must utilise both passive consumption and audience participation in order to create visceral reactions, emotional responses and ultimately encourage users to suspend their disbelief to become present within the VR experience. To do this VR creators must question “how to design virtual environments able to elicit a sense of ‘being there’ and an ‘illusion of non-mediation’ in the user”(Mantovani, Agliati, Mortillaro, Vescovo, & Zurloni, 2006, p. 5). By analysing “how users perceive and intuitively interact with various forms of reality, causes of VR sickness, creating content that is pleasing and useful, and how to design and iterate upon effective VR applications” (Jerald, 2015) hopefully creators should be able to create user presence in VR. If a VR environment achieves a feeling of presence it will allow us to modify a participant’s mental or emotional state (Mathew, 2014, p. 896) within the experience. The ultimate goal is to communicate effectively through Cinematic VR.

There are three main quantifiable areas creators can focus on to create presence in Cinematic VR. Each of these areas is discussed in more detail in this chapter. Firstly immersion is the technological aspects of VR technologies and how well they represent the virtual environment. The second aspect is narrative, how creators express their ideas and communicate with users. Lastly, established techniques are the established frameworks which audiences can understand the created world through. The rest of this chapter analyses the effects of immersion, narrative and established techniques on creating presence in cinematic VR.

PRESENCE AND **IMMERSION**

One contributor to presence in Cinematic VR is immersion; the technological aspects of VR. "Immersion refers to what is, in principle, a quantifiable description of a technology. It includes the extent to which the computer displays are extensive, surrounding, inclusive, vivid and matching." (Slater, Linakis, Usoh, & Kooper, 1999, p. 3). With VR technologies the combination of hardware, software and sensory synchronicity creates an environment where the subject really feels like they are are in the space. ("What is Virtual Reality?," 2015). Keep in mind that immersion helps to produce a stronger level of presence but is not a critical component to presence itself. "Users can simply shut their eyes and imagine being somewhere else. Presence is however, limited by immersion; the greater immersion a system/application provides then the greater potential for a user to feel present in that virtual world" (Jerald, 2015). Because of this, many VR displays are designed to mimic reality as closely as possible by "combining three important sensory elements for a maximum sense of presence: wide-angle FOV (for immersion), stereoscopy (for 3D), and orthoscopy (for proper scale), often called wide-angle ortho-stereo" (Naimark, 1998). Each technology addresses one or more of the human senses to create the perception that a mediated experience is actually reality.

The technology specifications recreate how people understand our world through their senses such as taste, touch, smell, sight, hearing and perception systems such as balance. Human understanding of reality comes by way of the senses. If you can present the senses with made-up information, the perception of reality will change in response to it. "You would be presented with a version of reality that isn't really there, but from your perspective it would be perceived as real" ("What is Virtual Reality?," 2015). The closer to reality that hardware emulates the more readily the mind and body accepts it as reality. "Different degrees of immersion find higher presence in more immersive VR systems compared to less sophisticated setups" (Diemer, Alpers, Peperkorn, Shiban, & Mühlberger, 2015). Therefore, the more accurately a technology stimulates the senses, the more immersed in the environment the user becomes and the more likely they are to suspend their disbelief.

Maria Sanchez-Vives & Mel Slater's immersive VR continuum (2005) discusses how the level of immersion technologies establish is created by how accurately and how many of the senses a technology addresses. There are two variables: one being the number of senses a technology addresses (breadth) and the other being how accurately it reproduces each perceptual channel (depth). The breadth of senses that are addressed could include: the auditory system, balance, the haptic (touch) system, the taste–smell system, the visual system and our ability to orientate ourselves within a space (Steuer, 1993, p. 12). The depth of each sense could include the resolution or frame rate.

Immersion can also be divided into two separate subcategories: vividness and interactivity. "Vividness and interactivity are both positively related to telepresence; that is, the more vivid and the more interactive a particular environment is, the greater the sense of presence evoked by that environment." (Steuer, 1993, p. 20). Vividness is the passive traits of immersion, while interactivity is the active aspects. The effects of vividness and interactivity are discussed in further depth below.

Vividness differs from interactivity because it is only concerned with "the richness, information content, resolution and quality of the displays" (Slater, Linakis, Usoh, & Kooper, 1999, p. 3) and discards active participation. Vividness is the extent to which a technology can produce a rich mediated environment (Steuer, 1993, p. 11). Games, three-dimensional films and holograms portray a sense of depth across part of the visual field. VR differs from these mediums in that "immersive visual displays such as stereoscopic head-mounted displays create a sense of presence by presenting a visual environment that moves with the viewer" (Steuer, 1993, p. 14). The reason VR is so different from other mediums is that it can passively address more senses. Cinematic VR content exists in some cases with minimal or no interactive elements. These experiences are automatically less immersive than their interactive counterparts as they do not address as many senses. The vividness capabilities of the technologies are important to the participant's understanding of a virtual experience. For example in some of the test footage for this thesis, the footage was shot at a lower 720p resolution. This had an adverse effect on the experience with the experience being difficult to interpret and the pixelation distracting. Therefore to create more immersive non interactive experiences the quality and resolution capability of technologies needs to be as high as possible.

It is important to note that "higher resolution does not automatically make a presentation more convincing. The relationship between photorealism of form and quality of content is complex" (Naimark, 1998). This can be seen in theories such as the uncanny valley and the way in which humans can interpret and enjoy 2D cartoons despite them being far from realistic. Vividness is about making an experience feel real, not making it as realistic as possible (Jerald, 2015). Therefore, the context a technology is used in is more important than the specifications of the technology. The higher quality technology simply makes the creator's job easier.

Unlike vividness, interactivity is about the control a user has over the experience. "interactivity, refers to the degree to which users of a medium can influence the form or content of the mediated environment" (Steuer, 1993, p. 11). In a perfect scenario interactivity is the ability to "navigate the virtual world and it is the power of the user to modify this environment" (Ryan, 1999, p. 38). In a truly interactive system, the virtual world would respond to any and all of the user's actions. Most media is unable to meet this bar and instead use the illusion of interactivity to propel the experience. Sanchez-Vives and Slater's immersive, semi immersive and non immersive continuum shows that VR can still be perceived as immersive without actually being fully interactive.

Cinematic VR is also not fully immersive. It is impossible to make a functioning experience that is truly interactive in Cinematic VR at this point in time. Due to the nature of Cinematic VR, the actual footage is a static representation of an environment rather than a dynamic virtual space as created in many VR games. This influences the way the media can be manipulated by the users and often means Cinematic VR is more limited. VR utilises immersion and interactivity through the mediation of the body. "Our body is our interface"

(Ryan, 1999, p. 38). A participant is actively involved in the experience, but the interactive elements are limited and bear no lasting consequences (Ryan, 1999). The interactive elements within these experiences are only the illusion of interaction, a semi-immersive or fish tank VR system. Fully immersive Cinematic VR cannot be produced so the focus is instead, to distill the key themes of interactivity.

Fortunately, like vividness, the realness of an interaction does not equal a better interaction. “Moving the sensors and enjoying freedom of movement do not in themselves ensure an interactive relation between a user and an environment: the user could derive his entire satisfaction from the exploration of the surrounding domain” (Ryan, 1999). VR experiences are a balance between human and machine where the hardware and software work collaboratively to intuitively communicate with the participant (Jerald, 2015). The context a technology is used in is more important than the specifications of the technology. Ideally users are focused on the experience over the technology. “Many people who work with computers think that interactivity is a critical characteristic, for both navigation and manipulation (e.g., when the user specifies, ‘move that chair to the right’). Sensory and physical realism is secondary. People who work in cinema often have the opposite priorities” (Naimark, 1998). The Cinematic VR experiences being designed for this thesis are the conjunction between vividness and interactivity and therefore one cannot be above the other when creating a sense of immersion and presence.

Another challenge of creating presence in Cinematic VR is in the crossover between vividness, storytelling and interactivity. Usually media are more concerned with one over the other. The challenge presents itself in that both are not always easily compatible within the same experience. “The various attempts by contemporary literature to emulate the interactivity of VR thus involve a sacrifice of the special pleasure derived from immersion. (Ryan, 1999, p. 36). The more interactive the experience, the less engaging the story. The incompatibility between storytelling and interactivity occurs for a few reasons. Firstly, because storytelling is reliant upon the narrative progression, while interactivity revolves around spatial organisation. Film and novel narrative is usually a passive activity, while interactivity thrives in a fluid environment undergoing constant reconfiguration. While, vividness is only concerned with accessing as many senses as accurately as possible, interactivity exploits the materiality of the medium. “Textual representation behaves in one respect like holographic pictures: you cannot see the worlds and the signs at the same time. Readers and spectators must focus beyond the signs to witness the emergence of a three-dimensional life-like reality” (Ryan, 1999, p. 36). One method to overcome this challenge is to separate the interactive and storytelling elements through bringing the participant in and out of the interactive elements. Games do this through creating cut scenes at specific points in the narrative to draw the undivided attention.

PRESENCE AND **NARRATIVE**

"Stories are a vital part of human culture. We use stories to entertain each other, to pass on our cultural and personal histories and values, and to make sense of our world. Stories give us continuity and context, and help us to understand not only what the world is like, but to discover our own places in the world and how to live our lives"

(Glassner, 2001, p. 51).

The significance of media is in its ability to express, educate, persuade, entertain or otherwise communicate with users. Computer games and filmic expression is usually conveyed through narrative and visual storytelling. "Storytelling, people, computers, and digital communications are becoming increasingly interwoven" (Glassner, 2001, p. 51). The digital era of enriched communication operates through image synthesis, digital special effects, new human-computer interfaces and the internet. These modern tools and new mediums such as video games and virtual environments allow creators to realize more sophisticated narrative forms and utilise more immersive technologies. VR utilises many of the human senses and allow users to interactively modify the virtual environment (Balet, Subsol, & Torguet, 2003, p. V). The possibilities of Virtual Storytelling are in the creation of nonlinear manipulation in real time and a means to enhance their production.

In each medium, narrative utilises the immersive media to uniquely communicate through established conventions. Narrative conventions are dynamic and shift based on the medium through which the story is being told. Because Cinematic VR is being analysed in relation to film and game design, the common practices of these two media will be the focus. Film and game design have many different approaches to storytelling, mostly relating to the role that interactivity plays in narrative, but they are both visual digital media and so have many similar conventions as well. Essentially, VR is the merging of visual time based conventions and interactive conventions. The narrative structure must conform to both areas. This is one of the challenges that Virtual Storytelling is facing. In many ways interactivity and stories are incompatible. “For example, we typically enjoy stories passively, and usually as individuals, even while sitting in a group audience. On the other hand, we participate in games actively, frequently in a social environment” (Glassner, 2001, p. 52). Virtual stories are about passively experiencing and empathising with events while interaction promotes experience of the moment and challenging oneself. Passive stories offer time for reflection, the ability to pause a movie or put down the book. Alternatively interactive narrative is more about immediate action. This barrier has been overcome before by means such as the ‘*choose your own adventure stories*’ popular in the 1990’s. Key characteristics of storytelling include the plot, characters and setting.

