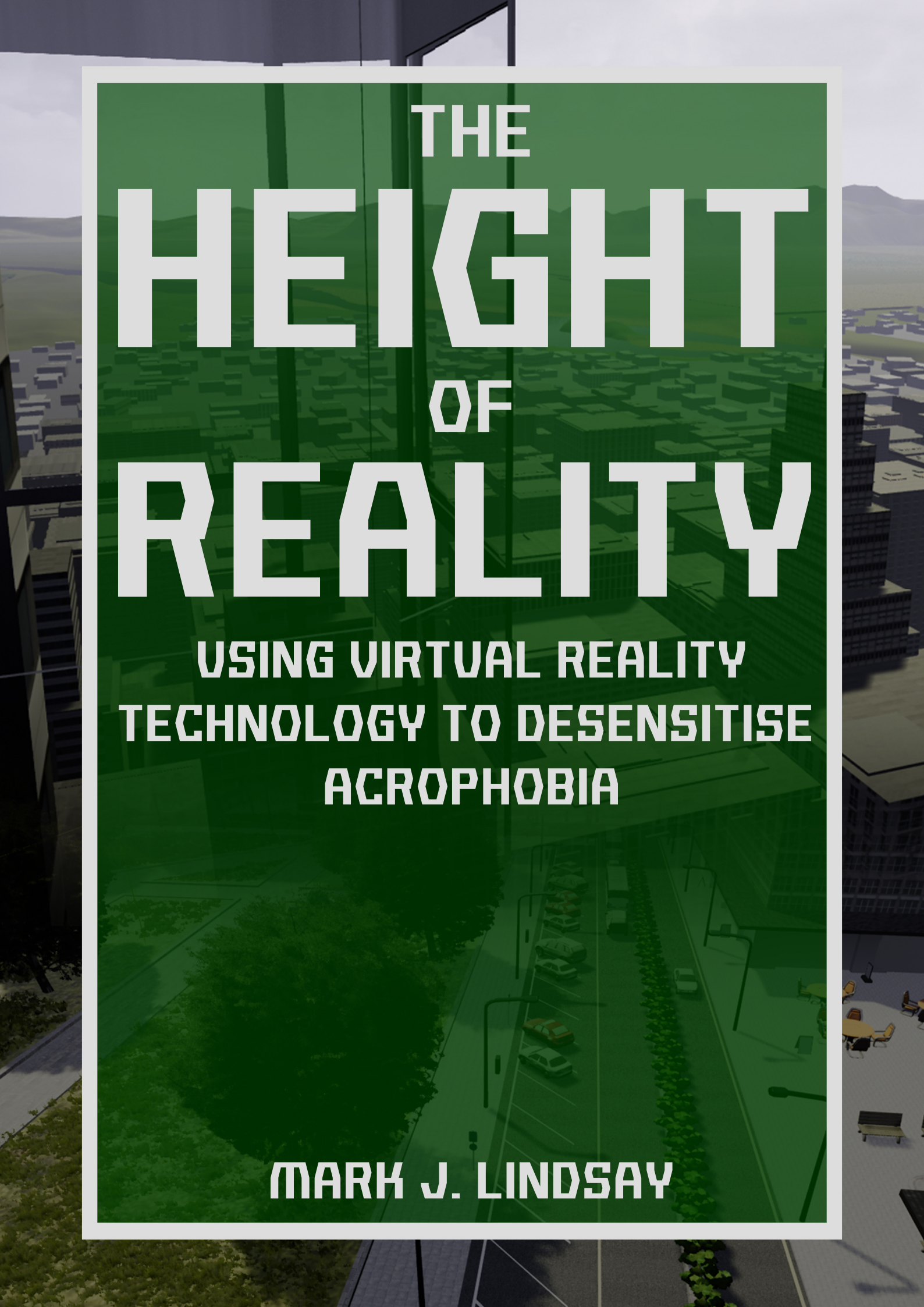

THE HEIGHT OF REALITY

USING VIRTUAL REALITY TECHNOLOGY TO DESENSITISE ACROPHOBIA

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A**bstract**

Virtual reality (VR) is a new up-and-coming technology on which to watch three dimensional films or play video games. However, the practical uses of virtual reality can spread much further than just media outputs. This research aims to explore one of the practical uses for virtual reality technology. VR has the potential to help patients living with psychological disorders, by reducing the anxiety that they experience to a more manageable level within a safe environment. This dissertation addresses the use of a virtual reality simulation to reduce the anxiety experienced by patients effected by acrophobia, known as the fear of heights. The preliminary research includes several in-depth interviews with psychologists and clinicians, as well as phobic patients to better understand the processes of gradual exposure rehabilitation. This method also determines how a virtual reality simulation may be effectively designed. The primary aim of this research is to build a VR simulation which will produce a conducive result in the anxiety levels of the participants' mental health, within a familiar and comfortable environment. User-testing the simulation will further refine the program's effectiveness. The outcome will be a program supported by existing virtual reality treatments for psychological disorders that ultimately reduces the anxiety experienced by participants.

Acknowledgements

I would like to offer my special thanks to my family and Michelle for their support and presence throughout the stress and technical issues.

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Introduction

In the public commercialisation of immersive gameplay and 3D viewing over the last decade, virtual reality has become an increasingly popular creative forum. 'Virtual reality' or 'VR' describes both the equipment and the process of creating an artificial, digital environment that can be experienced through sensory stimuli such as sight or sound.[1] Although unsuccessful devices existed in the early 90s, a resurgence of new VR technology appeared in the last four years, starting with the release of the *Oculus* DK1 in 2013. The resurgence has featured heavily on YouTube, popularising the application of VR in video games.[2] However, since the early 1990s researchers have begun expanding on the uses of VR by creating programs for other purposes.[3] These programs are becoming more accessible worldwide, exploring medical treatment, training and therapy through virtual simulation. Programs such as *FITE* (*Future Immersive Training Environment*) utilise VR technology to train military personnel in a safe environment.[4] HIT Lab VR Therapy and University of Southern California's *Bravemind VR* utilise the technology to help people suffering from phobias, social anxiety and post-traumatic stress disorder (PTSD).[5] Currently there are no programs commercially available that is dedicated to the research and treatment of acrophobia, the fear of heights. This phobia is one of the most common worldwide with approximately ten percent of the population medically diagnosed in 2011.[6] This thesis will research into how a simulation could be developed to treat this psychological phobia and the advantages and disadvantages of specific design techniques.

This thesis is divided into chapters outlining the design process for the simulation. Chapter One discusses the history of virtual reality and a selection of existing virtual reality programs which have directly influenced this project. This chapter provides information about current virtual reality technology and previous treatment methods for phobias. This thesis intends to evaluate these existing VR therapy programs and identify design elements which have been effective in the programs' applications.

Chapter Two features information gathered from psychologist and patient interviews. This information is provided by industry professionals that have had experience in acrophobia and its treatment. Interviews with psychologist John McDowall and medical clinician Dougal Sutherland will be discussed for insight into and their personal involvement in the treatment of phobias.[7] An interview with an acrophobic patient will be analysed to understand from a first-hand perspective of

[1] "Virtual Reality, noun." OED Online. June 2017. Full definition found in the Terminology section.
[2] Zyda, 2005: 26.
[3] Westwood, 1998: 2.
[4] Corrin, 2011.
[5] Washington *HITLab VR*, 1997; *Bravemind VR*, 2005
[6] Fadden, 2016.
[7] Full interview transcripts can be found in Appendix.

acrophobia and the challenges that the interviewee experiences on a day-to-day basis. Finally, an interview with the former Lead City Planner of Palmerston North, Caroline Miller, will be discussed to provide insight into the design of a city that is a direct influence on the design of the final simulation. These interviews were conducted throughout the design process where the information gathered was most necessary. The two interviews with the medical professionals were conducted early in the literature review, the acrophobic interview was conducted during the conceptual phase and the city planner was interviewed during the design and development phase.

Chapter Three focuses on the beginning of the design process, starting at the conceptual stage with four separate, distinct concepts and finishing with an early design of the simulated world. The information gathered from the literature review, the program analyses and the interviews directly influence the design process of this VR simulation.

Chapter Four refines the design of *The Height of Reality*, describing the early the user-test, the users' responses to the simulation and their influence on the development of the program. The user-testing will be discussed in three stages. Alpha user-testing focusses on refining the simulated world that the participant experiences. Beta user-testing confirms the changes from the previous testing was affective and additional features such as sound and ambient music are added. The final round of user-testing includes participants who experience acrophobic anxiety to test the practical application of this VR simulation. Taking into consideration that normal phobia therapy can take longer than six weeks of constant rehabilitation and therapy sessions, any minor improvement on the participants level of anxiety as a result of the testing will be considered as a successful response. This last round of user-testing and the finalised design are discussed in Chapter 5. The successes of the simulation and possible future developments will also be mentioned.

It should be stated that the final prototype is not intended to treat acrophobia; however, in the conclusion chapter of this dissertation an explanation of further development will be given as to how this may happen in future development.

Chapter One: Literature Review

This chapter reviews current virtual reality technology, VR devices and the uses for virtual reality. It is important for the development of the simulation to consider existing software that treats phobias through VR and understand why VR is the best option for digital treatment.

Virtual Reality

The term virtual reality (VR) can be defined as the digital simulation or recreation of a real or imagined environment, experienced visually in three dimensions. VR provides an interactive visual experience in full real-time motion with sound and the possibility of other tactile and haptic feedbacks to enhance the experience of immersion.[8] Although VR can include complex forms of visual entertainment and interaction, the simplest form of VR is a three-dimensional image that can be explored and manipulated.[9] Within VR, a virtual environment (VE) is used to convince users that are immersed in the interactive experience. The VE is a virtual image the user is placed within and interacts with. It can be enhanced with non-visual display modalities, such as auditory and haptic to increase the immersion.[10]

One of the earlier uses of the term virtual reality can be attributed to pioneering computer scientist Jaron Lanier in 1987; however Ivan Sutherland is considered the 'father' of virtual reality.[11] In 1965 Sutherland coined the terms 'virtual reality' and 'augmented reality.'[12] Virtual reality, he defined, was "an artificial environment which is experienced through sensory stimuli (such as sights and sounds) provided by a computer and in which one's actions partially determine what happens in the environment."[13] This definition has not since changed. Sutherland furthermore introduces the main concepts of immersion in a simulated virtual reality world, and of "complete sensory input and output," both of which are the basis of current virtual reality research and development.[14] Sutherland concludes in stating that "a display connected to a digital computer gives us a chance to gain familiarity with concepts not realisable in the physical world" and that "[VR simulation] is a looking glass into a mathematical wonderland."[15] These comments helped to reveal his idea of early virtual reality and the expectations he had for the technology in his time.

[8] Roy, 2003: 177.
[9] Biocca and Levy, 2013: 3.
[10] Biocca and Levy, 2013: 3.
[11] Roy, 2003: 177.
[12] Sutherland, 1965.
[13] Sutherland, 1965.
[14] Gobbetti and Scateni, 1998: 4.
[15] Sutherland, 1965.

VR came to public attention in the 1980s and 1990s as researchers continued to develop the technology. There were a large number of unsuccessful releases for VR devices during this time. Nintendo released a VR device titled *Virtual Boy* in 1995 - a large, clunky device that lacked basic movement, requiring the user to use the device in an upright static position.[16] The image was three-dimensional, but due to the underdeveloped technology at that time, the resulting visual quality was worse than existing Nintendo game titles. It was also common for the users to experience splitting headaches and intense nausea. Other releases include I-O Display Systems *I-Glasses*, VictorMaxx's *CyberMaxx* and Forte Technology's *VFX line.*[17] These head-mounted displays (HMDs) were complete failures during their time for several reasons. The technology was not good enough at the time, which meant the result was underwhelming and dissatisfying. The products were commercially unsuccessful due to their huge price tags which prevented a successful market from forming.[18] Among these headsets, the resolution and overall performance were usually underwhelming, with some models lacking basic feature motion tracking, and others lacking a stereoscopic 3D display.

In recent years, a new crop of VR devices have emerged which solve many of the issues prevalent in older VR HMDs. The most popular and current devices available to the public are the *Oculus Rift* (image 1) and *HTC Vive* (image 2).[19] There are a number of differences between the two devices. The *Vive* includes motion controllers which allow the user to be in a standing position and move freely around a room while their hand position is tracked whereas the basic *Oculus Rift* system is controlled via a gamepad controller.[20]

Image 1: *Oculus Rift CK1*

Image 2: *HTC Vive*

[16] *Virtual Boy*, Nintendo. 1995.
[17] *I-Glasses*, 1995; *CyberMaxx*, 1994; *VFX Line*, 1995.
[18] Parkin, 2014.
[19] *Oculus Rift*, 28 March 2016; *HTC Vive*, 5 April 2016
[20] Desai et al. 2014.

Oculus released motion controllers named "*Oculus Touch*" separately from the initial device which allowed users to track their hands in virtual spaces.[21] By selling the *Oculus Touch* separately it allowed the user to choose between using a controller and keyboard or the *Touch* device. The use of a gamepad controller led to a more seated, three-hundred and sixty-degree experience that could be considered less immersive than the motion controllers. The motion controllers increased the immersion and interactivity of users, allowing them to interact with their environment physically. The *Vive* comes with lower quality earphones that plug into the cables. These are not attached to the final headset and can be removed or replaced. These devices are the most commonly used headsets. The *Oculus Rift* focuses on both seated and standing experiences, and therefore supports the idea of artificial locomotion as well as the use of gamepads and controllers to handle in-game movement. The comparison between the two leading VR devices will be considered when designing the simulation. HTC says that real-world movement is the best option for VR, letting people walk around in their room scale-tracked spaces.[22] There are immersion issues with artificial movement, and difficulties with nausea in those less experienced with it. The room-scale VR used by the *HTC Vive* can minimalise these issues, but it requires more physical space than most people can dedicate to virtual reality. Room-scale is a feature in VR experiences that allow users to freely walk around the designated area, while their real-life motion is reflected in the VR environment. Room-scale VR utilises cameras that can record user motion in a large space. Stress Level Zero was one of the first developers to support the *HTC Vive* with *Hover Junkers*, a competitive first-person game.[23] The studio wanted to take advantage of the *Vive*'s room-scale experience, yet also address the challenges of limited space. In *Hover Junkers*, players choose a hovering ship that matches (roughly) their real-world play space in its virtual dimensions, and they can walk around it by using room-scale tracking.

Currently, video games are under development for commercial VR headsets that push the technology as far as possible and create unique experiences. Video games such as *Hover Junkers* and *Windlands* are prime examples of the immersive experiences created through VR gaming.[24] *Windlands* especially is a leading example of complex visual entertainment and interactions. In the game, the player is in a huge open area with floating islands and large structures. The players' controllers act as grappling hooks that can be aimed and shot at the environment to manoeuvre around.

Alternatively, an interaction in a VR program may simply require the user to navigate their environment without any gameplay mechanics. *Senza Peso*, a VR cinematic short film set to a mini-opera soundtrack.[25] In *Senza Peso*, players are a

[21] *Oculus* Touch, 5 Dec 2016.
[22] Krijn et al. February 2004: 230.
[23] StressLevelZero. *Hover Junkers*, 6 April 2016.
[24] Psytec Games Ltd. *Windlands*, 5 April 2016.
[25] Kite & Lightning. *Senza Peso*, 11 October 2016.

soul travelling between life and death along the river Styx. There are no control inputs in the cinematic – players are expected to view their surroundings in full three-hundred and sixty degrees. Utilising all the technology available, these examples are state-of-the-art in terms of virtual reality development. VR technology has developed so rapidly over the past decade, that it is currently at a point where triple-A large budget games such as *Resident Evil 7: Biohazard* can be converted to play in a VR setting.[26] There is little visual difference between the console release and the VR release of *Resident Evil* in 2017.

Virtual Reality Application

VR has become far a more popular entertainment platform in the past decade, mainly in the form of video games. A lot of that success can be attributed to the release of the *Oculus Rift* and the *HTC Vive*.[27] As stated before these two devices are revolutionary: the overall visual quality of the devices are remarkable, with the digital displays having caught up to a point where the visuals are similar to current digital programs.[28] The products were also helped by the overwhelming community support of these devices and the final price-tag.[29] These devices have been commercialised as VR for the everyman, and could be found in anyone's home.

In this virtual reality renaissance, the primary uses of the VR technology have been as a gaming console, and as a three-dimensional film/video experience. However, the technology stretches much further than these applications.[30] Medical treatment, education, scientific visualisation and military training are a selection of the other uses for VR that the public has little exposure to. VR has been used for both flight simulations and battlefield simulations by the military and air force, helping to train soldiers in a realistic training environment.[31] Trainees are expected to navigate a virtual battlefield relying on teamwork and tactics with their unit. It is an ideal method for teaching recruits the skills and techniques required to be an effective unit member. Recruits can be trained in a realistic digital scenario without the danger of combat. The US Military uses a Future Immersive Training Environment (FITE) to train platoons of soldiers in a combat simulation, without putting lives at risk.[32]

This dissertation specifically focuses on the application of VR in the medical field. Current researchers have begun developing on Hoffman's past research and are experimenting with virtual reality in the medical industry.[33] Their research involves utilising virtual environments to create a simulation that can treat different mental disorders such as post-traumatic stress disorder (PTSD) or psychological

[26] Capcom Co. Ltd. Resident Evil 7: Biohazard. 24 January 2017.
[27] *Oculus Rift*, 28 March 2016; *HTC Vive*, 5 April 2016
[28] Digital Trends, 16 October 2016.
[29] The *Oculus Rift* Kickstarter raised USD $2,437,429 from over 9,500 people
[30] Westwood, 1998.
[31] Programs include FITE VR, 2009; WorldViz VR Flight software, 2002; America's Army 2002.
[32] Zimmerman, 2011.
[33] Hoffman et al. 2003: 283-300

phobias. The results of their research have contributed to the development of a new form of virtual reality interaction: virtual reality therapy.[34]

Medical Applications

The development of virtual reality in the medical field has allowed alternative methods of treatment for people suffering from PTSD, social anxiety and psychological phobias through exposure therapy.[35] Before the development of VR therapy there were only two major types of exposure therapy: *in vivo* (in life) or by imagination.[36] *In vivo* therapy involves exposing the patient to their phobia or anxiety inducing experience physically with the therapist in a controlled environment.[37] However some phobias cannot be treated *in vivo*, for example fear of flying (aviophobia) or fear of the deep sea (thalassophobia).[38] Exposure to these phobias cannot be controlled as easily and have a higher risk to the patient. Imagination exposure therapy was relied upon when dealing with these types of fears.[39] Virtual reality exposure therapy (VRE) follows along the same premise as *in vivo* and imagination therapy by exposing the patient to their phobia but in a controlled virtual environment. VRE therapy utilises virtual environments to expose patients to anxiety-inducing experiences to help desensitise them.[40]

The use of VR in therapy was introduced in the late 1990s by Barbara O. Rothbaum and Larry F. Hodges.[41] They compared the use of VRE with standard exposure therapy on treatments for acrophobia (the fear of heights), aviophobia (fear of flying), glossophobia (fear of public speaking), and chronic PTSD in Vietnam War veterans. In each experiment, participants were exposed to their phobia over a six- to twelve-week duration.[42] Results varied between experiments. The controlled study in 2000 conducted by Rothbaum and Hodges researching into the use of VRE therapy for aviophobia resulted in an equal number of participants willing to fly as standard exposure therapy patients.[43] Their later study in 2001 researched into the use of VRE therapy for Vietnam veterans suffering from PTSD, which resulted in a significant decrease of symptoms in participants, ranging from fifteen percent to sixty-seven percent.[44] The Virtual Reality Medical Centre, a chain of clinics in California, has used similar programs to those used by Rothbaum and Hodges in their studies to successfully treat more than 300 patients suffering from phobias and anxiety disorders.[45] Although researchers are still conducting studies to evaluate the

[34] Hoffman, 2003: 284.
[35] North et al, 1998: 112.
[36] Roy, 2003
[37] Emmelkamp et al. 2002: 509-516.
[38] Jang et al, 2002: 213
[39] Jang et al, 2002: 214
[40] Rothbaum et al, 1995: 547-554.
[41] Rothbaum et al, 1995: 547-554.
[42] Rothbaum et al. 2001: 617-622.
[43] Rothbaum and Hodges, 2000: 1020-1026.
[44] Rothbaum et al, 2001: 617-622.
[45] VRMC, 2006.

continued success of these applications for specific phobias, it is clear that virtual therapy offers some very real benefits.

The main advantage of VRE therapy is the ability to provide a safe and comfortable environment for the patient to experience the phobia, which can be aborted as soon as the patient is uncomfortable. VRE therapy is considered a comfortable alternative for traditional 'talk' therapy.[46] An important aspect of VRE therapy is that, in its current state, it can result in effective and positive experiences using relatively cheap hardware and software available for personal computers. This provides an easier method for patients to receive virtual therapy treatments for their phobia without them physically leaving their comfort zones. Researchers are now exploring whether virtual reality programs can be used to standardise the therapy and improve the outcome for patients, especially those who do not respond to traditional methods.[47] Projects such as *Bravemind VR*, *HITLab VR Therapy for Spider Phobia* and *Fearless VR* recognise the importance of utilising correct medical practices in VRE therapy and work in tandem with industry professionals to ensure their projects provide the best results. These programs in particular were instrumental in the development of designed therapies.

Bravemind VR

Bravemind VR uses a real-time authoring tool to recreate PTSD-triggering experiences for soldiers.[48] (Image 3 and image 4). The software can recreate any experience described by the soldier by adding in specific assets as they are mentioned by the patient. By simply pressing a button, the *Bravemind* technician can add details such as civilians, helicopters flying past and more to the patient's digital environment, recreating the exact situation the user describes.[49] For PTSD, it is important to talk through the events as much as the patient is willing. The visuals help to fully recreate the scene and help the patient move past the fear. *Bravemind VR* has the potential to create custom experiences for patients, allowing the simulation to be used by any war veteran with PTSD.

[46] Rizzo, 2005.
[47] Emmelkamp et al, 2002: 509-516.
[48] *Bravemind VR*. Rizzo, 2005.
[49] Rizzo, 2005.

Image 3: *Bravemind VR.* Visuals from inside the simulation.

Image 4: *Bravemind VR*. User setup and technician's desktop

HITLab VR Therapy for Spider Phobia

HITLab VR Therapy for Spider Phobia investigates treating people suffering from arachnophobia (the fear of spiders) using a combination of cognitive psychology and behavioural therapy.[50] *HITLab VR* follows the premise that "the Stimulus-Response conditioning can be reversed."[51] Using this approach, they rely on behavioural conditioning to treat arachnophobia. The patient is deconditioned using stimulus-response learning and unlearning.[52] In the experiment, 280 participants filled out a questionnaire as a comparison group to arachnophobics. In the initial questionnaire, only one participant reported a higher fear level than the arachnophobic patient.[53] After twelve weeks of therapy sessions, twenty-nine

[50] Hoffman, 1997.
[51] *HITLab VR*, 1997
[52] Garcia-Palacios, 2002: p. 985.
[53] Hoffman, 1997.

percent of the initial participants reported a higher fear of spiders than the patients.[54] The therapy consisted of exposing their patient, ironically titled "Miss Muffet," to a simulated spider in a large virtual environment (image 5). The spider was limited to extremely basic geometric shapes and completely undetailed. As the therapy progressed, Miss Muffet was encouraged to move closer to the spider in the virtual space. When the patient's anxiety of being near the spider decreased, she was encouraged to handle the spider with a virtual hand. At no point in the therapy was Miss Muffet physically exposed to a real spider.[55] After several months of treatment, Miss Muffet could be near an actual spider without having an uncontrollable physical response.[56]

Image 5: *HITlab VR Therapy for Spider Phobia*.

Fearless VR

Fearless VR is another simulation dedicated to the treatment of arachnophobia. *Fearless* helps you overcome your fears, utilising the same techniques as gradual exposure therapy.[57] In *Fearless VR* the user is sitting at a desk as different levels of spiders are being displayed (Image 6 & 7). It would progress in slow steps to begin with, initially showing a picture of an extremely badly drawn spider, then showing a picture of a real spider at the earliest levels. This allows you to progress at your own pace and move from each step. Every few steps, the user is asked to talk about how they feel and how well they think they did. Their responses can then be recorded and analysed. In comparison to the previous simulations, *Fearless VR* can be run completely separately from a therapist or technician. Instead of the therapist talking to the user, *Fearless VR* has built in audio cues that recreate the same effect as a therapist would have. There are some potential issues with this system, as it can make the simulation seem less personal to each user. *Fearless VR* is still in the process of being developed for *Oculus Rift* and refining the simulation.

[54] Information provided on the *HITLab VR* therapy for Spider Phobia website.
[55] Hoffman, 1997.
[56] *HITLab VR*, 1997.
[57] *Fearless VR*, 2017.

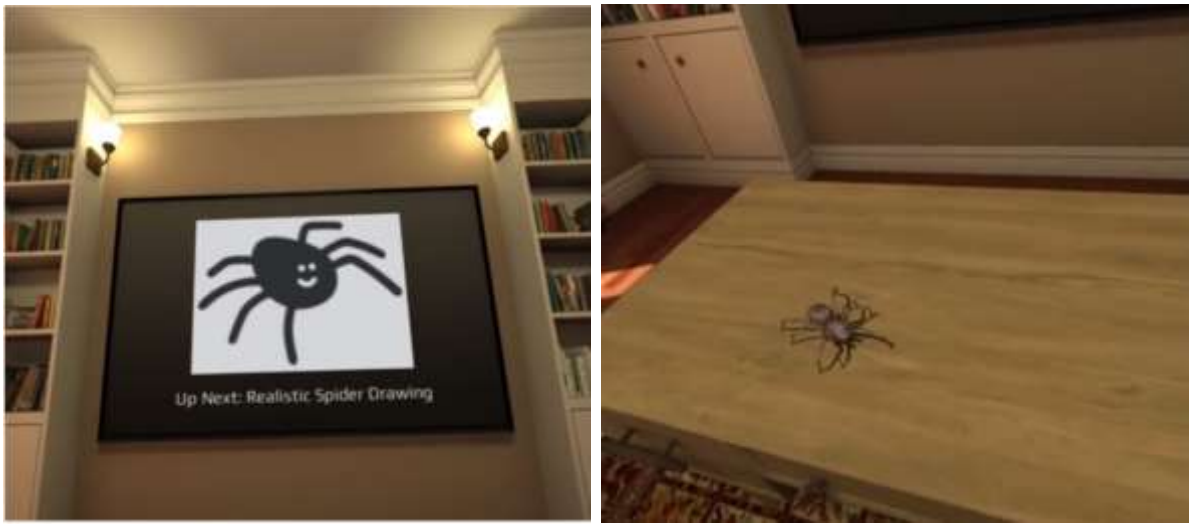


Image 6 & 7: *Fearless VR.* Images from the simulation. Left - Stage two. Right – Stage Eight.

Acrophobia

Acrophobia is one of the top ten most common phobias in the world, experienced by approximately three to five percent of the world's population.[58] The fear is disruptive to everyday life and can severely limit social participation in certain circumstances. It is recommended that sufferers seek psychiatric treatment to help recover from acrophobia.[59] Patients experience symptoms such as vertigo, dizziness, panic and anxiety attacks, physical paralysis and emotional distress.[60] Extreme cases of acrophobia complicate simple tasks such as climbing stairs or a ladder. Common forms of aversion therapy for acrophobia are gradual exposure and cognitive therapy, showing visible results after approximately eight sessions.[61] The effects of gradual exposure therapy are shown in the tables below. The first graph shows the effect time has on anxiety if untreated (Image 8). When the patient is exposed to their phobia, as shown by the "Exposure" marker, the patients anxiety increases rapidly. The patient's impulse response is flight in an attempt to reduce the anxiety, as shown by the "Avoidance" marker.[62] However because the patient is not managing their anxiety, the next time they encounter their phobia the overall level of anxiety will be greater. Alternatively, if the patient undergoes therapy for their phobia, the level of anxiety will increase to a point. The total amount of anxiety plateaus out and will not increase any further. Then over time the amount of anxiety will gradually decrease. The patient will then be exposed to the next step of the therapy and the same process will occur to the anxiety (Image 9).