PLOT

The plot of a story includes everything that happens within the narrative through a series of interconnected events (Media, 2012). There is a lot of study around narrative structure and many instances where the findings are then subverted into new unexpected stories (Ferguson, 2015). Cinematic VR is a medium where the conventions of storytelling have not yet been defined (Atkinson, 2011). Therefore, the narrative developed for this investigation will adhere to existing conventions where possible and only subvert the narrative where necessary to explore the medium more thoroughly. Narrative structure will be discussed in general terms.

Stories have a beginning, middle and end which is expressed through different narrative frameworks such as the 'Three act structure'. The Three act structure sets up "a series of cascading, increasingly serious disasters, and then a climax as the protagonist triumphs over evil... or does not" (Baldwin, 2016). It also scaffolds the times for action or change such as the midway turning point where the context changes but the conflict remains the same. Frameworks like this allow narratives to progress in a manner that audiences are already familiar with and engaged by. Narrative can often be categorised into story archetypes. One theory is that almost all stories in some way relate to one of seven story types such as 'overcoming the monster', 'the quest' and 'Voyage and return'. (Booker, 2005). These archetypes inform how narratives will flow through events. Genres such as horror, comedy and romance. are blanket descriptors with established conventions that users already understand Stories also have four potential central focus areas: One, the milieu story such as *The Wizard of Oz* (1939) which is structured around experiencing the created world. Two, the idea story which is about questions such as 'who?' or 'why?' something has occurred. This is a popular story format in mysteries like *Sherlock Holmes*. Three, the character story revolves around the character development, self growth and their experiences. This is the most popular format in coming of age films and dramas. Fourth, the event story which revolves around actions and occurrences within the world; often something is wrong in the world that must be fixed such as in *Lord of the Rings* (2001). All four story types are utilised in most narratives but one usually takes precedence over the others.

The plot conventions of Cinematic VR storytelling have not yet been fully defined. The change of format from the rectangle construct to the sphere construct, the ability for the user to become an active entity within the experience and the time distortions of Cinematic VR are particular areas where the plot may need to redefined for this medium. In the case of interactive Cinematic VR experiences the user becoming an active participant like in first person computer games. Avenues for nonlinear elements leading to dynamic multi-branched narratives may also need to be taken into consideration.

CHARACTERS

The characters of a story usually loosely follow a wide range of stereotypes such as the protagonist and antagonist which are adapted to the specific needs of the narrative. In film, the audiences are voyeurs to the life and events of the characters. The “conditions of screening and narrative conventions give the spectator an illusion of looking in on a private world” (Miller & Stam, 2004, p. 137). Cinematic VR differs in that often the user is an entity the characters may be aware of within the private world, similar to the role of the user in first-person computer games. Characters may interact directly with the user rather than the user only looking into the virtual space. Characters in Cinematic VR can be flat with no depth or developed characters which undergo change. With the user being an active participant in the experience there are three ways to portray the character they inhabit. Firstly, like in games such as Dishonoured (2012), the characters the user inhabits (Corvo Attano) are fully developed with backstory, personality, motivations, emotions, likes and dislikes which are all predetermined and the user is merely acting out the part. Secondly, in games such as Star Wars: Knight of the old Republic (2002) and Mass Effect (2007) the user is given parameters as to what kind of person they are within the narrative. The user is also given a limited amount of choice freedom, often along the lines of good or bad decisions. Lastly, the user can be given a basic framework such as in Minecraft (2011) and Skyrim (2011) where the user is simply 'an adventurer' or 'an outlander' and it is up to the user to decide who they are and how they will participate while the NPCs (non person characters) act out assumptive reactions based on the users behaviours.

SETTING

Narrative settings are as broad as the human imagination. For example, both Avatar (2009) and Star Wars (1977) are in set in outer space, but, the settings shown in each universe are significantly different in design and purpose. There are settings which subvert the existing world, recreate the existing world, fictional stories presented in the real world space and completely fictional worlds. The possibilities are only limited by the imagination, time, money and equipment of the creator. This is also true of Cinematic VR. The key differing points between Cinematic VR and film is the concept of 'narrative time'. The passing of time can be easily subverted in film through understood methods such as cut scenes. However, in Cinematic VR these methods have not yet been firmly established and so generally speaking events occur at the speed of 'real time'. First person games generally follow the same 'real time' approach and often use loading screens when a shift in time is required. It is important to craft a narrative for unique differences that Cinematic VR creates.

PRESENCE, **CINEMATIC AND GAME TECHNIQUES**

Immersion is the technological factors related to presence, while narrative is the thematic elements related to presence. To ensure that users understand what is being conveyed every medium develops a set of rules from aspects of both immersion and narrative that audiences either inherently understand or are trained to understand through repeated exposure. A visual language that anyone familiar with the medium or genre can interpret. “Visceral communication is the language of automatic emotion and primal behaviour, not the rational representation of the emotions and behaviour” (Jerald, 2015).The visual language produced in film is called cinematic techniques. Similarly, the game design language is referred to as game techniques.

These techniques are a set of rules that affect every aspect of media including: plot, cinematography, mise en scene, lighting, and special effects. They can include broad rules such as the ‘three act structure’ discussed earlier in the chapter or the ‘180 degree rule’. The 180 degree arc establishes an area for the camera to be placed which makes spatial sense to the viewer (Bowen, 2013). Techniques also aid a user’s thematic understanding of an experience through visual language such as colour theory and symbolism which is often appropriated from from existing historical events. Techniques can also be extremely specific. For example, the low angle shot and extreme close up are employed to generate specific physiological reactions in users. In game design the use of the exclamation mark to indicate a quest or an opportunity to interact within the game is also considered a game technique. The purpose of these established techniques is to aid user understanding, creator expression and utilising a medium to it’s fullest potential.

These rules or visual languages are also fluid constructs. The techniques for any medium are be different within different cultural fields and/or adapted over time to more readily accommodate both creators and participants needs/wants. For example The Matrix (1999) revolutionised the way film-makers approached CGI and established a new technique labelled bullet time; a different way of compositing that embellished slow motion scenes (Lister, 2009). Before The Matrix was released there was little to no crossover between the anime visual language and hollywood cinema techniques. At present, the techniques are often utilised across both mediums constantly. Techniques may also be different between genres, even within the same medium. Close up shots in dramas can create strong emotional moments indicating love or sadness, while close up shots in horrors create a sense of dread or suspense. Each cinematic technique or 'rule' can be deliberately broken or subverted to create new effects and that, in turn, affects the rules themselves (Ferguson, 2015).

In Cinematic VR these techniques have not yet been fully established. From existing Cinematic VR experiences and academic deduction it is theorised that Cinematic VR will appropriate techniques from the most similar mediums: games and film. It will also develop its own techniques that dynamically change over time in the same way as every other medium. In this thesis a range of cinematic and game techniques are appropriated such as cutting and mise en scene to make the final experience possible and legible for users. A few main techniques are analysed in more depth to further understand how Cinematic VR techniques may develop. These include aperture/depth of field, 3D white bar optical illusions, collision box movement and collision box Interaction. Each of these techniques is intended to complement each other and aid in communication between the user and the experience.

APERTURE/DEPTH OF FIELD

Aperture is the focal length of the lens and determines how much of the image is in focus (Joinsen, 2006). Depth of field is the area of the image that appears sharp and is the outcome of aperture. Depth of field adds dimension to the footage and can bring objects into crisp focus (Mansurov, 2017). Depth of field can be created through the camera mechanisms or applied separately in post-production. Aperture is also applied to games in order to create a visual hierarchy for the user's focus. In the Cinematic VR experiences created for this thesis, aperture will be one on the four main cinematic focuses for the reasons mentioned above. With 360 degree views for the user to engage with it is important to create a hierarchy of information so the creator can direct the user's attention. This will be accomplished through making the most important elements crisp and the lesser elements blurry. Also in Cinematic VR sometimes distance can be skewed by the fish eye lenses and depth of field can help with the user's spatial awareness. The technique will be created through post production techniques because 360 cameras are less capable of shooting a shallow depth of field. "As the focal length decreases and the lenses start getting wider, this effect becomes trivial. There is virtually no depth of field on a Fisheye lens" (Mansurov, 2017). I theorise that the the artificial application of aperture will be utilised by content creators to direct the user's gaze and embellish the sense of depth. I also assume that, like film, the application of artificial depth of field will be time consuming and so not utilised with specific intent.

3D OPTICAL ILLUSION GIFS

3D optical illusion .gifs, sometimes referred to as 3D.gifs or white bar .gifs, use depth of field and graphic elements (usually in the form of two evenly spaced white bars). These illusions define the plane and create a mental division between the foreground, midground and background (Diaz, 2014). This effect is similar to that of many classical paintings and enables the perception that an object is coming forward out of the screen. Essentially, it enhances the 3D effect without the use of stereoscopic cameras and 3D glasses. This illusion is often in .gif format posted on online communities such as *reddit*, *9gag* or *tumbler* and is not a commonplace cinematic technique in Hollywood filmmaking. In Cinematic VR experiences there can be a distortion from the fish eye lenses that skews the perception of depth. This optical illusion could help combat this distortion by creating a frame of reference for the user. Also, Cinematic VR enables the user's gaze to focus anywhere and so it is important to establish ways in which the author can draw the user's attention to key moments. To create this effect in the cinematic short film experiences for this thesis I will use post-production techniques such as graphical elements and rotoscoping to create these white bars. I hypothesise that this will aid in directing the viewer's gaze overall by drawing attention to key points in the foreground, but, the application of the technique may be a very time intensive process. Furthermore, the 3D optical illusion is already niche cinematic technique and so may remain little used in Cinematic VR because logically it does not make sense to have white bars across the scene.

MOVEMENT

The simulation of movement is created in a variety of different ways in game design. In early games such as Pacman, users controlled small 2D avatars. Later, 3D worlds like Skyrim were designed so users could control fully functioning characters within a virtual space. Movement can also be thought of in a more abstract sense shown in games such as Sid Meier's Civilisation V or Tetris where they user controls the space in more unique ways. Many forms of movement from game design cannot be appropriated for media that utilise footage due to the static nature of film. An image is only a pixel representation of a space in that moment in time. Although post-production enables a level of photo manipulation without light field technology or volumetric video it is still limited. Non-animation Cinematic VR encounters these same limitations. Therefore, in creating movement for a Cinematic VR experience, Google Street View is investigated as an artist model. Google Street View is already a popular utility that uses static 360 images to created a virtual environment that users can navigate. The main difference between my experience and Google Street View will be that the footage is time based, viewed in a HMD headset and interaction will be utilised in an entertainment context over a utility context. To achieve a similar effect in my Cinematic VR experiences I will create collision boxes either through a pre-build program or self created code that engages movement action based off the user gaze. I theorise this method will be intuitive due to people's existing exposure to Google Street View and similar games. I also theorise that this will not be as inherently immersive as complete freedom of movement and the success of this technique will rely on the interface and collision box design.

INTERACTION, USER INTERFACE DESIGN

User interface (UI) or interaction design is an extremely broad field of design that deals with every aspect of the relationship between the user and the media. For the purpose of this thesis special emphasis will be placed on the use of button interaction and collision boxes because this completement the section based movement from the previous technique. Menus are more common in web and game design than in film but are used in instances such as DVD's for navigation. The interactive VR experiences being tested will need interactive elements for both the menu interface and navigation. To keep the UI as intuitive as possible I will base my designs off already popular interactive frameworks such as bootstrap. To create the interactive element I will need to again either utilise an existing program of code from scratch. I theorise that the intuitiveness of the outcome will be largely based on the effectiveness of the design at communicating its purpose to the user.

PRESENCE **CONCLUSION**

In conclusion the degree to which immersion, narrative and established techniques are utilised determines the degree to which presence is facilitated. Presence is a cyclic event that brings into play the natural reactions to a situation. “The greater the extent to which these natural reactions can be brought into play the greater that presence is facilitated, and so on” (Slater, Linakis, Usoh, & Kooper, 1999, p. 4). Unfortunately, the degree to which presence is achieved is difficult to quantify. The analysis of Cinematic VR experiences will be instead from a purely textual analysis of the final product. This will involve analysing each technique appropriated for Cinematic VR in relation to the existing analysis of each technique as already established in film and game design. This will be accomplished by analysing the immersive elements and by discussing the tools being utilised. Secondly, each technique will be physically tested. Then, the narrative for the final Cinematic VR experience will be discussed and designed. Lastly the final Cinematic VR experience will be analysed in order to draw the final conclusions.

CHAPTER 5
TOOLS OF THE TRADE

Usability and accessibility are the primary motivators for the choice of each tool. The focus on amature film making led to the choice of tools that are at the lower end of the price range and skill needs. Many of the tools chosen and used in the practical sections of this thesis are from existing companies such as Adobe who already have a strong foothold in the digital industry. Although, as Cinematic VR is a newer field some of the more specialised software and hardware are in beta stages. Therefore, the products that are available and working at this time are given precedence and utilised. Other options included waiting for the perfect tools to be released or coding from scratch. As tools are always being improved and updated waiting for the perfect tool would be an exercise in futility. Coding content is a viable way to produce some of the technical outcomes and in some cases this thesis had introduced code to bridge problems the pre-built tools cannot solve. This has been done sparingly as its use moves away from the storytelling focus of this thesis and into a more technical direction. As the popularity of Cinematic VR increases the pipeline for creating content will become more formalised and ubiquitous while the need for technical innovation decreases. Although this thesis uses specific tools to achieve its goals, theoretically with alterations the same process could be applied using different technologies or coding languages. The basic tools include: Samsung's Gear VR, Gear 360, Gear 360 Action Director and S7 Edge mobile; Adobe creative cloud's Premier Pro CC, After Effects CC, Photoshop CC, Bridge CC, Illustrator CC, Indesign CC and; Klynt's Wonda VR.

HEADSET SAMSUNG GEAR VR

MOBILE DEVICE VR VS DESKTOP/CONSOLE BASED VR

All HMD headsets on the current market showcase the differences between VR and earlier human computer interfaces, but a majority of them also use these same technologies in order to run, for example the need for a desktop or mobile device. There are two main forms of HMD headsets; disregarding the small number of self contained headsets which are expensive and slow. Type one run via a mobile device and type two run via a desktop or console. This has contributed to creating two distinct markets for viewing and authoring VR/AR.

DESKTOP/CONSOLE VR

HMD headsets such as the Oculus Rift for $698(“Oculus Rift,” 2017) and HTC Vive for $825 (“VIVETM New Zealand,” 2017) both use Desktops or consoles to utilize a higher computer power and therefore, generate the most immersive VR experiences, but they are also more expensive than their mobile counterparts. Furthermore, a desktop that has the computer system requirements needed to operate a headset starts at around $1500. For now, the combined price of HMD headsets and VR ready desktops are consistently above $2000 to simply consume VR content.

MOBILE DEVICE VR

Mobile VR is less immersive and smartphones have lower operating power than VR ready desktops. Mobile headsets such Google Cardboard from $15 (“Get Cardboard – Google VR,” 2017) and Samsung Gear VR for $150 (“Gear VR,” 2017) are also significantly cheaper than their computer counterparts. Furthermore, most people already have a smartphone and although some headsets are only compatible with particular models, many are cross compatible. Desktop and console VR prices are expected to drop but it is still estimated that mobile tech will comprise 90% of VR headset sales by 2018 (Rosiński, 2015).

In addition to mobile based VR being predicted to lead the VR market, mobile devices are also leading the AR market with recent apps such as Pokemon Go with 650 million downloads (Sarkar, 2017) becoming huge hits. AR is predicted to be the leading market between AR and VR and therefore the trends in AR are significant to VR. Furthermore, both Facebook and Youtube have also created 360 video viewers specifically for mobiles (they are accessible through desktops but are far less intuitive).

ALTERNATIVE VIEWERS YOUTUBE AND FACEBOOK 360

As an alternative to HMD headsets, all filmed VR content can also be viewed through both Youtube and Facebook's 360 degrees video publishers, which are compatible with their websites and apps. There are three primary ways to view 360 videos. Viewers can look left, right, up and down by moving their head while wearing an HMD headset or, zooming in or out, and changing their viewing perspective simply by clicking or dragging their mouse, and lastly by directionally moving their tablet or smartphone screen (Highton, 2015).

Youtube's 360 video on the desktop allows the user to view the content while still being aware of the immediate surroundings. The shortcoming of Youtube 360 on a desktop is the inability to use your body to navigate. Instead the user navigates with a mouse, dragging the virtual environment (VE) rather than looking around.

Youtube's 360 video on mobile phone also allows the user to view content while still being aware of their real surroundings. Using a mobile however also has the added benefit of being able to navigate with your body. By moving the phone around a user may explore the VE intuitively.

HMD headsets allow you to view the VR content while excluding any external distractions, placing audiences solely in the VE and minimizing the awareness of reality. Like with Youtube's 360 mobile viewer, HMD headsets are operated primarily through body movement to navigate the surroundings, although some headsets do allow for controllers as well.

360 film can be viewed through any of these methods; the experiences differ between all three, but interactive content cannot be viewed through Facebook and Youtube viewers. Therefore, this study will only focus on creating content for HMD headsets.

SAMSUNG GEAR VR ANALYSIS

For these reasons mobile based VR and subsequent software and hardware are the best tools for this thesis. The reasons include: currently mobile VR is more accessible and affordable, mobile AR and VR are both predicted to have larger markets or more user access than desktop/ console VR and, lastly, Interactivity is not available with the non HMD headset choices. Due to these reasons the focus of this study will be on communication through mobile based VR headsets, specifically the Samsung and Oculus Gear VR which is compatible with all of Samsung's flagship mobile phones (such as s7, s7, note 7). Although I will be primarily using the Gear VR, all filmed VR content should be able to be viewed on other mobile based HMD headsets such as Google Cardboard and be seamlessly compatible with the content produced for this study.

According to Samsung's website (2017) "It's easy to get lost in the world of virtual reality because the Gear VR is engineered to feel lighter than it actually is. It's also designed to feel comfortable no matter your facial structure, while the foam cushioning offers a natural hold as it blocks light from seeping in". The Gear VR also boasts a 101 degree field of view, large lens, head tracking, built in gyro sensor/accelerometer, Micro USB, touchpad, home, back and volume keys.

SAMSUNG GEAR VR RETROSPECT

Samsung's Gear VR performed to satisfactory levels throughout the course of this project. The navigation of both the software and hardware was easy to use. The technical specifications were appropriate with the visuals being clear, buttons working and no faults with the head tracking. The only concern was that on occasion when placing the phone in the headset it would become buggy and not start properly. Removing the phone and re-placing it solved the issue. Due to the gyroscope, the headset would need to be fully placed on the user's head before they would be aware of the fault if it occurred. This did not cause any permanent problems and was merely an inconvenience as the user must fully remove the headset and start the activation process again. Overall this product suited the task.

OPERATING SYSTEMS SAMSUNG S7 EDGE

SAMSUNG S7 EDGE ANALYSIS

Desktop VR uses computers to power the HMD headset while mobile VR uses mobile phones. The Gear VR HMD headset chosen is only compatible with the Galaxy Note5, S6 Edge+, S6, S6 Edge, S7, S7 Edge and the Galaxy S8 once it is released. The Galaxy S7 edge is the flagship phone at this point in time and in this case will be used but any described phone would be appropriate. Furthermore, any mobile of capable computing power can work with the Google Cardboard if the situation requires it.

SAMSUNG S7 EDGE RETROSPECT

Samsung's S7 Edge performed to a satisfactory level throughout the duration of this thesis. The phone performed to the level expected of a flagship phone. I expected there to be distortion from the curved screen but there was no noticeable difference. There were no problems apart from the occasional connectivity problem between it and the Gear VR mentioned in the previous section. This issue created no permanent problems.

360 CAMERA SAMSUNG GEAR 360

The choice of camera is based on a balance between accessibility, image quality and workflow speed. A 360 degree camera is a camera or group of cameras with multiple lenses that have overlapping fields of view. 360° video is created via a variety of photographic equipment and techniques, ranging from arrays of low-cost GoPro video cameras to expensive custom rigs incorporating multiple high-resolution video cameras, high frame rates, and even 3D (Highton, 2015). Like HMD headsets, there are a range of cameras on the market that cater to different needs, quality and price range, with many brands producing both the hardware and software pipeline to produce content. For example, Jaunt creates camera systems, stitching software and original film productions. Google is developing Jump, a capture setup for creating 360 videos for Google Cardboard. 360heros created camera rigs, production software, and 360 players (Parisi, 2015). There are two main forms of 360 degree cameras: monoscopic and stereoscopic.

MONOSCOPIC

Monoscopic 360 video is where each lens takes a flat image that, when using a HMD headset, gives the feeling as if you are inside a globe looking at the inner surface. “2D spherical is a much more accessible field or form than when you get into stereoscopia and much more complex types of video” (Meegan, 2016). Monoscopic video is a flat set of images rather than a 3D environment and therefore has some distortion similar to the distortion between a flat and globe image of the earth. Google’s Street View and video players such as Youtube 360 show Monoscopic videos.

STEREOSCOPIC

Alternatively Stereoscopy, is “the sense of 3D that we get when we perceive a scene through both eyes, and requires two unique points of view – one for each eye” (Naimark, 1998). This creates a feeling of depth perception that is otherwise lost on monoscopic cameras; for example, the difference between 2D and 3D cinema. Stereoscopic cameras add more lenses and complexity to content creation, the outcome of which is small errors in the stitching having large consequences. Furthermore, the price range of stereoscopic is significantly greater than monoscopic cameras putting it out of the range of most amateur creators.

SAMSUNG GEAR 360 ANALYSIS

I will be working with a monoscopic camera over the stereoscopic models because: monoscopic cameras are more accessible in price and skill needed, 360 cameras already require a certain level of competency and the level of skill required to use stereoscopic cameras increases exponentially the more lenses used. The specific model I will be working with is the Samsung Gear 360 ($650)(“Samsung Gear 360 Camera for smartphone & Gear VR,” 2017); the natural counterpart to the Samsung S7 Edge and Samsung Gear VR that are already chosen tools. By using the same range of tools I gain complete pipeline cross compatibility and access to the post-production and VR Samsung software. There were other camera options such as the LG360 cam ($500) but the Gear VR has the best specifications for its price range. The Samsung website (2017) states the camera specifications include 15.0 megapixel images, 3840 x 2160 image and video resolutions, gyro/accelerometer sensors, dual lens fisheye for 360 field of view, a microSD slot and bluetooth.