[58] U.S. National Library of Medicine [USNLM], 2014
[59] USNLM, 2014.
[60] Fadden, 2016.
[61] Ritter, 2002: 41-45.
[62] Jansen et al. 1995: 644.

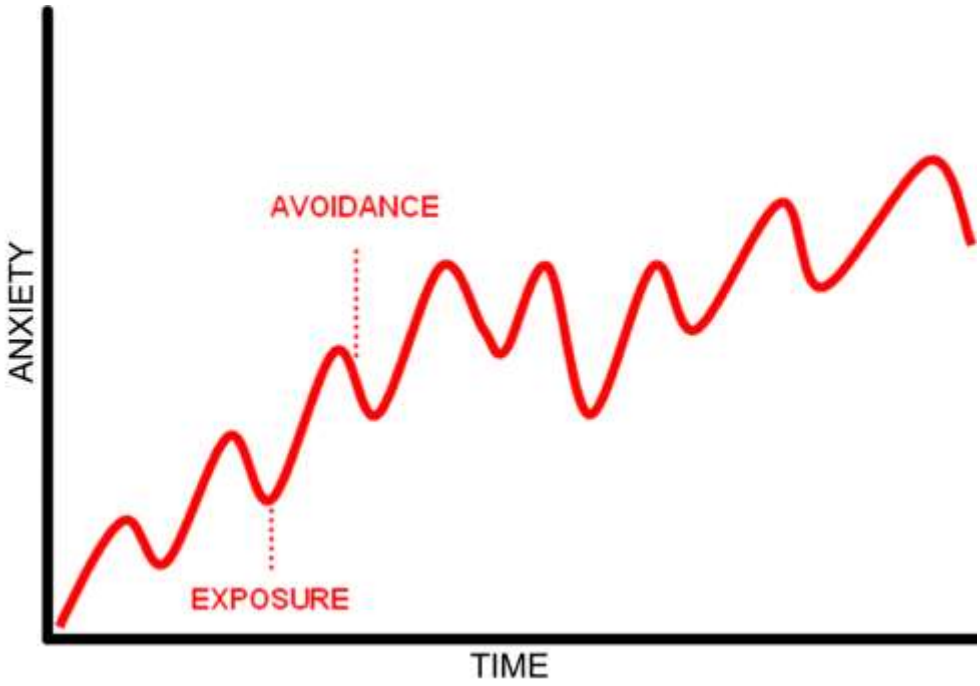


Image 8: Effect of a Phobia on Anxiety over Time

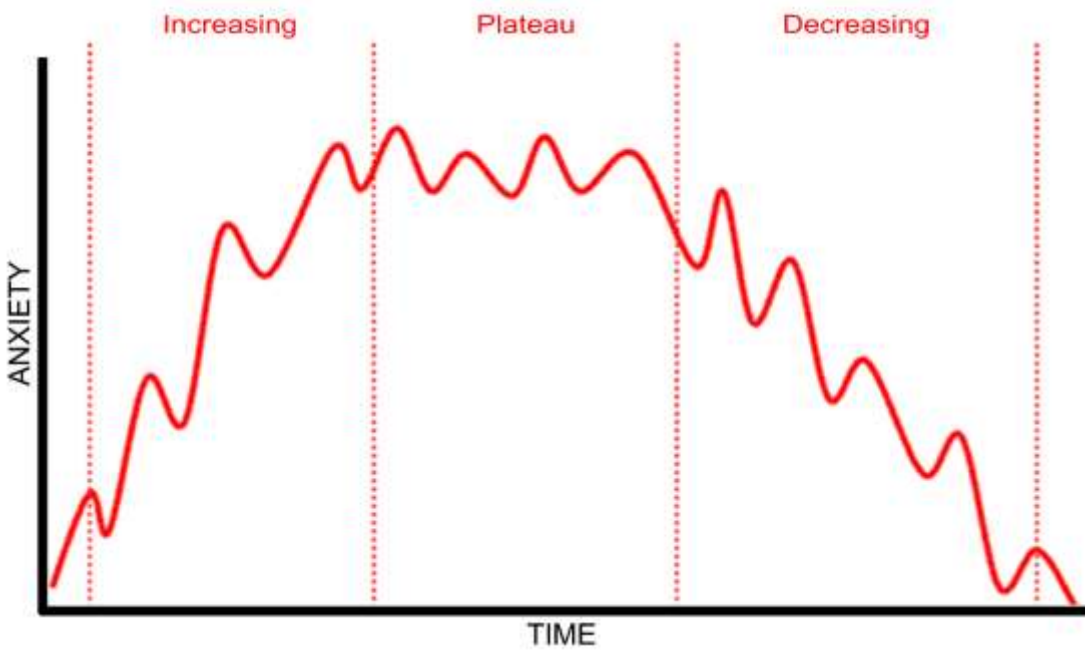


Image 9: Effect of Gradual Exposure on Anxiety over Time

VR is a recent development in acrophobia aversion therapy. Several VRE experiments have taken place to help treat phobias without resorting to *in vivo* therapy. In an experiment similar to Rothbaum and Hodges' therapy tests, ten tests are held to compare *in vivo* therapy and VRE therapy.[63] Virtual reality exposure

[63] Emmelkamp et al. 2002: 509-516.

therapy for acrophobia was found to be at least as effective as exposure *in vivo* on anxiety and avoidance.[64] This was measured with the Acrophobia Questionnaire (AQ).[65] VRT was considered as even more effective on the Attitude Towards Heights Questionnaire (AHQ).[66] The Heights Interpretation Questionnaire featured in Steinman and Teachman's report influenced the questions asked to users before and after the user-testing of the designed simulation.[67] The Heights Interpretation Questionnaire explains a scenario to the user then asks them to answer several questions per scenario. Questions include "How likely is it that you will feel faint?" and "How likely is it that you will feel unsafe?" and provide users with a one to five answer scale. For the questionnaire used in this simulation, advice provided by McDowall was taken into account. The one to five scales were replaced with a visual analogue scale to allow for any smaller changes in the anxiety.

The history of VR use in medical application and the ongoing development of current VRE therapy simulations underline the relevance of a simulation to treat acrophobia. As stated before there is currently no commercial program that treats acrophobia specifically. *The Height of Reality* is a simulation which uses exposure therapy and several aspects of the aforementioned VRE therapy simulations. The HIQ is adapted to suit the user-testing of *The Height of Reality*. The following chapters explore the creation of this simulation based on this chapter's research.

[64] Emmelkamp et al. 2002: 509-516.
[65] Cohen, 1977: 17-23.
[66] Originally Abelson, Curtis, 1989. Modified by Coehlo et al. 2006: 203-216.
[67] Steinman, Teachman, 2011: 896-902.

Chapter Two: Interviews

As stated in the introduction, four interviews were conducted over the course of the project to gather the information required to properly create *The Height of Reality* simulation.[68] The first interview was with clinical psychologist Dougal Sutherland, and the second with university psychology professor John McDowall. Both interviews provided knowledge of the causes and symptoms of phobias, as well as insight into the psychological and medical aspects of phobias. The third interview was conducted with a self-diagnosed acrophobic, to gain insight into the experiences and struggles of living with a fear of heights. These three interviews were conducted early in the design process to help determine the mechanics in the concepts designed. They also helped to develop the creation process once *The Height of Reality* was underway so that the prototype simulation could be as accurate as possible and medically informed. The final interview was conducted with the former lead City Planner of Palmerton North Caroline Miller. This information helped to refine the simulation world in the later stages of conception and provide more in-depth information about city planning and design. As stated before, these interviews were conducted over the course of the ongoing process to allow continual reassessment of the design of the simulation. The psychologist, clinician and acrophobic were interviewed early in the design process while the lead city planner was interviewed later in the development process.

Interview: Clinical Psychologist

Clinical psychologists rely on treatment methods that have proven to be the most effective. As a clinical psychologist, Sutherland was primarily trained in the use of cognitive-behavioural therapy for the treatment of depression and anxiety. To break cognitive-behavioural therapy down to its simplest: "Cognitive is just thinking. What you think to yourself, while behaviour is what you do."[69] More elaborately, cognitive-behavioural therapy is defined as a treatment that is centred around how someone's thoughts and beliefs influence their actions and moods. This type of therapy often focuses on a person's current problems and how to solve them. Sutherland then described the cognitive behaviour theory, which flows into the therapy as "the likelihood of a genetic predisposition towards being anxious, or to have some sort of anxious temperament where you're naturally the sort of person to be hesitant to do new things."[70]

Phobias are often grouped together, based on how natural it is to be afraid of those things. The three main groups phobias can be categorised as are: 'blood/injection/needle', 'animal/natural/environment' and 'situation'. Each

[68] A full transcript of each interview can be found in the appendix of this dissertation.
[69] Sutherland, 25 August 2016. Interview transcript found in Appendix Interview 3.1.
[70] Sutherland, 25 August 2016.

different group creates a different physiological response, such as a massive increase or decrease in blood pressure, resulting in fainting. It is not common for multiple phobias to be present in one patient, but it can be common for the phobia itself to be hidden beneath different symptoms. One client Sutherland spoke of was presenting symptoms of agoraphobia, the fear of open, public spaces. When the symptoms were broken down and spoken about, underneath the presenting symptoms was a specific fear of going to the hospital. Finding information like this underlies the importance of doing a thorough assessment and not jumping to conclusions after one session.

Sutherland has had the most experience in dealing with panic disorders and agoraphobia, but has also dealt with people suffering from a fear of vomiting, spiders and hospitals. Most people that he has treated have sought out treatment, while some have been forced into therapy; for example, one client was required to fly to another country for their new job but was afraid of flying. The theory behind psychological phobias is that you've learnt to, over time, avoid encountering the thing you fear because it provokes an anxiety response in you. This anxiety response can manifest as the fight or flight instinct. To reduce the level of anxiety you are feeling, you get away from the thing causing the anxiety. When experiencing the anxiety inducing situation, your autonomic nervous system brings activity into the centre of the body as a protection system. What the body has learnt over time through reinforcement of the fight or flight instinct is to give off a false alarm every time it encounters the situation.

For treating phobias and other types of anxiety issues, cognitive-behaviour therapy relies more heavily on the behavioural side than the cognitive side. Sutherland classed acrophobia and other phobias as a form of anxiety, and therefore required a specific type of cognitive-behaviour therapy to treat it – graded exposure. 'Graded exposure' is the process of gradually getting closer and closer to the thing you fear the most, coming into contact with it, and staying in that feared situation long enough for the anxiety to drop down naturally. Response prevention comes into effect with the graded exposure treatment, where the response to the situation would be flight, getting out. This response would create an immediate drop in anxiety and self-reinforce the anxiety. Response prevention is, at an overt level, not escaping the situation. But it is necessary, on a cognitive level, to think about the situation you are in as well.

The general principal for exposure based therapy uses some sort of hierarchy or ladder, with the most feared at the top and the least at the bottom, and that the patient does not progress up from one step to the next until their anxiety is either a zero or one out of ten, from whatever it registered previously. Patients are expected to repeatedly engage in the situation outside of therapy, which would govern how quickly they progress. By staying in the situation for long enough, your anxiety response can reduce and you learn that the situation is no longer associated with

anxiety. The connection between the situation and the anxiety response is broken or changed to another feeling, such as boredom.

Response prevention comes into effect with the graded exposure treatment. The response to the situation would be flight, getting out. This response would create an immediate drop in anxiety and self-reinforce the anxiety. Response prevention is, at an overt level, not escaping the situation. But it is necessary, on a cognitive level, to think about the situation you are in as well.

Sutherland has not had any experience with using digital technologies to treat patients, however had some advice to assist in the testing phase of the simulation. Because the testing cannot continue as long as regular exposure therapy, any change users experience is important. Therefore, when finding participants to experience the simulation, it is important to find users that exhibit a higher level of anxiety. There could be minor changes in the anxiety levels with participants with a higher level of fear, which will easily register. If the fear level is low, some changes may go unnoticed.

Interview: Psychology Professor

As a psychologist before he became a tertiary psychology professor, Dr McDowall has dealt with and helped to treat patients that suffer from phobic anxiety disorders. Some of the phobias McDowall has experienced in patients include acrophobia (fear of heights), claustrophobia (fear of enclosed spaces) and zoophobia (fear of animals) – specifically spiders, "creepy crawlies" and insects.[71] He confirmed that the main therapy treatment for psychological phobias and anxiety disorders was gradual exposure therapy, utilising response prevention.[72]

Psychologists are unaware as to the origins of phobic tendencies, but as McDowall states, just about anything could become the object of a phobia. McDowall was familiar with the behavioural view of phobias, which says they are learned.[73] This means that at some point a frightening or aversive experience has been paired with an object. The example McDowall used was extremely vivid:

> "You're walking down the street and you fall down a big hole. You're very frightened as you're falling. At the same time you fall, a big spider walks up your head. The behaviourist would say that the spider has now formed a conditioned response from you. In other words, the next time you see a spider you're going to feel frightened about it."[74]

McDowall states that a clear majority of people that have phobic anxiety cannot even remember any specific aversive event that could have caused the

[71] McDowall. 26 August 2016. Interview found at Appendix Interview 3.2
[72] Singer, 2011.
[73] James, 2011.
[74] McDowall. 26 August 2016.

fear.[75] Most people will state that they have always been afraid of the object. However, if phobias were the result of pure conditioning, many people would be frightened of mundane items, for example a pen or paper. Many phobias are based on survival implications. Heights, spiders and needles are all things that are potentially harmful, and humans are hardwired to be cautious of such things. People who develop phobias exhibit an extreme level of fear in comparison to those without phobias. Conditioning plays a part in the development of a phobia, but some objects by nature of their evolutionary significance, such as wild animals would require less time to condition fear.