SAMSUNG GEAR 360 RETROSPECT

Samsung's Gear 360 camera performed the tasks necessary but there were a few problems that caused the product to underperform overall. The camera did do all the tasks it needed to do such as shooting the video and sound, taking photos and utilising the phone app to control the camera settings. Some of the features performed averagely such as the battery, which lasted around a third of a full day shooting. I utilised battery packs to keep the workflow on set moving at a consistent pace. Some of the camera features also under-performed. For example, approximately one in every five takes the bluetooth camera/phone connection would break down in some form. This meant that I could not see the shot as it was being filmed, could not connect to the camera at all and in the worst case, on occasion it would completely stop shooting at arbitrary moments. Furthermore, the hardware of the camera was prone to overheating. The camera could last a maximum of continuous 20 minutes of shooting before overheating to the point of turning off. For a camera that markets itself as a traveling and vlogging device this is an unacceptably short amount of time. In the case of this project each take was approximately 5 minutes long. This meant that I could conceivably take four shots maximum at a time before the camera needed to be put aside and cooled down. This severely hindered the workflow on set and resulted in shooting being extended an extra day. The Gear 360 did the essentials but was overall a poor choice. If I were to do this project again this would not have been my camera of choice.

SOFTWARE ACTION DIRECTOR, ADOBE, WONDA VR

ACTION DIRECTOR ANALYSIS

The Gear 360 Action Director program is Samsung's dedicated VR editing program and is designed to be compatible with the Gear 360 and related technologies. It is a rudimentary program with options for basic file organisation, editing, and exportation. For any moderate to advanced projects other programs such as the Adobe suite are more adaptable.

The Samsung Gear 360 camera records using two unstitched fisheye lenses. The standard for editing VR footage is an equirectangular stitched image. The Gear 360 Action Director automatically stitches each clip and exports it to a specified folder. Other programs are available for converting VR footage to the equirectangular format but Action Director is designed specifically for the Gear 360 and is therefore the more accurate stitching option. Furthermore, it is a free program with the purchase of the Gear 360.

ACTION DIRECTOR RETROSPECT

The investigation into the Gear 360 Action Director revealed that many of the features were aimed at more ameture film makers and did not contain the functionality I would need throughout this process. From the outset I only used this program to automate the stitching process with the two fisheye lenses and used different software for the rest of the workflow. A 5 minute clip would take approximately 30-35 minutes to stitch and auto export to a specified folder. This is an average amount of time for an export of that size and I encountered no problems or error messages with the process. I cannot comment on any other functionality of this program but the stitching process was accurate and intuitive.

ADOBE CREATIVE CLOUD ANALYSIS

Adobe Creative Cloud products are an industry standard for photography, film, motion graphics, illustration etc. The entire adobe suite (20+ creative desktop and mobile apps for $80 per month) includes programs such as After Effects CC, Premiere Pro CC, Bridge CC, Photoshop CC, Illustrator CC and Indesign CC ("Creative Cloud pricing and membership plans | Adobe Creative Cloud," 2017). Each program is made for a specific section of the design pipeline process; for example, Premiere Pro CC is made for the editing and colour correction while After Effects CC is dedicated to the visual special effects (VFX). Furthermore, the Adobe suite is compatible between programs in real time and VR capable. This project's post processing, editing and VFX are created through Adobe products (mainly After Effects CC and Premiere pro CC).

ADOBE CREATIVE CLOUD RETROSPECT

I have worked with the Adobe creative suite for over 7 years and so am familiar with the applications, functionality and flaws of their products. Overall, I have been satisfied with the Adobe software and used it in a range of projects. In 2017 Adobe released updates enabling VR compatibility ("New features summary for the 2017 release of Adobe Premiere Pro CC," 2017). For the bulk video, assets, editing, post-processing and post-production aspects of the final project were created through Adobe Premiere Pro and Adobe After Effects. The non-VR functionality performed as expected. The VR aspects Adobe has released work and intuitively allowed me to work with my VR content to a satisfactory level, but did not really break the mould in any way. Working between Adobe product is completely seamless but working between Adobe tools and tools from other creators was far less intuitive, often requiring me to fully export footage and then re-import it after every change. Overall, I was satisfied with the performance of the Adobe products.

WONDA VR ANALYSIS

Wonda VR ($499 yearly subscription ("Wonda VR", 2017)) is a beta program aimed at creating interactive cinematic VR experiences. The Wonda VR website (2017) boasts a range of features. Wonda VR has it's own phone app, desktop software and browser previewer. It gives the creator the ability to design multiple story paths, create timed or special hotspots and multitrack. Wonda VR also supports gaze tracking and stereoscopic equirectangular footage. The website also states that they are working on importing 3D assets. For this project Wonda VR is the man platform for the interactive aspects and the application in which the final product is presented.

WONDA VR RETROSPECT

Wonda VR was one of the few interactive Cinematic VR programs on the market at this point in time. It performed the basic tasks required of it. It also allowed to me insert code snippets when I needed to create something outside the scope of the program. The UI was fairly intuitive but in some instances too simple and did not allow for any more advanced functionality. This can be attributed to the beta state of the product. The program had a viewfinder and could be auto viewed in the Firefox browser. Furthermore the program could be exported and played through both the Samsung Gear VR and Google Cardboard as long as the Wonda VR app was installed on the mobile device. Overall, I was happy with the product and expect more advanced features to come.

CHAPTER 6 **TESTING**

CINEMATIC TECHNIQUES

A wide range of photography and film related visual media utilise cameras for communication and storytelling at both amateur and professional levels. Fortunately, this means that the techniques and rules for cameras are well documented. The main difference between traditional cameras and 360 cameras is the change of frame from the rectangle format to the sphere format and the unique challenges this presents. Therefore, the first part of this analysis goes towards the Samsung Gear 360's technical properties and the techniques that are directly translatable between media. Then, analysis will be conducted on the cinematic techniques that are unique to Cinematic VR or require significant changes to be applied. Lastly, appropriation of aperture/depth of field and 3D gif cinematic techniques to Cinematic VR will be explored in detail:

Exposure refers to the quantity of light that falls on a light-sensitive material (Joinsen, 2006). To explore the Gear 360's exposure range I took a photograph of the same subject matter from -3 to +3 at 0.5 intervals in daylight conditions. From this I discovered the range of light that the camera could accommodate. One challenge of 360 filming is all lighting must be diegetic. This meant that in order to get a suitable amount of light into the shots the windows had to remain open. This in turn caused some of the pixels to be either at 255 pure white or 0 pure black. The outcome of this is that colour information is automatically lost and is referred to as peaking or bottoming out. Unfortunately this was an unavoidable side effect without expensive window gels to defuse the light. Additionally I noted that from both research into 360 photography and my own experiences/tests that the two lenses can read the light differently and one shot can be noticeably brighter than the other.

White balance is the process of changing the colour temperature so that the scene appears true to colour (Joinsen, 2006). White balance was tested at auto, daylight (5300K), cloudy (6200K), incandescent (2800K) Fluorescent (4000K) and aqua (7000K). White balance was tested in the same manner as the exposure test to maintain the overall cohesiveness to the test footage. The white balance settings are standard for a Samsung device. The auto was accurate but in order to white balance consistently across all footage colour correction was needed in post-production.

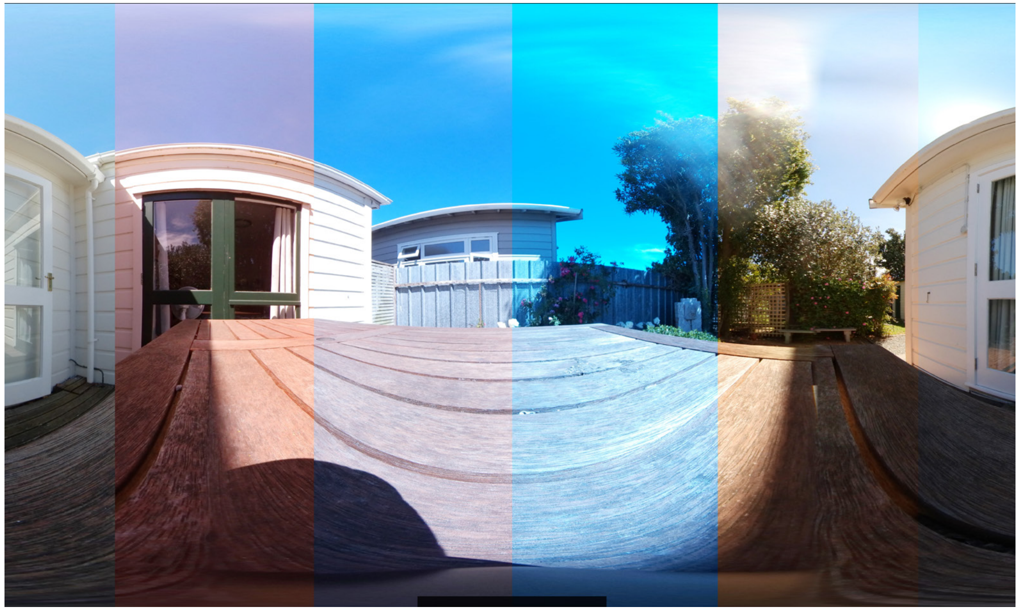

Figure 2. 360 Testing conposition shot, white balance

ISO measures the light sensitivity of the image sensor in digital photography and is one of the contributing factors towards image grain (Joinsen, 2006). To explore the gear 360's ISO settings a photo was taken at each ISO setting 400, 800, 1600, 3200 and 6400 in daylight conditions with a black object in frame to analyse the grain that the images produced. In the final experience some shots did have film grain from the ISO which was most likely created through the lower budget of the camera and the imperfect lighting conditions due to the inability to add non-diegetic lighting. Through the proper application of post-production colour correction the gain was minimised without the need for a de-graining filter which can be a time consuming endeavour.

The stabilisation function is both in-camera and a post production feature that makes the camera appear more stable. To test the stabilisation of the Gear 360 I tested the camera with the setting both on and off. The stabilisation made the most improvement while the camera was static but hand held. While the camera is panning or moving the stabilisation adds a level of polish to the footage. While the camera is placed statically the stabilisation makes little to no difference. Sharpness, auto correct and HDR all improved the footage to some degree. But, again these features are usually used situationally.

Sound was recorded throughout the test shooting and overall turned out to be very poor quality, especially with Wellington city (nicknamed windy Wellington) being quite a windy environment. Although sound is an important factor in creating presence it is not an area being focused upon in this study. For the final shoot I took all reasonable precautions such as shooting in an indoor space and turning the refrigerator hum off. I would recommend obtaining an omni directional sound recorder or creating a film with entirely non-diegetic and silent sound elements in situations where the sound is important.

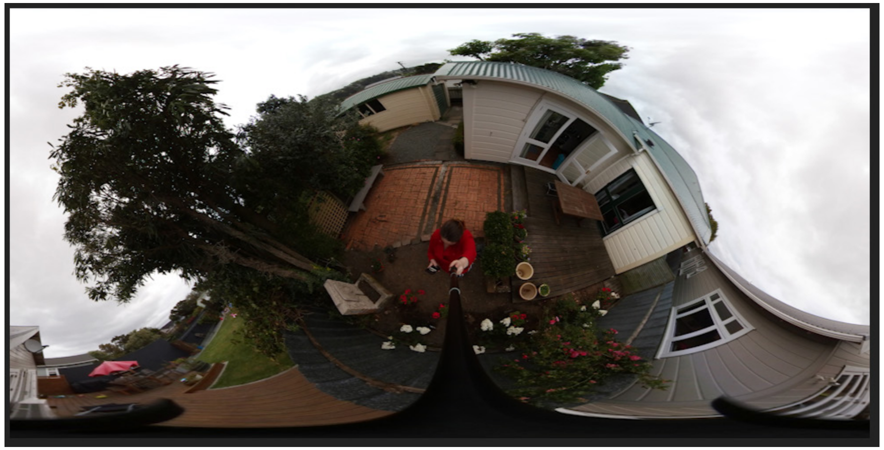

Figure 3-8. 360 Testing conposition shots, camera height

The height the camera is placed at is a more subjective film technique. For example, in cinema, the low angle shot can give a the perception of disorientation and foreboding (Mamer, 2013). To investigate the effect of height in Cinematic VR I took images from a range of vantage points (ground, waist, chest, head, overhead and behind objects). In Cinematic VR the camera angle is literally where the user's eyes are in the virtual space. Therefore, it makes sense that the camera is placed between chest and top of head height. This is challenging with the varying heights of humans. Throughout the first shoot I placed the camera mostly at stomach height (as this is the height of many surfaces such as tables). This tended towards being too low if not creating an intentional effect. Either some form of tall slim tripod needs to be utilised or the camera need to be attached to an actor at the appropriate height to provide a body. Distance was also tested by moving the character to different positions on an open field and by placing the camera in different relative positions to objects and having my actor pace around the space. Overall the outcome of testing distance showed there to be distortion between the perceived distance within the experience and actual distance in the real space. While filming props I thought close to the camera appeared much further away in the headset.

Aperture is the focal length of the lens and determines how much of the image is in focus (Joinsen, 2006); it is both a technical and subjective element. Aperture and the depth of field was tested both in the camera settings and as a post production technique. As expected the nature of 360 cameras meant I could not produce a shallow depth of field in-camera. I tested various post-production methods to achieve a blur effect and tested more dynamic effects such as a pull focus. In addition to drawing attention to one focal object, adding artificial blur to the images actually diffused some of the pixelation problems the footage was having. While first testing the camera some of the footage was accidentally shot at a lower resolution than 4K. The testing involved blurring through both keyframing and rotoscoping. Both techniques could be situationally effective but each was time consuming. I tested each kind of blur in Adobe After Effect, some blurs affected the render time and a few distorted the edges of the images to create a vignette appearance. In the case of VR content this effect was negative as it produced a black line along the stitch points and a black dot at the top and bottom of the experience. This distortion was not discernible in the flat viewer and appeared only in a 360 viewer either in-program or in the headset. Overall, artificially testing the aperture was very informative about the limitations of this technique. Further testing this area also strongly illustrated the differences between viewing an experience on a 2D screen and in a HMD headset. Effects I deemed finished in the 2D viewer looked too fast or out of proportion once moved into the HMD headset space. This testing showcased the importance of testing the content in the context it will be viewed in.

Figure 9-11. 360 Testing conposition shots, aperture

Testing the 3D optical illusion (also referred to as 3D .gifs or white bars) was an interesting experience as prior to this thesis I knew of this technique, but, had not studied it nor to designed one. During testing I tried to create this effect through several different means. The first shot I made, the action was too far away from the camera and therefore the movements made were not impactful, nor was there enough diversity to represent multiple planes of space. The second shot (the one I made for the test shots) still could have been closer and the actions could have been higher in relation to the lens to utilise the space best. When working with the shot in 2D adobe after effects everything looks in proportion but once it was moved to the VR space it was distorted. The distortion of the sphere works in a similar way to the distortion of a world map between flat and sphere where changes occur such as Canada appearing much larger than in physical reality. This same distortion occurs because the parallel white bars meet at points at both the top and bottom of the image. This is a unique aesthetic in comparison to the existing techniques in other visual media. Overall the testing of this technique was only moderately successful. Varying factors such as the object's distance from the camera and errors in the rotoscope generates unanticipated outcomes. From what I could extrapolate from the research so far, this looks like a viable way to create separation between the foreground, mid ground and background. The main drawback of the technique is the need for rotoscoping which can be time consuming.

To achieve both the aperture and 3D optical illusions on both occasions I had to utilise the rotoscoping technique. In both film and Cinematic VR, rotoscoping is similar; the only difference that I could discern was the creator needed to be actively aware of the distortion created with Cinematic VR footage. During the test shoots some of my images were not created in the right situations for easy or accurate rotoscoping. When I create my final project I will be mindful of the rotoscoping I will need to complete.

Figure 12-13. 360 Testing conposition shots, white bar illusion

GAME DESIGN TECHNIQUES

A wide range of photography and film related visual media utilise cameras for communication and storytelling at both amateur and professional levels. Fortunately, this means that the techniques and rules for cameras are well documented. The main difference between traditional cameras and 360 cameras is the change of frame from the rectangle format to the sphere format and the unique challenges this presents. Therefore, the first part of this analysis goes towards the Samsung Gear 360's technical properties and the techniques that are directly translatable between media. Then, analysis will be conducted on the cinematic techniques that are unique to Cinematic VR or require significant changes to be applied. Lastly, appropriation of aperture/ depth of field and 3D gif cinematic techniques to Cinematic VR will be explored in detail:

The interactive techniques were tested after the visual cinematic techniques had already been fully explored. The interactivity was created to navigate the user through the test experiences and to create user controlled movement throughout the space. Movement is a difficult feature to emulate using film or photography due to its static nature. For the movement, Google Street View was used as an artist model. The test experience made allowed the user to move from set place to set place with relative ease though the use of collision boxes. There are two main considerations for using this method. One, it relied on the environment remaining static indefinitely. Therefore during the first test footage images rather than videos were taken at different locations both vertically and laterally so the user may navigate indefinitely through the space. I predict that with access to more cameras a creator could make more dynamic events and ever real time movement through the virtual space. This idea is outside the scope of this thesis.

The second test involved time based recordings and interactive points that users could gaze at to activate various parts of the footage. The interactive event and image movement experiences and menu navigation are very similar in that they will use events such as the user looking in a particular direction to progress the experience. For example, if the user looked at the window an actor would walk past outside and if the user looked at the bench the actor would also walk down the hallway inside. In true reality, there is no way for that same individual to be in both position A and position B. This method was more dynamic but also was limited in that the virtual space must return to its original form to keep continuity.

To accomplish both of these interactive elements the user needed some visual indication of where the collision boxes existed and this is where the UI elements are most important. Interaction design is a large and diverse field that this thesis only skims the surface of. Having indicators to alert a subject to what and how they can interact with something is common practice. There are large buttons to press when crossing the street. Websites have buttons that perform various actions when clicked. Games also have glowing icons and different textures to alert a user to interaction opportunities such as looting or quests. When Creating VR content there is a lot of room for innovation, but that must be tempered by creating legible content for audiences. Therefore, when designing the interactive buttons, the priority is first comprehension of purpose, then aesthetics.

When initially testing the movement aspects of my experience I simply added white asterisks (*) at the indicated places. These crudely got the point across but this is unacceptable moving forward as it has no visual or auditory feedback. The second consideration was that of scale. The Wonda VR program has no definitive way to place interaction collision boxes or visual feedback in space accurately, so instead the positioning needed to be manually chosen and the size of the point adapted accordingly. Therefore, from the test footage I confirmed that the final experience would need to utilise the basic existing interaction design functionality such as animation and scale. During the testing phase I also developed a basic menu system for the final experience. This menu was largely based off interactive menus that DVD’s contain to navigate through content. It also draws from web and game design in that menu interaction can be used to drive content in addition to passively playing content.

Figure 14. 360 Testing conposition shots, interaction movement

ADDITIONAL THOUGHTS

The testing phase of this thesis allowed me to start testing concept development and begin the iteration process. It also allowed me to think more critically and practically about Cinematic VR and discover or confirm trends in the medium.

In the presentation of the exposure range I divided the image into 12 rectangles to create a gradient of exposure. This was an interesting way to present multiple sets of information for comparison. The second interesting point about this image is the distortion of the rectangular sections into oval sections in the same manner of maps. Maps and the equirectangular format work the same in that the center in the closest in representation while the top and bottom are both stretched and distorted.

Throughout the editing of the shoot, the differences between the flattened image and the spherical image in VR meant I could not tell immediately the effectiveness of the things I was creating. My workflow between the Adobe products and Wonda VR meant that I needed to export the footage, import the footage and link the footage each time I wanted to analyse the interactions or aesthetics of my experiences. This drove the workflow to be more similar to game and code based design. The outcome was throughout the test footage my expectations and the reality of my work had some discrepancies. To overcome this i think is a matter of becoming more familiar with the difference and utilising Adobe Premier's inbuilt viewer more thoroughly.

As flat images both the photography and film did not look appeared 4K. The still images transferred to the VR environment well but the filmed content, on the other hand, created quite a significant loss of quality. The settings on the camera were set to a lower resolution for the final shoot the footage will be taken at a higher resolution although there is still some loss of quality. Otherwise I can use post production techniques such as sharpen or blur to minimise the effects of the pixelation.

The Gear VR's cut when working with Adobe production is through the center of the front camera so when editing either the focal point needs to be shot from the rear camera or for each shot you must offset by 50% horizontally

CINEMATIC VR PIPELINE

A challenge of creating content for this medium is no company has created an adequate established pipeline of products and procedures for the work this thesis is trying to produce. There is no way to work from A to B to C seamlessly. Samsung has created a primitive internal pipeline but it does not cover any advanced techniques or interaction. Therefore the workflow being used is appropriated from existing film and game pipelines. From other film and game design projects I already have a working understanding of the existing workflow models. Both film and game design have established pipeline workflows that are fit for purpose and the overall process remains the same even if companies and personnel differ between projects. I utilised my existing knowledge as a base and created a workflow specific to my needs as they appeared. The testing process enabled me to examine and iterate upon my Cinematic VR workflow adaptively. Through the application of trial and error, considerable time was taken to test various pipeline methods that dynamically grew as unforeseen requirements needed to be implemented. The biggest drawback of this pipeline was time. Having no business-engineered established pipeline primarily affects the workflow of the project. Companies have not created tools that work together effectively meaning extra time is wasted exporting, importing and reviewing files which in both film and game pipelines are are easily and instantaneously previewable.