Not all people suffering from a phobia seek treatment. Many phobias are of little consequence as the object of anxiety can be easily avoided. However, the severity of the phobia and the effect it has on a person's lifestyle is what brings people into treatment. McDowall gives some examples of such situations: perhaps if phobic people are forced to fly, then they would seek help to overcome this phobia. Alternatively, a patient may seek treatment if their phobia affects their livelihood; for example, if the patient secured a new job, but they fear heights and their new office is on the 20th floor. graded exposure and response prevention therapy were the main methods of treatment McDowall has experienced using. As stated in Sutherlands interview, when the patient first encounters the object of fear the automatic reaction they will have will be to run away. This reaction undoubtedly reduces anxiety, and so the habit is cognitively reinforced. Response prevention therapy forces the patient to stay and confront the object of their anxiety. Over constant sessions of gradual exposure, the fear of the object is greatly reduced. The patient is not likely to ever fully relax around the object, but they are not going to panic, which is the response if the patient was not treated.

Graded exposure and response prevention therapy (ERP) have consistently shown positive outcomes, with a high number of people reporting they are less anxious, post-treatment.[76] People have reported being able to carry on doing normal tasks where before they would have avoided them. However, these processes are predominantly self-motivated. If the patient is unnerved by the initial session they may refuse to continue the treatment altogether. Also, the success of the treatment relies in part on the patient reinforcing the therapy in the period between sessions. The results are as much on the patient as they are on the behavioural psychologist. Therefore, a simulation that imitated such therapy treatments would have to be appealing, whilst also carrying an element of self-motivation.

When asked for advice on the testing of the simulation, McDowall suggested the use of a visual analogue scale in the result collection. A visual analogue scale is a simple line with an anchor point on each end. Users are required to mark on the line where they believe their anxiety rates. The benefit of a visual analogue scale allows for a smaller change to be recorded, as opposed to a Likert scale, which requires a

[75] McDowall. 26 August 2016.
[76] Chellingsworth, 2011.

one to five response. While a Likert scale would work, the smaller changes are the most important as the testing will not last the same duration as regular gradual exposure therapy.

Interview: Acrophobic Patient[77]

Miss T. is an acrophobic, but has not sought help for her phobia.[78] She displays several of the symptoms when experiencing heights, including profuse sweating, uncontrollable shaking, loss of motor skills in limbs and a strong potential for an anxiety attack.[79] She only displays these symptoms when several storeys from the ground, which is much higher than an average acrophobic person.[80] Despite experiencing these symptoms, Miss T. has never sought professional treatment for her fear. She described her acrophobia as something that she can control, with only minor adaptations to her lifestyle. The only major affects her phobia has had on her lifestyle is limiting available living spaces. At an earlier age when the symptoms were at their worst, she had to avoid apartment buildings when looking for a rental property as the height would be too much to cope with.

When asked whether she would like treatment for her fear, Miss T. responded only if it was not intensive professional help. She feels that her fears are not strong enough to warrant professional help, but if there was something that she could do or steps she could follow by herself, she may try them to see if they helped. Cost, involvement with the process of therapy and having to confide her feelings and fears in someone she does not know are the main reasons Miss T. is hesitant to seek professional help.

It was important to determine what a person with this level of fear is comfortable with and would be tested by, so Miss T. listed things she could and could not handle. She was fine going up a ladder resulting in a very minimal level of anxiety, if the ladder was securely on the ground and wasn't too tall. However, as soon as the height was past a normal two storey building, her level of anxiety rises dramatically. When asked if she could rate her anxiety on a one to ten scale (one being not anxious at all and ten being inconsolably anxious) she stated that looking out of a third-floor window is about a four. The anxiety maxed out at nine or ten out of ten around eight floors up.

When shown the concepts created for the simulation, Miss T. noted she would be most comfortable in the elevator. She completely ruled out the window washer's box and the hot air balloon as something she would be comfortable experiencing, as the washers box was not secure and she would not feel safe in that situation due to the lack of full walls, and the hot air balloon would go far too high

[77] The Interviewee requested their interview not to be recorded.
[78] The Interviewee requested their name kept from the publishing, therefore the pseudonym Miss T. was used.
[79] USNLM, 2014.
[80] USNLM, 2014.

and she would “absolutely freak out”.[81] It is highly likely that a similar response would be received from user-testing participants for those two concepts as the design is does not have a reasonable amount of safety precautions in the users direct surroundings. This response deemed the concept unsafe to use on phobic participants. The location based concept would be visually interesting to Miss T. as it would allow her to focus on taking her mind off the heights, however this action is a form of response and avoidance to face the fear, which as Sutherland discusses, is not conclusive to treating phobias. The elevator concept means less visual input, forcing her to focus on the height to a larger extent. The distance an elevator travels creates a believable and manageable height for an acrophobic. Miss T. stated she would feel most comfortable inside four walls when experiencing heights. She would feel safer in any concept if there was a physical interaction for the simulation, such as a handrailing. This particular detail determined that, regardless of the final world design, a physical handrailing would be made a part of the experience.

Interview: Palmerston North City Planner

Historical information provided by the former Lead City Planner of Palmerston North, Caroline Miller provided insight into the planning and layout of the city, which is the main inspiration for the layout and landscape of the HOR simulation. Palmerston North began as a distribution centre due to its’ location in central North Island and the surrounding area. In the early 1800s, Palmerston North had railway tracks and a station right in the centre of the town.[82] The entire area was heavily planned and designed as a location to distribute goods north to Auckland and south to Wellington. This design is still seen in the industrial areas of Palmerston North, featuring large storage warehouses instead of factories or production buildings. In the early 1800s cast iron and metal pipes were the popular material for sewage and water transportation. Because creating curves in cast iron pipes was expensive and extremely difficult with this material, the early expansion of Palmerston North was characterized by gridiron streets. Aerial views of the Palmerston North streets reveal a change in the street composition from around the early 1900s onwards with the introduction of cement pipes, moving from the gridiron, straight streets around the Square out to more curved streets. ‘The Square’ is a public park directly in the centre of Palmerston North, with four main streets leading from it: Rangitikei Street, Fitzherbert Avenue, Pioneer Highway and Main Street. Until the 1970s, the Square was the location of the railway line and station. When the station was relocated to the edge of town, the centre of town was disputed by different government parties in an attempt to decide on a purpose for the land and was later legally named a reserve. The Square has gone through several major changes since the cities conception. The railway station and tracks were

[81] Miss T. 23 October 2016.
[82] Miller, 27 April 2017. Full interview transcript found in Appendix Interview 3.3.

replaced on the outskirts of the town, leaving behind a large empty space.[83] More recently, sections of the Square have been converted into carparks and information sites as a way to make access to the CBD more convenient. Over time the city has built outwards from the Square in all directions because the land surrounding the city is flat farmland (Image 10).

The straight, grid-like streets and large park in the centre of the Palmerston North CBD will help to open the space for the user, providing them with something interesting to look at while keeping the design clean. Without the park, the user would merely be staring at a building directly across from themselves. The inclusion of a park will open up the area in the users view and provide several focal points for them, if the anxiety becomes too overwhelming. However, it does run the risk of the user "zoning out" and not focussing on the height itself. Sutherland spoke of this occurrence as it can happen quite often.[84] When a patient is not fully immersed or involved in the treatment, they can focus on one thing, such as the light above them or their shoes, and move through the steps of the gradual exposure without mentally being involved. With the environment open, the user will have many visual stimuli and the potential of a stronger response.

Despite being based on the layout of Palmerston North, the environment features a few distinct differences. A nearby ocean will be included to break up the countryside and give the user another natural landmark to focus on. The ocean will help to create a cut off for the city also, decreasing the amount of city modelling required. Aerial photographs of the greater Manawatu area will help to develop the detail in the plains in the surrounding countryside. It is important to create subtle detail to the plains around the city, as fields and paddocks are not identical colour and create interesting patterns from a distance. As for the design of the city, as the buildings expand outwards further and further from the CBD the districts will change to residential and finally industrial. Larger residential suburbs surround the CBD, followed by industrial areas and lastly smaller suburbs that transition into rural farmland. This information will help to further develop the design of the simulated city and give insight into existing city design.

Image 10: Google Map image of Palmerston North.

[83] Miller, 27 April 2017.
[84] Sutherland, 26 August 2016.

Image 11: Palmerston North Square

Image 12: Palmerston North Square

Chapter Three: Concept Designs

Concept phase

This chapter discusses the four potential design concepts for *The Height of Reality* simulation, and explains the advantages and disadvantages of each. For each concept, believable, realistic environments were designed so the rehabilitative effect of the simulation would translate to the user's everyday experiences. However, it is important to acknowledge the limitations of VR. The immersive experience will differ from user to user. As stated before, each concept was shown to and examined by Miss T. Her responses helped to determine the final concept decision.

Regardless of the final visual design of the simulation, the following two aspects will be implemented. Firstly, after analysing the information gathered from the interviews, it is clear that the final design concept will have a step-by-step, gradual exposure progression. It is important for the participant to have control over the gradual exposure to allow them to progress at their own pace. Secondly, the concept must allow for a believable user response implementation. In existing programs such as *Fearless VR* and *Bravemind VR*, user response to the simulation at certain phases is an important factor in understanding and progressing through their levels of anxiety.[85] Furthermore, in *Fearless VR*, a voice-over is built into the simulation to recreate the effect of having a therapist talking to the user. A similar style of voice-over will be included in the final *The Height of Reality* simulation, which will help with response prevention and push the user to the next step in the simulation. As Miss T. had mentioned that talking to a therapist was a hindrance to her seeking help for her phobia, *The Height of Reality* voice-over acts as an encouragement as opposed to a therapist.

[85] *Fearless VR*, 2017; *Bravemind VR*, 2005.

Concept 1: The Hot Air Balloon

The 'Hot Air Balloon' concept involves users stationed in the basket of a hot air balloon in the centre of an open-world environment. The participant would control the height to which the balloon would travel, utilising a step-by-step method. For the full potential of this concept to be achieved, the user would need to travel to extreme heights. The advantage of this concept is that due to the extreme heights that a hot air balloon can travel to, there is a higher chance of inducing an anxiety response in the participant.

The concept could involve the creation of beautiful countryside scenery, showing a birds-eye-view of farmland and even a city. However, the visuals would not have enough of an impact on the participant to effectively distract the extreme height users are exposed to. In any case, for the exposure therapy to be effective, it is important that users fully experience the height simulation rather than being distracted from it.

The further disadvantages of this simulation were quickly pointed out by Miss T. The Hot Air Balloon simulation would involve portraying a much greater height than the other three concepts. Hot air balloons go much higher than an acrophobic person is likely to be comfortable with. There is a lack of safety in the simulation evident by half height walls of a hot air balloon basket. It is important for users to feel as safe as possible in the experience. If an acrophobic person has difficulty with minor heights, there is absolutely no way they will consent to experiencing the extreme heights a hot air balloon can travel to. An extremely phobic patient may have difficulty with the height of a normal ladder, let alone an average of approximately two thousand feet in the air.

A similar concept of an aeroplane was quickly ruled out as it faced the same issues as the hot air balloon. The height of both experiences would be far too great and could potentially cause more harm to the user than good.

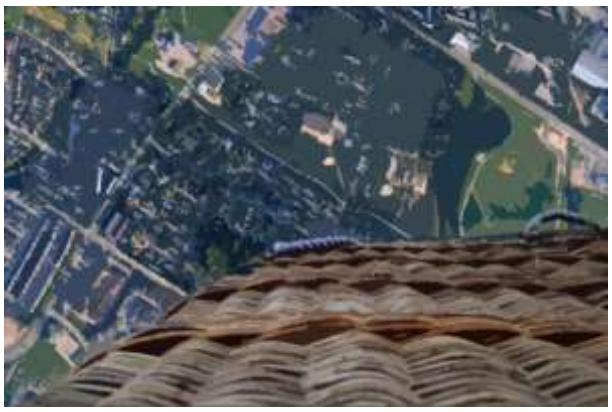
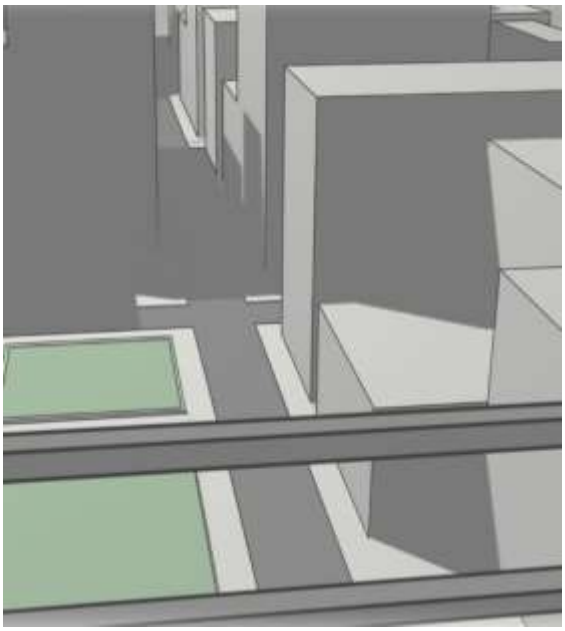


Image 13a (Left) & 13b (Right): Hot Air Balloon Concept Visualisation.

Concept 2: The Window Washer's Box

The 'Window Washer's Box' concept positions the participant inside a window washer's box on the side of a skyscraper. Participants would be able to travel up each floor individually, resulting in a 4-metre vertical ascent on each level. This concept reduces the height that the user experiences to that of a rudimentary building, which became the chosen environment for the final concept. The building would be situated in the centre of the city, which would reduce the amount of modelling required. Like an actual washer's box, the user's control would be limited to a simple up and down movement. This creates a very smooth, gradual experience that minimalizes the risk of a high level of anxiety.