EXISTING FILM PIPELINES

The film industry pipeline is split into three main sections: pre-production, production and post-production. Pre-production is “the time to prepare for the shooting and completion of your film” (Honthaner, 2013). Pre-Production includes the idea generation phase where the brief, concept, treatment, outline, screenplay/script and script breakdown are generated. It also includes the financing, casting/hiring and planning phases such as the production design, tech/location scouts, and blocking. Finally, pre-production includes of the planning for both the production and post-production phases of the project such as scheduling the shoot and shot lists. The production phase is the actual on-set shooting of the film. This phase includes setting up, blocking, filming and the packing down process for every department including photographs, sounds and lighting departments. Finally, the post-production phase is everything that must be created after the production phase. This includes the cut, audio, colour correction and special effects. There are also additional areas such as distribution which are important, but are outside the scope of this investigation. Filmmaking teams can consist of only one person to large scale productions with hundreds of employees. Regardless of the number of employees, the tools used and the specific requirements of the film, almost every film will loosely follow this same process.

EXISTING GAME PIPELINES

Game design like a film production can be split into three distinct areas: Pre-production, the 1st pass and the alpha/beta phase (2nd and 3rd pass). Pre-Production includes the idea generation phase where the pre visualisation, game design outline, level design, level flow, and character mechanics are outlined. More technical aspects such as the data pipelines and camera tools are also decided upon in the technical specifications document. The 1st pass is where the basics of the game are developed including: map, character and object design, BSP blockout and objects, navigation, modeling, and rigging. Lastly the alpha/beta phase focuses primarily on refinement and optimisation. The rigging, lighting, cinematic animation and collisions are fully completed. While the game design and technical specifications documents are updated and all technical requirements met. Again, there are additional areas such as distribution which are important, but are outside the scope of this investigation. Game design teams can be between one person to hundreds of employees. Creators are split into four basic types: artists, designers, programmers and animators. Each designer works on every section of the process while focusing on the key areas each person specialises in. Regardless of the number of employees, the tools used and the specific requirements of the film, almost every film will loosely follow this process.

CINEMATIC VR PIPELINE

From the test footage conducted and the investigation into existing film and game workflow pipelines a ‘cinematic VR pipeline’ has been devised in order to create a final cinematic VR experience.

The pre production phase devises a framework, a concept and all planning leading to the shoot. The framework needs to address the themes and technical specifications that the experience must adhere to. This framework phase also outlines areas such as budget and ideal locations. From the framework a concept is developed through research and iteration that fits into the framework. The concept is refined into working draft and then broken down into the planning stages including: scheduling, actors, location and props.

The production phase consists of everything on set including setting up, blocking, lighting, sound, filming, continuity and packing down, The production phase is identical to the filming production, the only difference lies in the crew being aware of the 360 lens. In Cinematic VR there is no out of frame.

The post-production phase includes every aspect from after the footage is taken to the final distribution of the experience. First the files are copied and backed up incase of hardware failure. Then the raw fish eye lens footage is stitched into the equirectangular format that is usable with post-production softwares. Due to the interactive nature of this experience, doing the post processing before the rough cut is more economical time-wise. The colour correct and grade are applied first. Followed by the rotoscoping and post processing techniques in order to apply aperture and create the white bar illusion. The polished footage is exported from the visual effects program and imported into Wonda VR. In wonda VR interactive buttons should be designed before the rough cut and applied as presets in order to create the most effect time management. The rough cut primarily revolves around the the interaction timing between each clip. Once the final cut is complete and has been tested the final production can be exported and distributed to be viewed in the Wonda VR native app.

CHAPTER 7 **FINAL SHORT CINEMATIC VR EXPERIENCE**

The final short film experience analysis will follow the outline of the pipeline created in the previous chapter. The purpose of exploring the Cinematic VR techniques (movement interaction, action interaction, 3D optical illusions and aperture) is to apply them within a narrative context. The test footage conducted only discerned if each one was possible to produce technically with the software and hardware available. It also allowed analysis of the differences and similarities between each technique used traditionally and within the 360 VR space. Lastly, the test footage allowed an overall understanding of how the medium works and any other conventions that needed to be taken into account; for instance, the considerations surrounding 360 footage stitch lines. The test footage gave valuable insight into the technical opportunities Cinematic VR presents. The test footage did not test or explore the impact each technique has on storytelling, so each technique needs to be tested within a narrative context to determine if and how they affect storytelling.

FRAMEWORK

To create the final Cinematic VR experience a narrative construct was developed. To conduct this analysis a short story was crafted that facilitated the application of each technique. Once the short Cinematic VR experience was produced it was cinematically analysed to examine in what ways each technique contributed to the narrative and extrapolate future applications for these techniques. The device framework discussed what was needed in the story, what was wanted in the story, and what could not be in the story. Then, an overarching idea was devised that met the requirements. Finally, the details were generated from existing narrative ready for further pre-production development into a script, storyboard and shot list.

The narrative must meet a few specific needs. The story must be outside of copyright and/or royalty free to avoid plagiarism. This thesis is about innovation through technical application not innovation through narrative and therefore the story needed to adhere to the generally understood visual language of film so as to least distort the final analysis. Most importantly this experience had been created to showcase each technique being created. Creating an environment where the use of aperture can be utilised. Include objects in the foreground to apply the 3D illusion technique to. Create an opportunity for user movement throughout the space and encourage interactive storytelling via ‘point and clicks’. From the test footage Investigating the use of scale was interesting and so if possible I would like to utilise this mechanic in the final experience. This thesis is created with an ear towards ameture filmmakers and so should represent that. For instance the budget is fairly low, and the post production should be beginner to intermediate level when possible. From these specifications I then created a narrative that would address as many as possible.

CONCEPT

The framework that outlined what the experience needed to include and exclude was then developed into a working story concept. The narrative was developed further into a treatment, outline, and visual story. Lastly, the core narrative was dissected into a script and storyboard and shot breakdown.

When a story is chosen, adapted or developed, it should be appropriate to the medium. When a novel is made into a film the film does not state “Kevin exclaimed that...”. In most cases, settings, dialogue and even core plot arcs are radically changed to suit the medium. For example, in Nathaniel Hawthorne’s novel The Scarlet Letter the townspeople persecuting the main character learn that the father of the baby is Reverend Dimmesdale, who eventually dies from guilt. Alternatively, The Scarlet Letter film produced in 1995 opted for the ‘Happy Hollywood ending’ where no one dies and the two characters leave town to find their happy ever after. To create Cinematic VR experiences, designers must also develop the story for the medium in this same manner. In the case of Cinematic VR a story must be produced that utilises the 360 field of view over the traditional rectangular view and provide the opportunity for interactivity.

Due to this, originally the intention was to choose an existing story and adapt it for the Cinematic VR medium. Upon further investigation this proved more difficult to accomplish without extreme plot and setting alterations. Most traditional stories are linear with a beginning, middle and end which is not conducive to interactive storytelling where stories can take us on different paths. Alternatively the rise of interactive storytelling in games like Mass Effect are made so recently they are still within their copyright. Lastly, other older interactive stories such as the ‘choose your own adventure’ series are inconvenient to create with resources available to amateur filmmakers. It was concluded that a narrative would need to be created to fit the purpose of this research.

Now that the premises or core theme of the narrative had been established I investigated existing works either about cats or from a cat's perspective. The works that influenced my final experience the most were: She and her cat (Kanojo to Kanojo no Neko) (1999) a short film and its remake/adaptation She and her cat: everything flows (Kanojo to Kanojo no Neko) (2016) a four part series about a cat observing and interacting with the ordinary life of his owner. A short story The Black Cat by Edgar Allan Poe (published 1845), a morbid story that looking into a darker relationship between cat and owner. Chi's Sweet Home a japanese children's anime about the miscommunications between cat and owner and the trouble this causes. Simon's cat (2008) an ongoing YouTube animated series about the daily interactions between a cat and the world around it. Finally, I watched an extensive range of cat videos through YouTube and a variety of online articles.

From the research I realised that I wanted the cat/participant to be the main character but, for them to be looking in on an outsider's life. From this research I brainstormed any ideas I could think of and then systematically eliminated them until only the final ideas remained. These thoughts are written in the order I originally thought of them to give an idea of how my process developed: looking through the eyes of a cat was a kept theme along with the protagonist being a different entity to the user. The story begins with the cat being found in a box and taken by the main character into their home and was a kept idea although developed further because it is relatively cliche but indicates that the life they are entering is better than the life they were in before. As this is a short story I only intended there to be the cat and one other character; any other interaction would be conducted via phone or some other means. This idea was kept with the small addition of a second character for the purpose of exposition. The idea of a silent film was discarded because it would be less engaging, but the idea was first considered because of the poor audio quality in the test footage and the sound being outside the scope of this thesis. The idea of the user/cat interacting with something and knocking it off the table (like cats do in reality) was kept as it was an interesting dynamic to test. I considered the idea of creating both positive and negative endings such as the cat dying.

These random thoughts created a foundation of ideas. From this I started to brainstorm story arcs for the protagonist. Again these are listed in the order they were conceived. The character dealing with mental problems, although interesting I discarded because I did not want this experience to become about ethics. Abusive relationship, drug or alcohol use, pregnancy, and disabilities such as being blind or death were also discarded for the same reasons. Dealing with a breakup was almost an included idea but as my work progressed I realised I wanted to deal with an older protagonist and those two concepts did not mesh well. Financial problems/getting a job was discarded because because I had no personal interest in this topic. The idea of an artist trying to sell their work was discarded for the same reason. The protagonist having to leave the cat behind for graduation or some other reason was a considered idea, but ultimately discarded because the cat is newly introduced to the environment. A sick person and the cat must make the person happy before they pass away. This idea was discarded but aspects were appropriated into the final narrative. I liked the idea or the cat interacting with another cat but working with animals is difficult and I do not have easy access to a cat to use. The human being afraid of something and the cat having the ability to help consol their fears is an included theme moving forward. The human trying to make the cat feel welcome in the new environment is also an included idea.

From these ideas the first draft outline of the narrative was established: Side character finds cat in a box and decides to give the cat to the protagonist because they are ill. The protagonist is very ill, coughing. It is made clear this is a long term illness and the protagonist seems depressed and has giving up on life. The cat/user can now execute tasks that interact with the protagonist to make them happy or ignore the situation completely to explore the area.

The story was then further developed into into a cohesive outline. First the cat is brought into the house. The cat is then put down and the protagonist then goes to make a cup of tea. Once the cup of tea is made the character goes to sit on the couch and use the laptop while drinking. Then when the phone rings the main character places the cup on the bench and goes to look at the phone. The protagonist does not pick up the phone and shows great distress at the fact it is ringing. To distract themselves they walk up to the cat/user and initiate a playing game. The cat and protagonist play together (or not this would be the user's decision). The phone rings and this time the protagonist does go to answer the phone. THe conversation is one sided and the protagonist is not happy. It sounds as if someone close to them is very ill. Once they finish the phone call they are visibly upset and decide to go to bed. The cat can follow them and make them feel better or continue exploring the space. The experience then ends.

The final outline ready for planning was then established from the previous iterations. The cat (user/camera) begins inside a cardboard box with a hole in the top to see the outside world. The SC (Side character), a young woman, peers into the top of the box and starts reassuring the cat and patting it. The SC picks up the box and walks it to the door of the house and knocks. The MC (main character), a middle aged man answers the door looking a little haggard. SC gives him a warm hug and explains about the furry present she has gotten her dad. The cat is then picked out of the box and placed on the ground inside the house. From this point the user will first gain freedom of movement to a degree. Once the SC says her farewells MC goes to put the jug on, gets a cup from the overhead cupboard, get tea from the pantry, puts tea in cup and fill it up with hot water. MC picks up the tea and walks himself to the white couch and sits down. MC sits there drinking his cup of tea and working on his laptop until the phone rings from the kitchen counter. As the MC walked to the phone he pours the left over tea into the sink then places the cup on the bench. He he considers answering the phone but ultimately ignores the call. The user may choose to push the cup off the bench for as long as it remains there. Looking upset MC sees the leash beside the phone and decides to try playing with the cat to distract himself. “CAT” “CAAT” (user movement is suspended). MC walker over to the cat’s position “Do you want to play? Well come onthen!”. MC walks over to stool and sits with toy. (special button appears to follow human once he is out of visual sight, normal buttons reappear if cat follows them it does not get to play with MC). Either the user and cat play until the phone rings again or the phone rings immediately based off the user’s choice. Phone rings again and this time MC gets up from the stool and this time pics it up. He then walks around the house getting more and more upset at the person on the other end. It is clear someone close to him like his wife is very ill. He places the phone down with shaking hands at the end of the call. Looks directly at the cat and gestures with his head at the bedroom while walking in that direction, he can’t deal with this anymore. Puts cup in sink on the way through when he gets to the bedroom doorway he states “everything will get better after a nap” then gets on top of the bed and curls up into a ball. Three endings are generated from this: First, if cat is in the bedroom at the time MC picks up the cat and snuggles it closer. Secondly, if cat does not reach the room in time then MC comes and picks up the cat “I know she was trying to do what’s best for me but i can’t deal with you I will return in the morning” MC then places the cat in the cupboard. Lastly if the cat is in sleeping position and MC forces the cat to come to bed with him. The end.

PLANNING

Once the narrative had been fully developed the shoot planning could commence. The location had already been decided upon as the story was in development. An actor volunteered for the role. Props were kept simple with multiple mugs that could be broken, a leash, consistent ‘old man’ outfit and brown paper to cover the parts of the new kitchen not completed. I decided to act the role of side character myself as a sort of cameo. Sounds and lighting will both be done naturally with the camera mike and natural lighting. The camera positions needed to be placed but as the film is 360 actual camera angles were not necessary. To find the best positions I constructed a blueprint of the filming environment and placed each camera accordingly. I also created a timeline of exactly when each part of the story should occur, how long it should take and each interactive even available at that time.

The production schedule was decided around when my actor was free and the house was unoccupied. Lighting was an important issue with the schedule only being for the day and alterations occurring accommodate the best lighting for the time. The night before each shoot the house was cleaned to make everything as consistent as possible.

SHOOTING

The actual shooting of the cinematic VR experience was conducted over a few consecutive weekends. The onset pipeline is directly derived from a film pipeline with a small crew. Before the shoot began, the set was cleaned and organised, then snapshot photos were taken of the space in order to recreate the exact environment for all subsequent shoots. Working with such a small crew had both virtues and faults. In 360 the crew must vacate the set entirely so as not to be in shot. But, the smaller crew meant that it took longer to set up and small things were often overlooked as there was not one person focusing on individual tasks such as sound, lighting, and continuity. Once the actor arrived he and I blocked the scenes and practiced off camera the actions, movement times and continuity. The on set schedule was fluid as the shooting was conducted in whichever room had the best lighting at the time. On day one the sun was out so the scenes were shot in the rooms with the least direct amount of sunlight at the south of the property. The other shooting days were overcast so in the mornings shooting was done in the west sections of the house and in the afternoon on east sections to minimise direct sunlight effects on the shot. Once shooting began there were a few shots discarded while the actor and I familiarised ourselves the the various aspects of the narrative and technical considerations such as lighting. Each shot would be approximately 5 minutes long and within the first five takes the camera overheated. This problem was not discovered in the test shooting because each shot approximately one minute long. Therefore, the battery never got as hot as it did during the five minute shots. This overall extended the shooting process by an extra day as between every four shots the camera needed 10 - 20 minutes to cool down. The shoot was completed despite the delays caused by the camera hardware and then moved onto the post production process.

The differences between a film shoot and a 360 shoot are mostly in the considerations that need to be made around the space that is in shot. For instance I cannot stand and watch the scene play out from behind the camera. I must move to a location outside the space and watch from the view finder. There was a time when I stood out of line of sight of the camera, but, when the camera was picked up and moved by the actor I ended up directly in the shot. On a normal set this kind of error is more easily avoidable. The actor also spoke about his experiences shooting with a 360 camera.

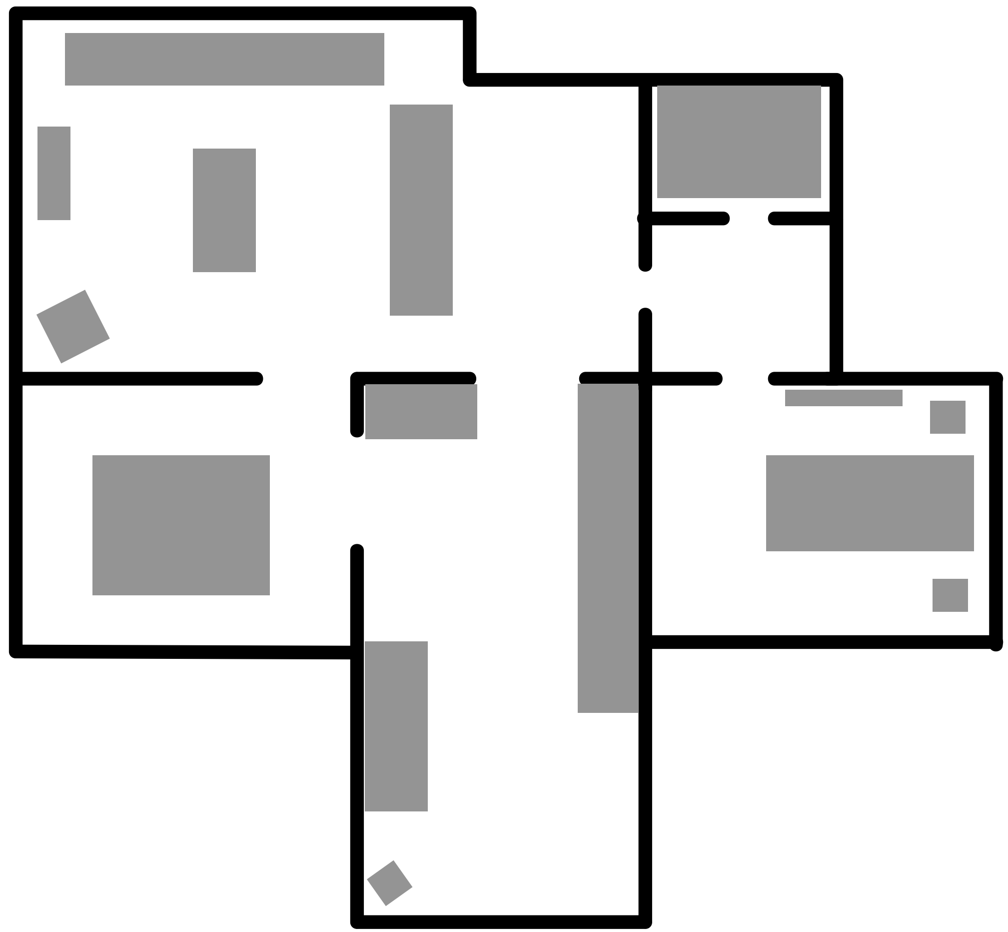

Figure 16. Diagram of the location

360 VR FROM AN ACTOR'S PERSPECTIVE

I have performed as a leading actor in some high school dramatisations and been involved in stage crew work for other projects. I am not currently a professional actor and I do not work within the film or theatre industries for a living.

I was asked to do this project because of my age and availability. I accepted because I felt it would be an interesting experience and I was excited to explore the possibilities of this new approach to media entertainment.

1. The Stage To begin, I wanted to discuss the locations and environments where filming took place.

- *Big Area The stage in this project consisted of four rooms in a home plus an outside area. This gave me a lot of space to act in and provided the shots with brief pauses while I moved from location to location within a shot.*
- *Spatial awareness While acting out a scene I often had to be aware of the location of objects and furnishings within each room in relation to me and the camera. The environments were not cluttered and I was not asked to do any action scenes, but I can imagine that safety would be a concern under certain conditions.*
- *Lighting We restricted our filming times to daylight hours. Much of the lighting from the shots came from the windows. The changing position of the sun was a concern on blue sky days because the changing angles of sunlight falling on the floor presented us with continuity issues for shots taken at different times of the day. Where possible we had to mask the sunlight by subtly moving the curtain positions, or blocking the sun from outside.*
- *Crew location Keeping directors and crew out of view of the camera was a concern, especially during shots where the camera was moved. Because the camera had such a wide view, it was necessary to either keep crew out of the rooms in which we were filming, or move them from room to room out of camera view during the filming of a scene.*
- *In a play I was used to crew being available for prompting me when I needed it, but in this project that was not feasible because crew were not physically close. I found myself doing much more off the cuff acting because of this.*
- *Camera location The position of the camera had a large impact on how each scene was done. Sometimes the camera was not located in the same room where the scene began. In those scenes my focus was on the timing of the sound elements until the point where I had to walk into camera view.*

In other shots I was asked to pick up the camera. There were times when I was carrying the camera and had to block its view of certain parts of a room to maintain continuity.

An example of this was when I inadvertently left a cup on a bench which should not have been there. It was difficult to do this without appearing awkward. By cradling the camera close to my body I was able to mask the cup and save the integrity of the scene.

During shooting I was asked to make a cup of tea. In most shots I pretended to make the tea, but in shots where the camera was positioned on the bench I had to make it for real simply because the camera had a view of me pouring the water from the jug.

- *Documentary style vs acting out a story Because the camera in this project was effectively an audience and an actor, I had to address it as both. This made me feel more like I was doing a documentary than acting in the play or a traditional film. I had to imagine the camera as a cat and infer how it would respond to my acting without much feedback.*
- *Repetition The nature of this project meant that I had to repeat each scene multiple times, one for each camera angle. This meant that I had to maintain some consistency in what I did across each shot. This required a fair amount of concentration and attention to detail. It also meant that the amount of acting time to produce a short scene was longer than I would expect acting for traditional media.*

2. External Factors Because we were filming in a private residence it was not possible to control every aspect of the filming environment. I wanted to mention a few of the external factors which affected the shooting.