While this concept is more viable than the hot air balloon concept, there are still disadvantages to this design. Firstly, like the hot air balloon, the window washer's box is not an enclosed space. A participant who is afraid of heights is highly unlikely to be comfortable in this environment, causing more anxiety or even an adverse effect on the participant. Furthermore, an unenclosed space runs the risk of decreasing the immersive experience, as the participant is more likely to be distracted or disengaged by elemental effects such as a lack of wind or physical movement of the washer's box.



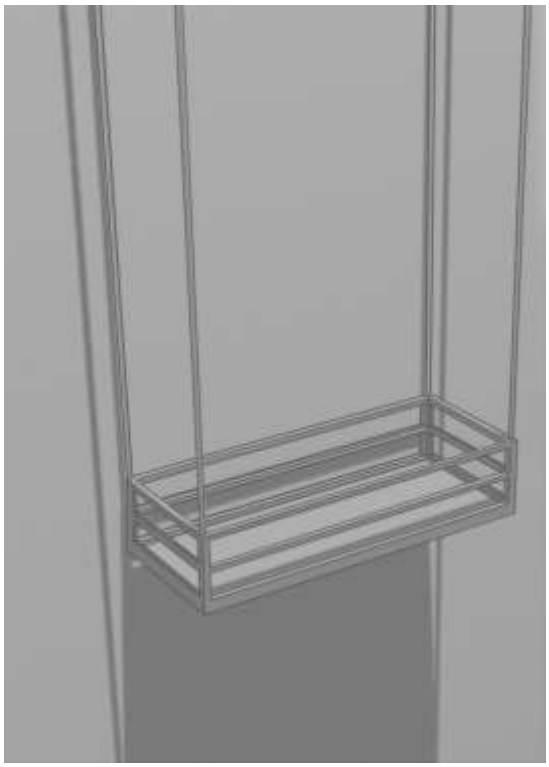


Image 14a (Left) & Image 14b (Right): Window Washer's Box Concept visualisation.

Concept 3: Location, Location, Location

The ‘Location-Based’ concept involves exposing the participant to a series of different locations that simulate varying heights. The user is positioned in the centre of the landscape and can look out over the location. Unlike the window washer’s box and the hot air balloon, the simulation requires no movement control; the participant is static throughout the experience. Once the user is comfortable with the height level on that level, they would merely have to press a button and the location would fade slowly to black and then fade in to the next environment. The systematic process would involve a series of different scenes, increasing the amount of work required to complete the simulation. Each location would increase in height and involve new visuals for the user to experience. Some of the concepts for the proposed 10 levels for this simulation included locations such as a building balcony, a cliff and a lighthouse.

This concept was quickly ruled out by Miss T. for several reasons. The main problem with this concept is that the height differences between locations may be difficult to replicate effectively; the different locations would make it difficult to create and effective simulation if the location is not designed and modelled meticulously. For example, standing on a cliff may be lower than the roof of a building, but the scenery may make that difficult to tell without increasing the height drastically. Above all, this concept requires an accurate scale for every scenario. The amount of time it would take and the visual design work to create this concept is simply out of the scope of this thesis. Finally, the proposed environments could make it difficult for patient to be fully immersed as the scenario presented to them may be unfamiliar or even entirely unknown to the participant. Miss T. was particularly concerned with the over-intensive visual experience. These visuals may act as a distraction from the height, resulting in little to no effect on the user’s level of anxiety.

Image 15a (Left) & Image 15b (Right): Location Based Concept visualisation.

Concept 4: The Elevator

The ‘Elevator’ concept is similar to the window washer’s box, positioning the user instead in a glass elevator. Like the washer’s box concept, the user has control over their movement up each level. The user is fully encased within the four ceiling-to-floor walls of the elevator. This provides more security to the user than any of the previous three concepts. Elevators are equipped with speakers, playing the well-known “elevator music” frequently. This provided a chance to use the speakers for the voice-over, creating a believable source for the voice-over. This increases the immersive experience of the simulation by creating a more believable environment. Each skyscraper floor, depending on the building, is approximately three to four meters high on average. Assuming the main building is twenty-five storeys high, the user could travel a maximum of one-hundred metres in the air, with a view out over a city and its countryside at the top of the building.

The limitations of this concept are similar to the limitations of the window washer’s box. The user could be staring at a building opposite them, limiting the visual stimulation of the simulation and making it easier for the user to “zone out” by not focussing on the height at all. A viable way to avoid that is by creating a park or wide road in front of the building, opening the space more and forcing the user to see more than a plain building.

Miss T. confirmed that she would feel the safest in this particular simulation over the other simulations as she would be encased inside four complete walls and would feel more in control of the heights.

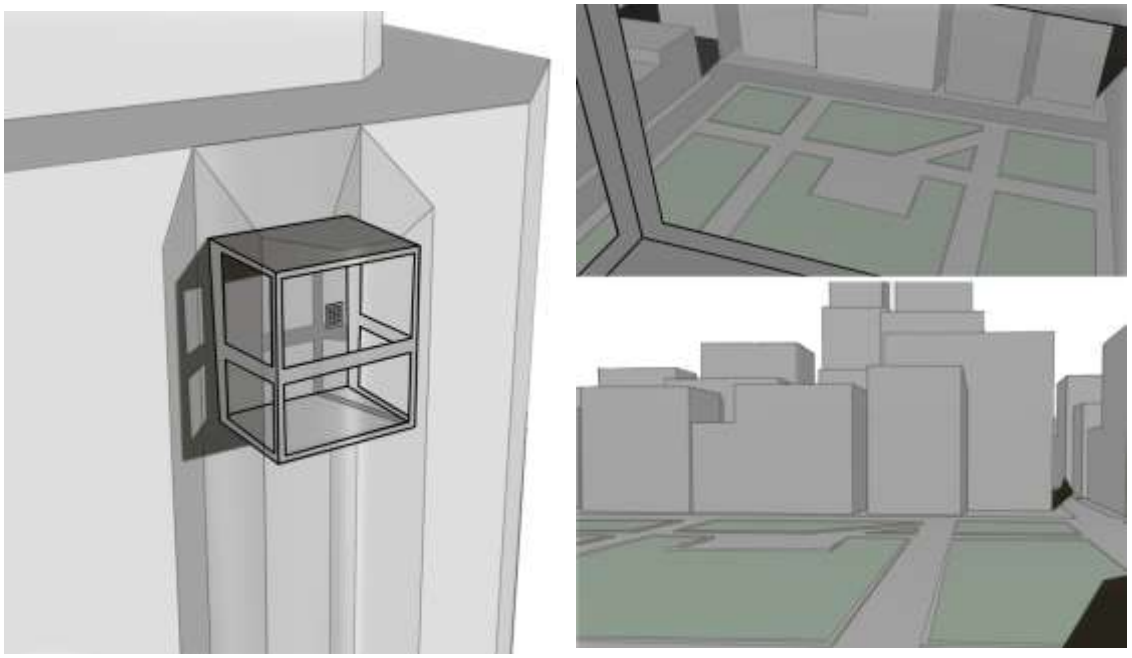


Image 16a (Left) & Image 16b (Right): The Elevator Concept visualisation.

Other Considerations

Immersion

Immersion is an important aspect of the simulation, as the success of an immersive experience is what will gain actual results in users. The user must feel immersed in the simulation to create an effective experience. The use of VR has an innate sense of immersion through the motion and location capture. As the user looks around their environment, the VR devices are capturing that movement and replicating it in a VR world.[86] This helps to mechanic bypasses the feeling of simply sitting and looking at a screen and instead makes the user feel like they are in that environment.

Several options are available to create a more immersive experience. The *Oculus Touch* remotes and the controllers for the *Vive* can help to increase the immersion in a VR experience. Because *The Height of Reality* does not require the use of the handheld controllers, the rest of the simulation needs to feel more immersive. The visual style of the simulation is imperative to creating the right, immersive experience. The more realistic and lifelike the simulation appears, the easier it is to believe the user is in that situation.[87] For example, a bright cartoon-like environment will be less believable than an environment with natural sunlight and photo-realistic textures and models. The tone is similarly important. Whereas visual style is the direct visuals of the simulation, tone is the emotions which a simulation can create. For example, the purpose of the VR version of *Resident Evil: Biohazard* is to produce a strong sense of fear. It works unison with visual style to create a more believable experience. In *The Height of Reality* simulation, the feeling of safety and security is imperative. Therefore, the tone of *The Height of Reality* is designed to be realistic and not to create any surprises for the user.

Body Presence

Body presence is another key aspect of the simulation which has to be considered, as it also has the potential to increase or decrease the level of immersion. It is likely that the user will exhibit a different response depending on whether the user can see a body or not. Responses from the initial user-testing revealed that if the users saw a body below them it would feel more realistic. However, the scope of the project has been kept narrow to allow time to fully develop a working prototype of the simulation, therefore body presence was not included. It is, nonetheless, important to take body presence into consideration for future development of the simulation.

There are several different forms of body presence that could be included in a future build of the simulation. The following section will discuss two which have the most potential use in future development. The first is a prebuilt body, in which

[86] Desai et al. 2014.
[87] McMahan, 2003: 2.

the simulated body appears the same for each user. However, this has a high potential of decreasing the immersive experience. If a prebuilt body was for example, a muscular male body type, this limits a fully immersive experience to that one select group. Therefore, the response from a female compared to a male would differ as only one prebuilt body-type could be used. Other alternate forms of body presence are available to use. For example, Leap Motion can capture the user's hands and the user's exact movements within the virtual world. The main purpose of a Leap Motion is to allow users to interact with objects with solid digital hands based on the movement of their own hands.[88] While this increases immersion for the user because they can see their own movement, it can also disrupt the experience. The Leap Motion capture usually cuts the hands off at the wrists, not digitally generating any further than that. Furthermore, there is no element of object movement in the simulation, so the Leap Motion is not a necessary accessory. However, in future development of the simulation there is potential to include Leap Motion-generated interactions. This could involve the user interacting with the elevator buttons to move further up floors instead of using a handheld remote.

Physical Support

It is important for users to feel as safe as possible in the simulation. Because the users are being placed in a reasonably unfamiliar environment that requires them to interact with their fear, it is important for a form of physical support to be available for them. The most appropriate form of physical support for the users would be a hand railing, which is also a visible aspect of the elevator in the simulation. This works as both a support system for the user and has the potential to increase the immersion of the simulation. This form of physical interaction will be used to help the user feel more comfortable in the simulation by offering them four points of contact to the physical world: their hands on the railing and their feet on the floor.

Music and Sound

There is a strong relationship between music and emotion.[89] It can be used to convey emotions and modulate particular moods in listeners, whether that is inducing intense feelings or prompting relaxion through ambient sounds.[90] Music can be utilised in an effective way to help calm the users as they experience *The Height of Reality* simulation. This feeling of calm can be enhanced by the music the user is hearing. Working together with a Duncan Phillips, a Master of Music student at Victoria University of Wellington, custom music has been created to induce such a feeling. Several aspects of music needs to be taken into account. Tempo, pitch and

[88] Leap Motion, 2017.
[89] Juslin, 2001.
[90] Chen and Yang, 2011.

tone are all incredibly important to convey emotions.[91] The result is an endlessly looped smooth Jazz soundtrack.

Sound effects were designed for the simulation to increase the immersion and work as a source of information for the user. Firstly, a basic sound effect for the movement of the elevator was included. This helps the user feel like they are moving and actually in an elevator. This sound effect assists in separating when the elevator is static and when it moves. As well as the elevator movement sound effect, basic traffic and wind sound effects will be included. The volume of these sound effects will be minimal, with the intention of creating muted ambient sound effects. This will assist in making the user feel as if they are in the city.

The final sound effect added to *The Height of Reality* is a script inspired by the style of script in *Fearless VR.* Although the script in *The Height of Reality* does not act as a therapist as it does in *Fearless VR.* The purpose of the script is to inform the user what floor they are on and provide a form of encouragement for the user. The script also asks the user to provide feedback about their feelings and anxiety on every five floors. The full script can be found in the Appendix, Table 2.1.

[91] Read, 2016.

Final Concept

The concept chosen for the final design was the Elevator concept. This concept involved the most security for the user as the participant is surrounded by the four complete walls of the elevator, making users feel safer in the environment. The height can be easily controlled and restricted to each floor, which means the user can only ascend a maximum of four metres per step. Because of the style of simulation, location remotes are not important for the experience. Therefore, two styles of controlling the simulation will be available: a computer keyboard and the handheld *Oculus* Remote. It is important, however, to reward participants as they move higher through visual stimulation which is achieved through the encouraging voice-over and the view of the countryside at the top of the building and the end of the simulation.

The program simulates an entire cityscape including a CBD, industrial area and suburbs, and the outlying countryside. The cities of Palmerston North and New York inspired these designs – two different cities with very similar features which will be discussed in the next chapter. The design and layout of the countryside needs to be taken into consideration, as well as the way in which the city interacts with the countryside. While the prototype simulation of this thesis has the above features, there is room for other potential mechanics such as including a physical hand railing for participants to hold on to if they need to, providing them with four points of contact.

Acrophobia is above all a visual fear; therefore, immersion is limited to visuals rather than user interaction. This means that little controls will be needed in the scene. The necessary controls can be reduced to three: A control to make the user to go up, a control to make the user go down and a control to start, pause and stop the entire simulation. Because the elevator is a fully encased space, no environmental elements are necessary. The inclusion of wind could increase a sense of the immersion and is less likely to have a negative effect on users as it would in the other three concepts, as wind is not experienced inside an enclosed elevator.

The simulation will be limited in its scope as it is a working prototype, but further development could see some impactful changes. The inclusion of motion controller such as the *Oculus Touch* or the *Vive* remotes may be one of them. The interaction to increase the height could be modified to involve having to press a button in the simulation to go to the next floor. This would allow users to skip to certain floors and increase the involvement of the user.