- *Interruptions Filming was interrupted many times. The camera would overheat if left on too long. Gardeners would arrive and walk past windows during a shoot. We would be partway into a scene and realise that a crucial prop was missing from a room. House residents would accidentally walk into the field of view of the camera. A real cat wandered into the house during a scene. These interruptions were made worse by the fact that the camera could see more of the environment than a traditional camera.*
- *Continuity We had a small crew. Sometimes this worked in our favour because it was easy to keep them out of the shots. At other times this was a liability because the total set area used in the scenes was large and it would have been better to have more people available to adjust each area for continuity before commencing a shoot.*

Also because of the nature of the project and the branching alternatives offered by the audience choices, we sometimes struggled to adjust each set properly to maintain continuity.

- *Sound There were unplanned sounds out of our control however the difficulties encountered with sound appeared to be similar to what I would have expected for a regular media shoot.*

3. *Timing and Narrative*

- *Movement Because filming could span multiple rooms in the set I found myself moving from place to place a lot, much more than I would expect to move on a regular stage during a scene. Add to this the high degree of repetition in shooting each scene and I found that I spent much of my time on my feet and walking between locations which mark important story points.*
- *Pausing and Pace The story in this project is supposed to progress in real time shared among different camera positions in the set. That meant that the timing between my actions in the scenes became very important. I had to pay a lot of attention to when I did actions and often I would find myself counting seconds in the gaps between periods of physical activity or exposition.*
- *Positioning I was concerned about appearing to act naturally while attempting to position myself for the camera so that it could get a good view of my actions. I also wanted the camera/cat to have a sense that I was aware of it in scenes where it was not hidden and in plain view.*

Sometimes I would add a deliberate stumble into a scene where I would be walking and find the cat on the floor where I would not expect it to be. This type of personal interaction is not commonly used in a regular shoot because usually the actor would not be aware of the camera and it would also not be in a position to hamper free movement.

I found it difficult to know if my acting appeared natural to the camera because I did not have any experience working with this kind of media and the camera angles were unusual and awkward to visualise from my point of view. I expect with more feedback and practice this would improve.

- *Field of view As an actor knowing what the camera could see was important. This was especially true when I was expected to move the camera.*

4. Projecting emotion

- *Face I was concerned about presenting my face to the camera especially when it was close to me and I was moving or I was carrying it.*

A camera view below above or too far to one side or the other would not be as impactful as when it was front on and I was not moving in relation to it

I tried therefore to not overly rotate or tip the camera if it could be avoided during filming. When addressing the camera I pretended that the front lens was the point where I was making eye contact.

- *Ad libbing Due to the technical difficulties in getting prompting and the absence of crew I had to do a fair amount of improvisation and hope that post production would compensate for any mistakes.*
- *Playing to an Audience versus Authenticity I was asked by the director to exaggerate my movements somewhat. I was told that this would appear more natural to the camera. Therefore that is how I behaved for the duration of the project.*
- *Control Because I had the ability to move the camera and improvise I felt more in control of the scene except for the unplanned interruptions.*

I did however find the camera fairly unstable when trying to move it. Sometimes it would tip or wobble and I wished that it was a bit heavier and stable.

I accidentally tipped it a few times and in some scenes I left it tipped over because I was curious about how that would work in he shot.

Conclusion The whole experience for me was unique and intensely interesting. Much of the work required me to concentrate hard on the environment and positioning for each shot for long periods. This was somewhat tiring mentally and physically.

It was definitely very different from acting in a play. Learning lines for this project may have helped a little but much of the work involved familiarising myself with the actual set.

POST-PRODUCTION

For the post production process first the files need to be organised and stitched. Then, any post production processes such as colour correction and rotoscoping need to be applied. Once the raw footage has been touched up it needs to exported from the Adobe products, then imported into wonda VR. In Wonda VR the footage can then be organised into an interactive format, the buttons created and the overall rough cut and final cut developed. Finally, any changes can be made and the finished product can be exported.

The file organisation was loosely made into four different areas: one, the raw footage, two the sorted, labelled and stitched raw footage, three the working files and exports from Adobe After Effects and Premiere files and four, the Wonda VR working files. Basically one folder for each main stage of the process with backups kept on in multiple locations both online and offline. This is similar to the film post production pipeline, but the post processing and editing are swapped as to when they are completed.

The first stage, stitching, was a simple process. The raw footage was manually sorted and labelled and then the best shots were imported into 360 Action Director which automatically stitched the files and rendered them to a specified folder. Each 5 minute clip took approximately 35 minutes to stitch. In both film and game design there is no stitching process, therefore additional time must be factored in when creating 360 experiences. The stitching for this experience was about 24 hours but for a feature length film this time would substantially increase.

Once the files are stitched and exported into the equirectangular format they can be imported into any post-production software which supports 360 video. In this case Adobe After Effects and Premier. In film and static Cinematic VR experiences the next step would be to create the rough cut. But, in interactive Cinematic VR the process of colour correction and compositing comes first. This is due to Wonda VR and Adobe products not being cross compatible at this time. Much time would be wasted constantly exporting and importing between programs, therefore the post-processing will be finished first, then exported, then re-imported to Wonda VR.

The colour correction and colour grade are used to match the colour between shots and add an overall colour, tone and feel to the film. To do this I first matched the colour between every shot through the use of Adobe Premier's colour correcting tools then applied applied the colour grade to create the impression that the film world is dark and sad. I accomplished this through making the shots darker in the blacks and whiter in the whites to increase the contrast. Furthermore, I worked with and orange and teal pallet to help draw the participant's gaze to the areas of the film I wanted to highlight. This process was exactly the same as it would be in both film and game colour correction and grading. The only difference would be any changes to the border of the image must be changed equally on both sides to avoid distortion. Effects like the vignette are not possible for this reason.

The artificial aperture/depth of field was created manually through a combination to rotoscoping, compositing and keying using a difference matte. The final effect does not look natural. It is distinctly different from the style that the in camera settings could produce. However, the effect is intentionally stylised to look more like a computer game. The inspiration for this aesthetic came from the glow effect around some computer game NPCs to separate them from the background. The aperture is lessoned if the camera is moved from a static position to help participants orient themselves within a changing space.

The white bar optical illusions were the most difficult technique to create and were ultimately removed from the final experience. The main reason this technique was removed was the white bars took away from the narrative rather than enhancing it. The hardware was not had too low a resolution and the white bars themselves were distracting within the context of a longer clip. Firstly, everything is enlarged when moving from the equirectangular format to the HMD headset VR space. This means the overall resolution is too pixelated and created blurry points when the footage crosses the white bar. Furthermore, even the smallest errors in the rotoscope are also magnified creating bleeding issues which can be distracting when viewing the experience. Rotoscoping is already a time intensive process with the magnification of problem areas are highlighted. This projects rotoscope could have taken months of full time work to get to level of detail required. The level of detail needed to create an acceptable matte is an advanced intensive process and as this thesis is aimed towards ameture creation, it places further investigation into this technique out of the scope of this thesis. With higher resolution hardware, time, advanced rotoscoping knowledge and a very specific environment I hypothesize the white bar optical illusion could be a successful technique.

Exporting the final clips was done when the all the compositing was complete and the white bar optical illusion technique had been tested and discarded. Exporting each composition is a time consume process but not labour intensive. The render queue needs to be checked periodically for errors but other than setting the initial settings (.mp4 equirectangular format) the computer drives this aspect of production. This is the same for importing the 5 minute clips into Wonda VR.

The designing of the interactive elements of this experience were conducted in a similar manner to website design. Before the rough cut is assembled the design outline or the CSS classes in website design were developed. By taking this approach the designed elements such as the interface and buttons are developed in advance and added as a presets within the application, or as a class in the base code (when a preset could not be applied). This automated a large amount of the design process and kept the designs consistent throughout the experience. The rough cut became about assembling the presets into the footage at the right times rather than assembling every aspects manually for every interaction.

The design specifications for the interaction UI were that they: must not take away from the story, they should exist but not dominate. The design should change when the user looks at it to indicate interaction. Be a UI type that people are already familiar with. The design should be transparently obvious to facilitate intuitive understanding. For instance arrows indicating location. The UI must also be legible on a moving background that is primarily teal, orange, black and white. Finally, Wonda VR at the time of this thesis cannot import 3D assets therefore a flat UI is a better direction for compatibility. The end design was white icons from font awesome with a darker more blurred background to the encompassing div. Then the experience was completed by linking up each clip and inserting the presets in the appropriate spaces at the appropriate times. Lastly, the final product is exported into a project folder which can be copied over to the mobile device to view.

Figure 17-21. stills from the final expereince

CHAPTER 8 **CONCLUSION**

"Creating compelling VR experiences is an incredibly complex challenge. When VR is done well, the results are brilliant and pleasurable experiences that go beyond what we can do in the real world. When VR is done badly, not only do users get frustrated, but they can get sick. There are many causes of bad VR; some failures come from the limitations of the technology, but many come from lack of understanding perception, interaction, design principles and real users"

(Jerald, 2015).

This thesis began by analising what virtual reality is, and the role of cinematic VR in the entertainment industry. Cinematic VR could be considered non-immersive. The application of game techniques to these experiences is intended to create a more engaging experience and cross pollinate the VR and cinematic VR mediums.

The history of the VR industry, the current state of VR financially, content wise, it's impact and potential applications were documented in a broad overview to identify trends, and gaps in the area. This investigation helped determine the specific focus areas of this thesis. It identified that hardware still needs further development, but the visual language VR content could adhere to is has also not yet been defined. This lack of established techniques leads to a loss of communication between the creator and the user.

Therefore, the subjective nature of understanding and communication was analysed through the theoretical application of presence. The minimal technology level required for a convincing experience was defined. Cinematic VR was also broken down to identify how a visual language could be designed. This is done firstly through the of narrative, visual and interactive techniques from the most similar mediums: game and film. Multiple key areas, two from film and two from game design were identified as techniques that could be appropriated across mediums. Aperture/depth of field for it's ability to draw the user's gaze, white bar optical illusion to help define the plane of action, movement to bring the mediums cinematic VR and VR closer together and interactivity to give the user a limited control over the environment. Each technique was chosen for the aid in communication it could facilitate.

Once the basic parameters of the testing and final experience had been defined, hardware and software tools were utilised to realise these goals. This thesis worked with samsung's Gear VR, Gear 360, s7 edge mobile and Action Director. Multiple applications from the Adobe range and Wonda VR was used to assemble the final product.

Each technique being studied was tested alongside the basic functionality of the tools. This process also aided in the creation of a cinematic VR pipeline which was usable within the context of this thesis. The approaches in this thesis towards testing these techniques and devising a cinematic VR pipeline are not exhaustive in their experimentation, they are offered as basic approaches for creators to consider and thereafter innovate from.

Utilising what was discovered in the testing phase of this thesis, a final cinematic VR experience was created following the pipeline. A framework was developed that depicted everything the experience must include. Then a concept was devised that adhered to this framework. The planning and shooting was then conducted according to the pre-production specification. Then finally post-processing techniques were applied to the footage before being assembled into the final experience.

This was not an exhaustive study of the pipelines and techniques associated with cinematic VR, game and film; instead this thesis focused on how to apply a few specific techniques within the context of cinematic VR. Ultimately, this thesis was intended as an example for how other creators could extrapolate and innovate across different industries or genres to further define the visual language and communication techniques for cinematic VR.

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