Chapter Four: Development

Design Inspiration

The design of the city is loosely based on existing cities, utilising the best design elements of each. When designing the cityscape of *The Height of Reality*, the three main environments are the CBD, the surrounding countryside and the ocean. When the elevator reaches the higher floors, the user can see out over the city and see mountains, the ocean and farmland. The city design for the simulation is inspired by the overall layout and design of Palmerston North in New Zealand and New York in America. These two locations are extremely different in both their geographical size and population but they have similar design aspects between them.

The city of New York spans across the Hudson River, the East River and Hackensack River, breaking up the CBD into several large suburbs.[92] These suburbs such as New Jersey, Manhattan and Brooklyn are large enough to be cities on their own, with a total population of 8.5 million people in New York City, with 1.6 million living in Manhattan alone. Palmerston North replicated this on a smaller scale, being broken up by the Manawatu River with a population of 84,300, making it New Zealand's seventh largest city. The street layout of both Palmerston North and New York incorporates the grid-iron, straight streets that is utilised in the design. Central Park, Manhattan, sits in Manhattan's CBD and spans 3.41 kilometres square.[93] This huge park is surrounded by skyscrapers which reach heights of fifty floors or more. The Square in Palmerston North (Image 11 & 12) is similarly positioned in the city's CBD and is approximately 250 metres wide and 300 metres long. These parks are inspiration for the design in the centre of the simulated city, directly in the participant's field of vision.

Fearless VR is a strong point of inspiration for the step-by-step design and the soundtrack of *The Height of Reality*. As stated before, *Fearless VR* is a simulation for rehabilitating arachnophobes. It progresses in slow steps, initially showing a picture of an extremely badly drawn spider, then showing a picture of a real spider on the earliest levels. The simulation speaks to the user throughout, telling them the next step and explaining exactly what is going to happen next, for example "If you feel anxious or uncomfortable at any step, try to embrace that feeling and wait for the anxiety to decrease before continuing […] Now we'll look at a photo of a spider."**.**[94] This helps users to control their anxiety by reducing the risk of triggering their instinct to flee. After a few steps, the user is asked to talk about how they feel and how well they think they did. Before the user can continue to the next step, they are required to verbally address their anxiety after a prompt from the voiceover which occurs inside the simulation, making *Fearless VR* a self-contained therapeutic experience. User responses can be utilised by the creators to improve the overall

[92] Worldmark Encyclopedia of the States, 2017.
[93] Worldmark Encyclopedia of the States, 2017.
[94] Dialogue from *Fearless VR*

impact of the simulation and by clinicians to analyse the state of the patient to ensure the user is not progressing too slowly or quickly.

These mechanics are adapted to *The Height of Reality* simulation. Unlike *Fearless VR,* the progression of every level is not pre-empted by an explanation. Instead the user is periodically congratulated on their progression. A full script is implemented, with audio output at every second stage. The simulation begins by informing the user they are on the "First Floor. You have made your first step to helping with your fear of heights." At every fifth floor, the user is encouraged to talk about their feelings; for example, on the fifteenth floor the user is informed: "Fifteenth Floor. You are now approximately 60 meters up. Take a moment to tell me how you are feeling." When the user is nearing the top, the audio messages are important to assure the user they are still safe. For example, on the nineteenth floor the user is reminded that if they are feeling faint, to "remember there is a hand railing" in front of them and that they are "in control" and can "stop at any time." Like in *Fearless VR*, user input not only serves as a warning in the case that the user feels uncomfortable, but also helps to further develop the immersive experience. The latter effect will be exhibited in a later section of this dissertation.

Scale

Scale is immensely important for a successful immersive experience and needs to be considered for the design of the whole cityscape. If the scale is off, the visuals may look distorted or unnatural. Without an accurate scale in the simulation, the response to the simulation therapy may not be applicable in real-life situations. Below is a list of the average height and size of everyday structures and items that are implemented in the cityscape of *The Height of Reality*:

Object	**Average height**	**Average width**	**Average depth**
Elevator	10 – 13 ft.	6.5 – 7 ft.	5 – 6 ft.
CBD floor	10 – 13 ft.	n/a	n/a
Door	6 ft. 8 inches	3 ft. 96 inches	n/a
Mid-sized car	5ft	6 ft.	15 ft.
SUV-sized car	5.5 – 6 ft.	6.5 – 7 ft.	15.5 ft.
Park bench	3 ft.	2 ft.	5.5 ft.
Street Light	25 – 30 ft.	n/a	n/a
Traffic Light Body	3.5 ft.	1.5 ft.	n/a
Traffic Light Post	4.5 ft.	6 inches	6 inches
Rubbish Bin	3 – 4 ft.	1.5 ft.	1.5 ft.
Staircase Step	7 inches	n/a	11 inches

Early Design

The city was designed in *Autodesk Maya* as it is the most common tool for creating game engine assets.[95] Everything is created on a 1:1 scale, that is one Maya square equals one metre. Approximately four Maya squares equal the average height of a building storey in the simulation. A basic street layout was created, based on the style of the street layouts of Palmerston North and New York (Image 17). It was important to create density in the buildings without creating an unrealistic layout.

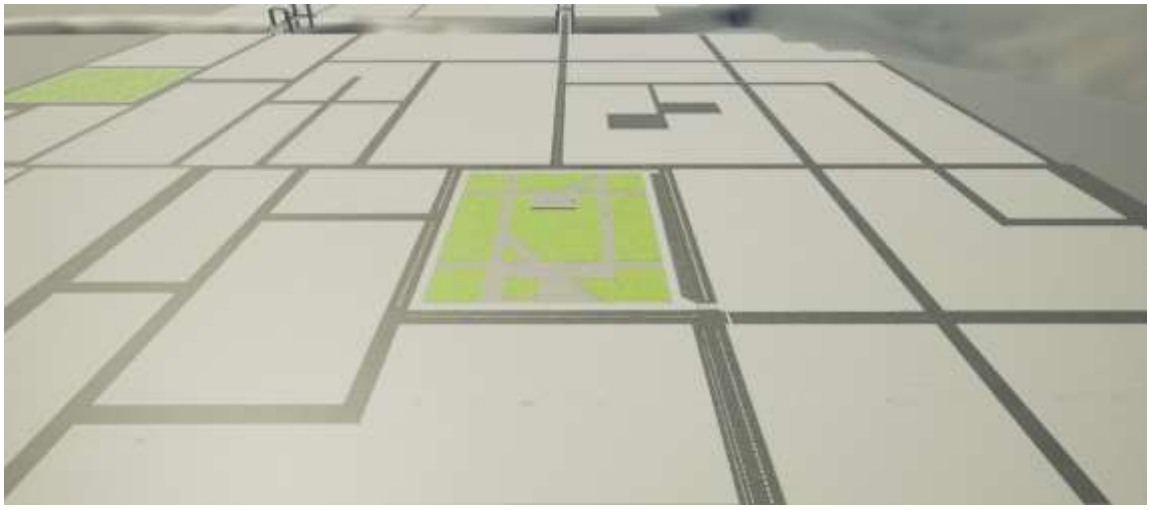


Image 17: Created a street system for the city. The grey squares will be populated with buildings.

The cityscape expands out from the main building, to which the elevator is connected (Image 18). As the user does not see behind the main building, therefore the design ends at the main building. Directly in front of the participant is the park, in the centre of the city, inspired by the Square of Palmerston North and Central Park in Manhattan, NYC. This provides a large open area for the user to enjoy. The park measures approximately fifty metres wide by seventy metres long. While it is important to open up the space in front of the user to create a more visually interesting location, the size of the park does not need to be similar to that of the inspiration. As mentioned in the interview with Caroline Miller, the Palmerston North Square features a carpark, an Information Site (I-Site), a clock tower and a large building connected to the city council, with still more space left over for a small field and an area with trees. Although visually interesting, not all of these structures are necessary or even applicable to the simulated cityscape. Therefore, the park in front of the user in the simulation acts as a simple pedestrian park, featuring mainly walkways and seating areas. The park is populated with trees and simple features such as rubbish bins and park benches.

[95] All screenshots are taken in Maya 2017 or Unreal Engine 4.16.

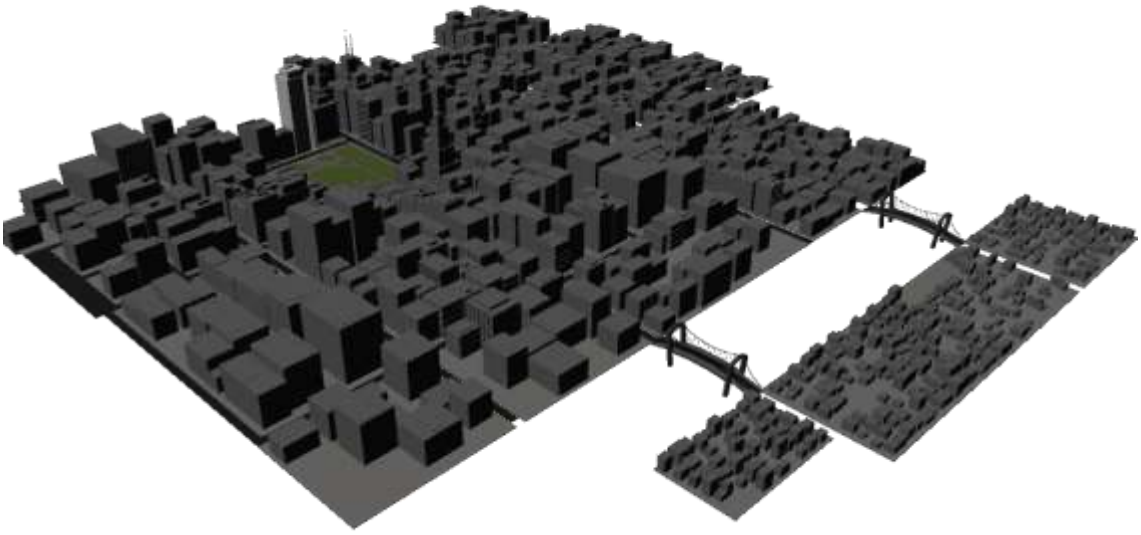


Image 18: The basic city buildings, including bridges leading to the suburbs.

The simulation was created in *Unreal Engine*, version 4.16. The reason this game engine was chosen was the beautiful lighting quality, the inbuilt VR systems and the simple blueprinting system for programming development. The river and bridges were used to break up the edge of the CBD from the suburbs areas. This made a cleaner transition between the larger buildings and the smaller house style buildings. The bridges were based off a simplified two-lane suspension bridge and when measured are approximately fifty meters long.

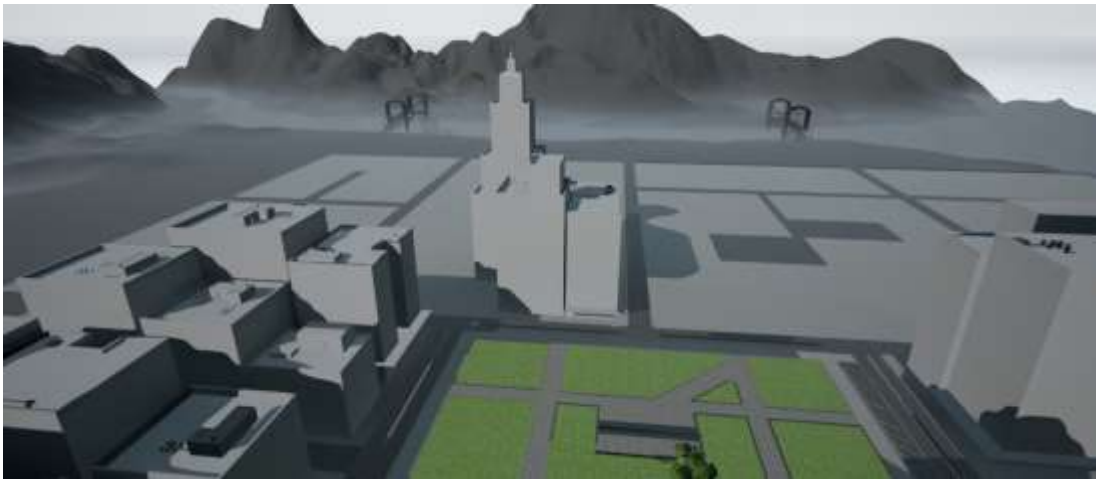


Image 19: Terrain designed by the Terrain Tool in Unreal Engine. Individual city blocks were imported to the street layout.

The buildings were exported from *Maya* in city blocks. This allowed for easy import into *Unreal Engine* and easy placement in the scene (Image 19). This also

meant the files were a reasonable size for import. The landscape tool built in to the *Unreal Engine* was used to create the surrounding area. Several iterations of the mountains were made. The mountains were made using the terrain tool built in to *Unreal Engine* (Image 20 & Image 20a). This creates a flat plane that can then be edited with brushes to increase or decrease the height. The first iteration was too close to the city and the mountains were too large. When compared to the scale of the scene, the first mountain design measured approximately one kilometre tall. There were not enough foothills at the base of the mountains which created an unnatural transition between plains and mountain.

Image 20: Second iteration of the mountain range.

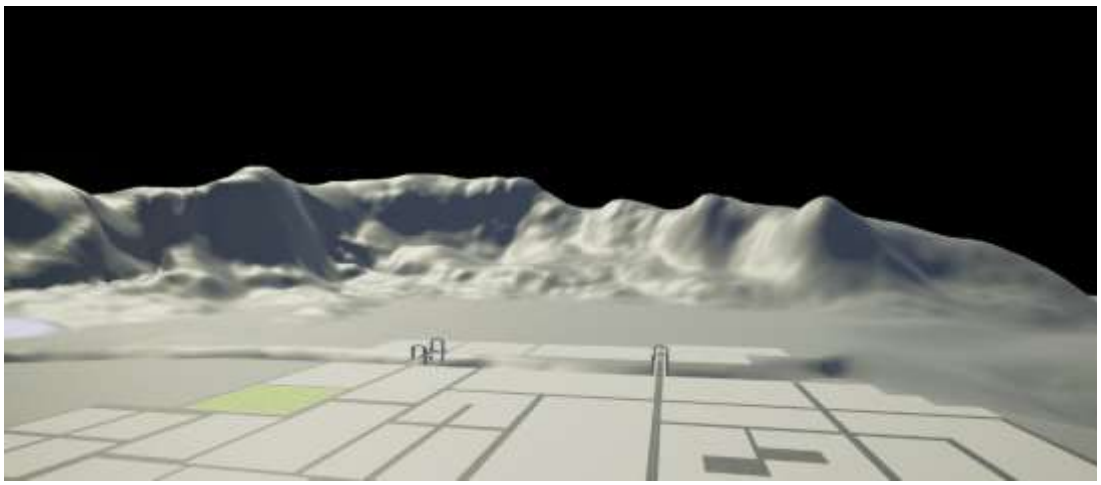


Image 20a: Detail was added to make it appear more natural.

The ocean texture was then added (Image 21). This was a flat, unmoving texture that had the appearance of water. Suburbs of smaller buildings were created on the far side of the river. This area will be seen by the user on the higher floors, therefore it is important for the suburbs to look detailed. These suburbs stretched around the entire city so the user can see them when they look to the left. This helps to make the city look like a large establishment and feel like a real city.

Image 21: Added a basic water texture to the ocean. Added suburbs to the city.

A basic sky-dome was used which included clouds and a sun (Image 22). *Unreal Engine* allows developers to easily generate a sun location and clouds. When the sun location is changed, the shadows it causes changes with it. It was important to ensure enough light was found in the scene, especially in the central park area. The sun location was place to diagonally to the left. This created a small amount of shadow on the central park from the left-hand buildings, but did not darken the scene much. Had the sun been positioned behind the building the user was positioned in the shadows cast by the main building would have extended over the entire park. By positioning the sun on an angle to the buildings, the shadows cast are more interesting and unique. The landscape shown in Image 20 and Image 20a was textured with simple grass textures and rock textures, adding more detail to the scene (Image 23).

Image 22: Basic Unreal sky-dome was added. This generated clouds and a sun.

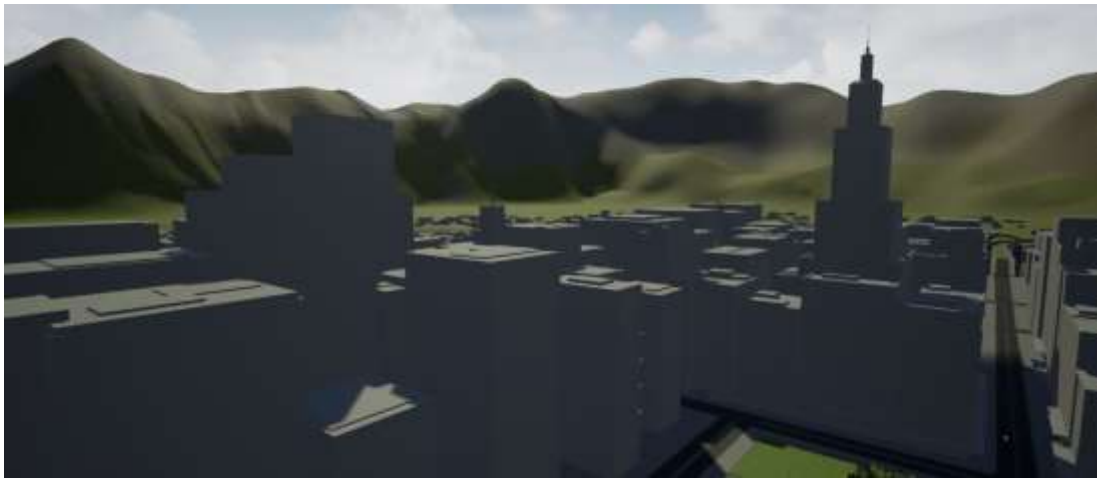


Image 23: Added texture to the mountainside and the terrain surrounding the city.

The intensity of the sunlight was too low in the first iteration (Image 24). This meant that the entire scene was too dark and shadows were extremely dark. The intensity of the sun included in the sky-dome was increased to brighten up the scene (Image 24a). The before and after of this change is shown below.

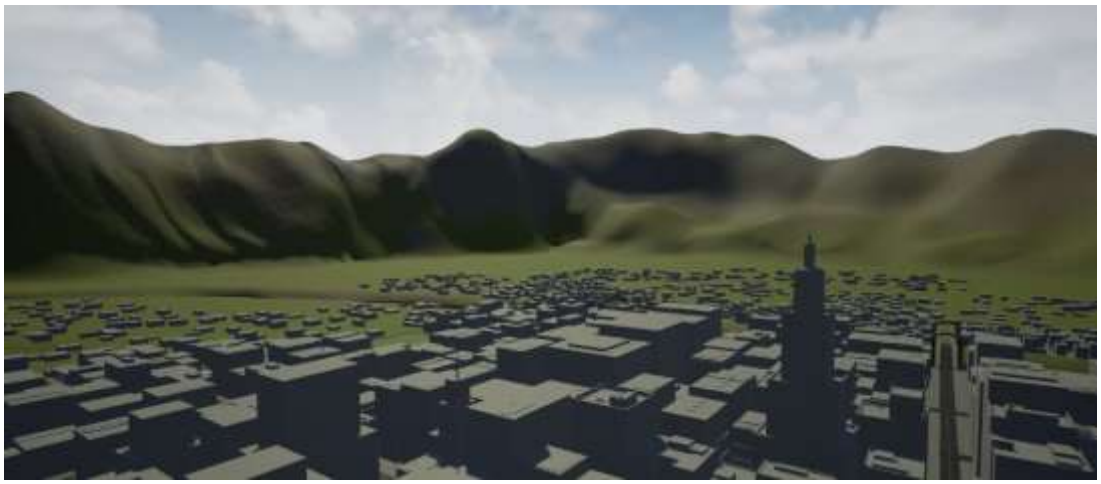


Image 24: Before the light was changed.

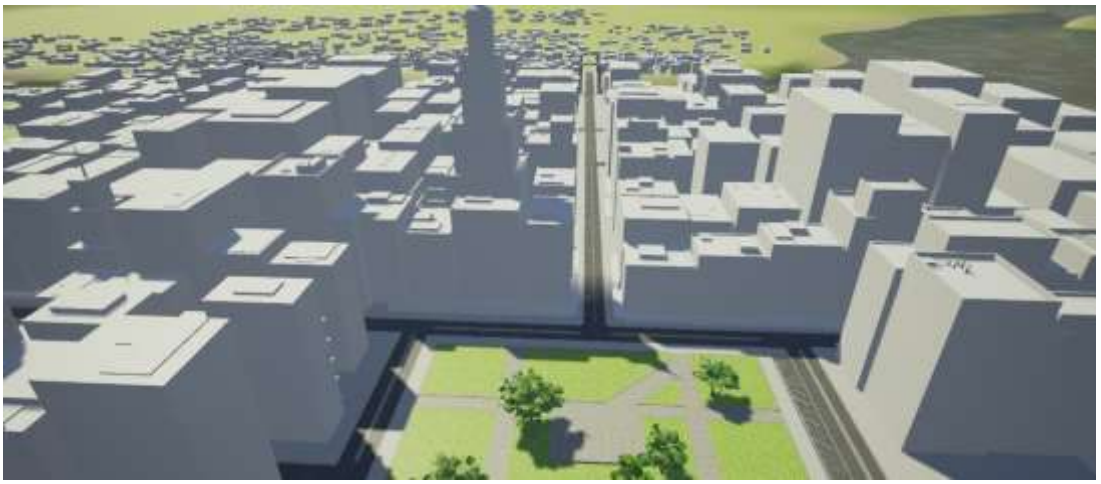


Image 24a: Increasing the light of the simulation and decreasing the intensity of the shadows.

The mountain range was still too close to the city and looked unnatural. When the mountains were redone and pushed further away, they were affected by the atmospheric haze (Image 25 & 25a). Texture was added to the buildings to make the city feel more realistic and detailed (Image 26). There was a total of ten different building textures that were repeated over all the buildings. The user is far enough away from the buildings not to notice the repetition of textures.

Image 25 & Image 25a: Change to the mountainside surrounding the simulation.

Image 26: Repeated and tiled textures added to the buildings.

When the user is on the higher levels of the simulation, they can see out over the countryside and ocean (Image 27). It is important for the countryside to look visually interesting for the user (Image 27a & 27b). Farmland varies in colour and shape in real countryside's. Five different textures were used on randomised shapes to create the farmland seen in the simulation. This provides enough variation in the visuals for the user.

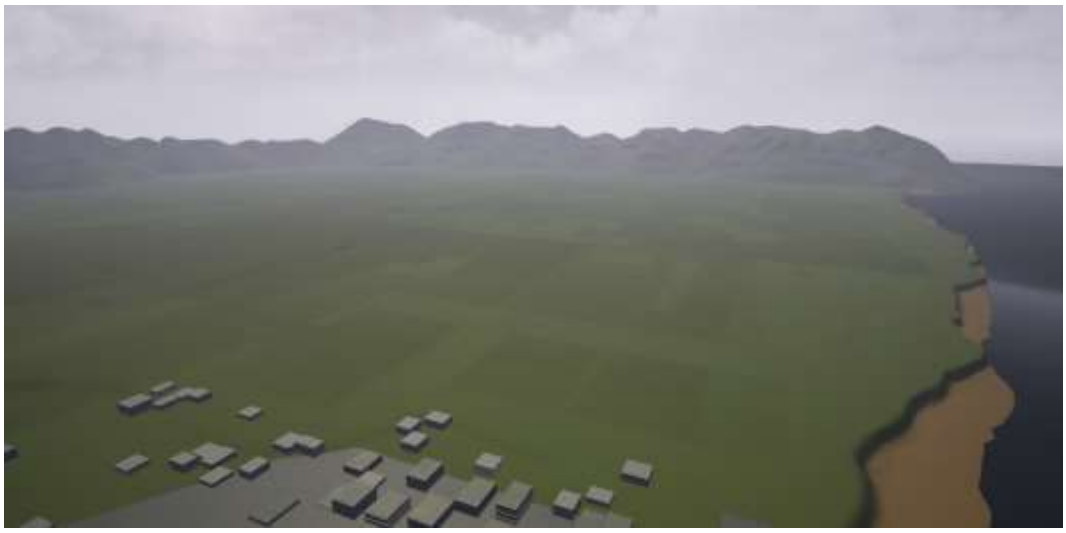


Image 27: Terrain before farmland is added.

Image 27a & Image 27b: Terrain after farmland is added.

Lastly, more trees were added to the park in *The Height of Reality* to make the park feel more populated (Image 28). There are two different style of trees, one darker than the other, and different layout of trees without those styles.

Image 28: Different types of trees added to the park.

The controls of the simulation were implemented for use with the *Oculus* Remote and a keyboard (Image 29 & 29a). Although keyboard is not a common control system for the *Oculus Rift*, the simulation is not a control intensive program. Following this, the simulation was at a stage that it could be experienced in VR. Early design-related user testing took place to develop the visuals further.

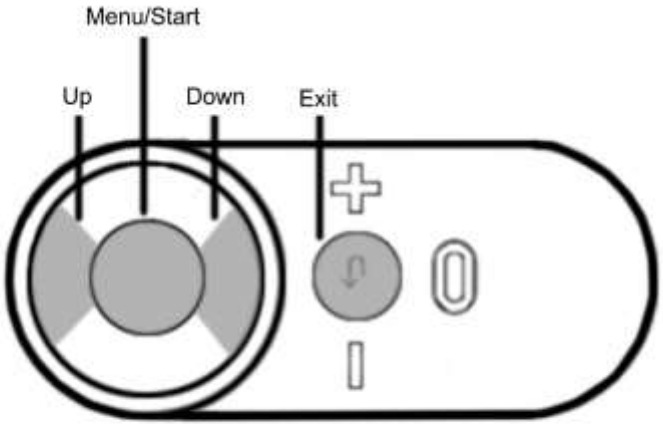


Image 29: *Oculus* Remote controls.

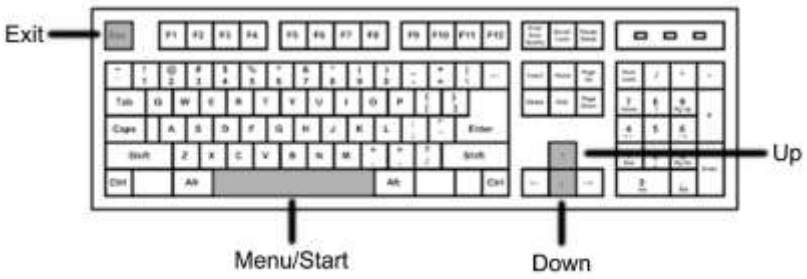


Image 29a: Keyboard controls.

Alpha Design

Once the basic controls had been refined, *The Height of Reality* could be experienced in VR for further development. A small group of initial users were collected to test the simulation and provide feedback specifically about the design aspects. The questions users were asked at this stage of testing can be found in the Appendix, figure 1.1 and included questions such as, "did you find the controls for the simulation were easy to use?" Because this testing focusses specifically on the design, the effectiveness of the simulation on the acrophobic users was not required. Their responses helped to further develop the visuals of the simulation to ensure the best possible results.

As the simulation was in an early development stage, audio had not been implemented. The audio cues were read out to the users as the moved up the floors, simulating what the user would hearing when audio was added. Users were exposed to a reassuring message on each floor. Its purpose is to provide necessary information to the user as the move up the floors, and acts as a reassurance the user, letting them know they are not alone and everything is okay. The floor script informs the user what the controls are on the first floor – the Up Arrow to move up a floor, the Down Arrow to move down a floor and the Spacebar to pause the simulation. This translates from the keyboard to a handheld *Oculus* remote in a clean and understandable way.

Alpha User-Testing

The user-testing for *The Height of Reality* was completed in three stages: Alpha User-Testing, Beta User-Testing and Acrophobia User-Testing. The first two stages focus on the development of the design of the simulation. The main purpose these stages are to question users on their opinion of the simulation itself, instead of focussing on the effect. Users were asked to answer a short questionnaire post testing to receive feedback.[96] The beta stage of the user-testing again focussed on the design of the simulation. The purpose of this stage was to test the changes made to the simulation based on the feedback from the earlier testing. Users were again asked to complete the same questionnaire to determine the need for any further significant changes to the world and final design of the simulation.

With the simulation in an Alpha state, a random assortment of users was asked to spend time in the simulation and provide feedback on the design and functionality. Five users were tested in the simulation and their responses from this testing were taken into account when developing the simulation towards a Beta state. It was important that the simulation remained restricted to a limited scope. In the Alpha state, the design of the simulation was kept to a simple state that showed

[96] Questionnaire can be found in Appendix Questionnaire 1.1

the full city with user controls. Audio cues were played to the users to create the full effect of the simulation. The audio cues were not implemented at this stage. This is because there was the potential that the recorded audio needed to be changed or re-recorded to increase the effectiveness. The audio would be implemented into the simulation prior to Beta testing to create a more effective simulation. Feedback from this testing stage helped to further design the simulation to ensure a high quality of detail to maintain a sense of realism of the simulation.

The first main point of feedback was the world was too static, mainly due to the fact that human presence was removed from the simulation. The simulation was designed in a way to keep the user calm. Research dictates that people feel more calm and relaxed when surrounded by nature as opposed to civilisation and a city.[97] Paulsen states that "looking at rural images makes the limbic or 'calm' area of the brain light up."[98] Because of this, people and moving traffic have been removed from the simulation. Including these features would make a more stressful and chaotic environment for the participants. The first idea implemented was animated water (Image 30). The slight movement on the water helped to increase the feeling that the world is moving and alive.

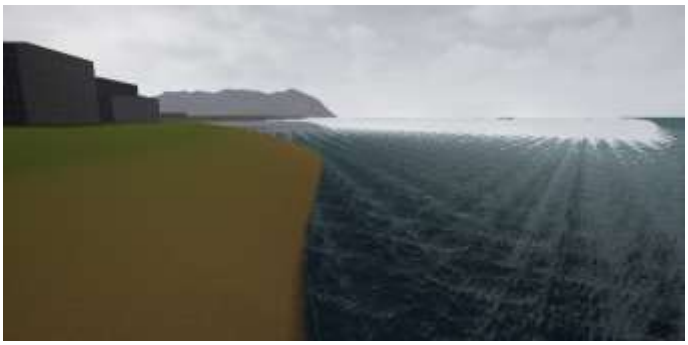


Image 30: New animated ocean texture.

Another feature added was wind animation for the trees and a higher resolution grass (Image 31 & 31a). *Unreal Engine* has a system included that allows developers to add wind to objects such as trees and grass. This involves increasing the 'Wind Direction Force' for the leaf material. Up close, the resulting effect involves each individual mesh warping and distorting its shape. From a distance, the object looks as though all the leaves on the tree are blowing in the wind.

Image 31: Before trees were changed.

[97] Paulsen, 2016.
[98] Paulsen, 2016.

Image 31a: Grass foliage was added to the park. The trees were updated to be more detailed.

Traffic and cars were an issue in the Alpha state of the design. The early Alpha design lacked any form of automobile which made the scene look incredibly empty. A selection of cars have been added to the scene, but because of the nature-versus-city effect they have not been animated to move.[99] This makes the city look slightly more active and lived in. Adding parked cars to the central square and side streets help to simulate the idea that the area is busy, without needing to include people (Image 32 & 32a).

Image 32 & Image 32a: Cars were added to the carpark and the streets.

[99] All cars obtained from creative commons website: https://archive3d.net/?category=28

The final point of feedback from the first testing phase was about the textures on the buildings themselves. The textures reach right to the ground. A CBD would have shops and store fronts on the ground level of each building. To create this, new geometry was created for the shop fronts and the over-hangs (Image 33 & 33a). Photos were taken of the surrounding area and applied to the geometry, simulating the idea of shop fronts and stores.[100] However, because the user is a huge distance from the shop fronts; as the user ascends, they do not see the detail in the shops. It was not necessary to include the shop front textures in the finalised design.

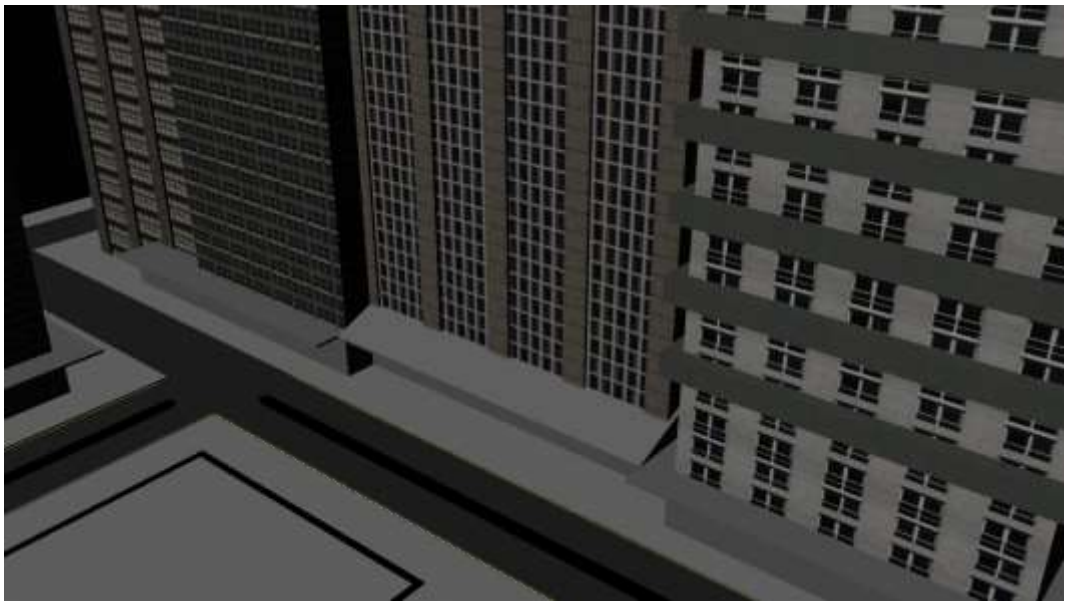


Image 33 & Image 33a: Shop fronts were designed and textured. Textures were not needed. Different styles of covered rooves for the footpath was added.

[100] Photos were taken of Wellington CBD; however, the images were not included in the final prototype.

Image 34: Outdoor seated area and 3D detail on shop faces.

A frame was created to surround the elevator (Image 35 & 35a). The frame helped to show the vertical movement as the user would move past a horizontal beam and is also similar to how a real glass elevator looks. A realistic glass elevator is generally encased in a frame that both protects the elevator and the mechanics that make it function.

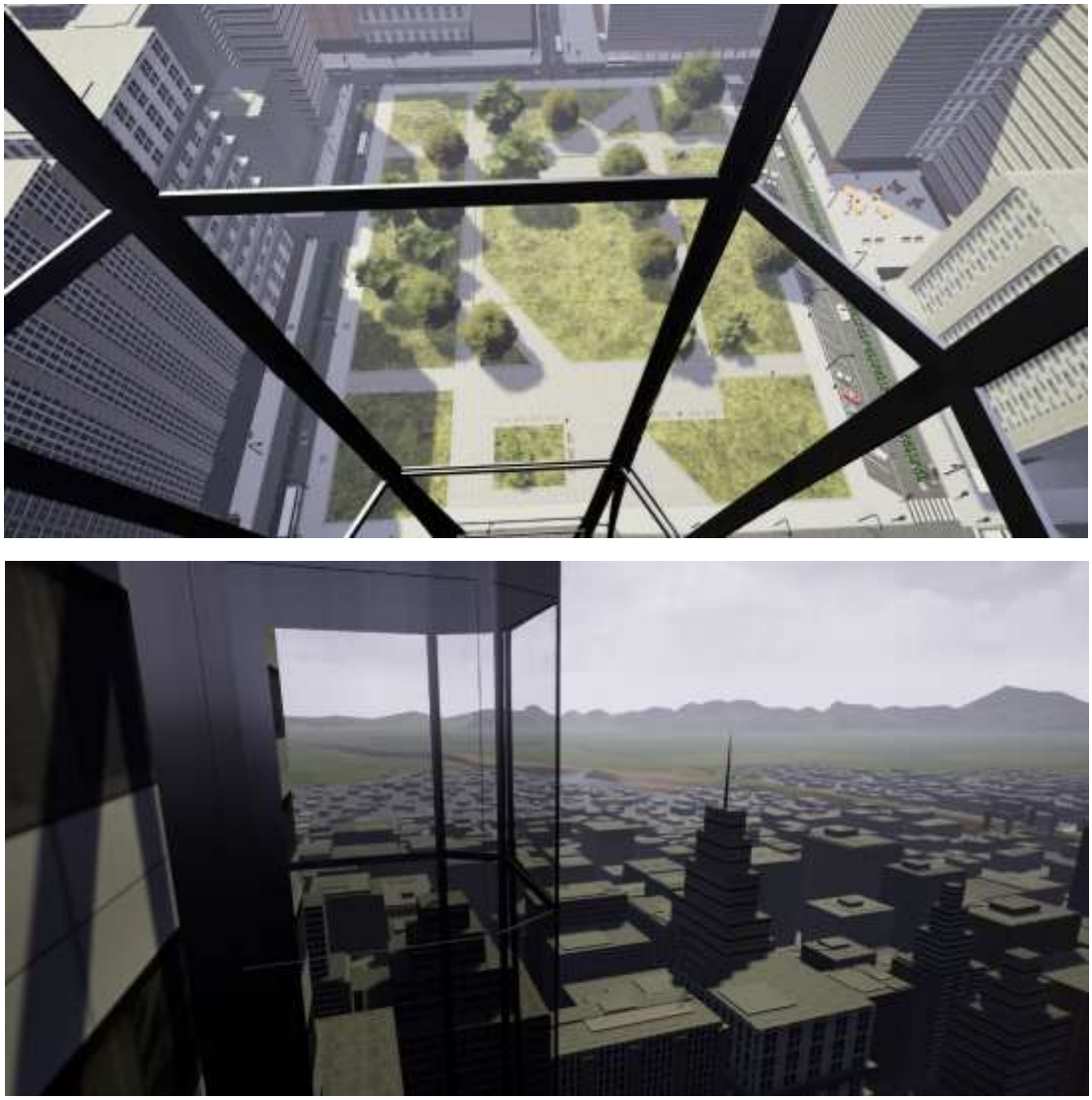


Image 35 & Image 35a: Frame surrounding the elevator.

Beta Design

The audio had been implemented into the simulation by this phase. There are three parts to the audio. The first is the sound the elevator makes when in motion. The second part is the soft music, designed and composed by musician Duncan Phillips, playing from the elevator speakers. The last aspect of audio the user will be hearing is a spoken script. The script is listed earlier in the Alpha design. Several issues not mentioned by the alpha users were fixed for the beta design. When looking to the far left, the user could see the edge of the city and the edge of the unreal landscape. To fix this, the elevator was moved further to the right and the landscape was extended. Now the user cannot see the edge of the city and it appears as if the city extends past the building the user is positioned on. When the user looked to the right towards the ocean, a gap in the buildings was visible (Image 36). Through this gap the user could see the landscape texture and the edge of the ocean. This looked unnatural and was quickly changed by creating a block of buildings to fill that space (Image 36a). Several other minor changes took place to make the simulation more appealing to view. For example, traffic lights were added to each corner with glowing lights, street sights and more park benches were added to the environment.

Image 36 & Image 36a: Before blocking off the street and after blocking off the street.

Beta User-Testing

The purpose of the second stage of user-testing was to confirm that the changes made in the first stage were appropriate and helped increase the immersive experience and realism of the simulation. The same group of users were tested along with several new users, for a total of ten users. They experienced the simulation for approximately ten minutes each before being asked to fill out a short questionnaire. Much like the previous testing stage, the questionnaire focussed on the design of the simulation. The feedback from this stage confirmed that the changes made between stage one and stage two and helped to create a more active and realistic simulation. Several points of feedback suggested extremely minor changes to the design, for example better quality trees and more of them in the park area. Following the final changes made after the Beta testing, the simulation will be ready to test of height sensitive users.

The users who experienced the simulation in the Alpha user-testing were requested to complete the simulation again. The main feedback from the Alpha testers was the changes made to the simulation helped to improve the overall visuals. Even though they are minor changes to the movement of the simulation, the wind effect in the trees really helped to make the area feel more alive. The movement added to the ocean cannot be seen easily because the texture is distant, however it does create the sense of a moving ocean instead of static.

The new beta testers were requested to complete the simulation then provide feedback in the form of a questionnaire. The purpose of including new users is to get new viewpoints from users who have not experienced the simulation yet. These users pointed out some aspects of the simulation that needed extra refinement. The main point of feedback from the beta testers is that the buildings directly around the elevator appear undetailed. All the buildings have extremely simple geometry, limited to a basic cube with detailing on the roof. While it is a valid concern, the buildings surrounding the participant are behind the user and will not necessarily be seen. Therefore, it is not necessary to increase the detail of the buildings surrounding the user as it is not common for those buildings to be viewed.

Image 37: Recreation of the user in *The Height of Reality.*

Chapter Five: Conclusions

Final Prototype

The final prototype included the changes from the Alpha and Beta user-testing to create a completed prototype simulation. It was at this point that the simulation was ready to be tested with participants that reported a moderate and high level of fear, including Miss T., the acrophobic interviewee.

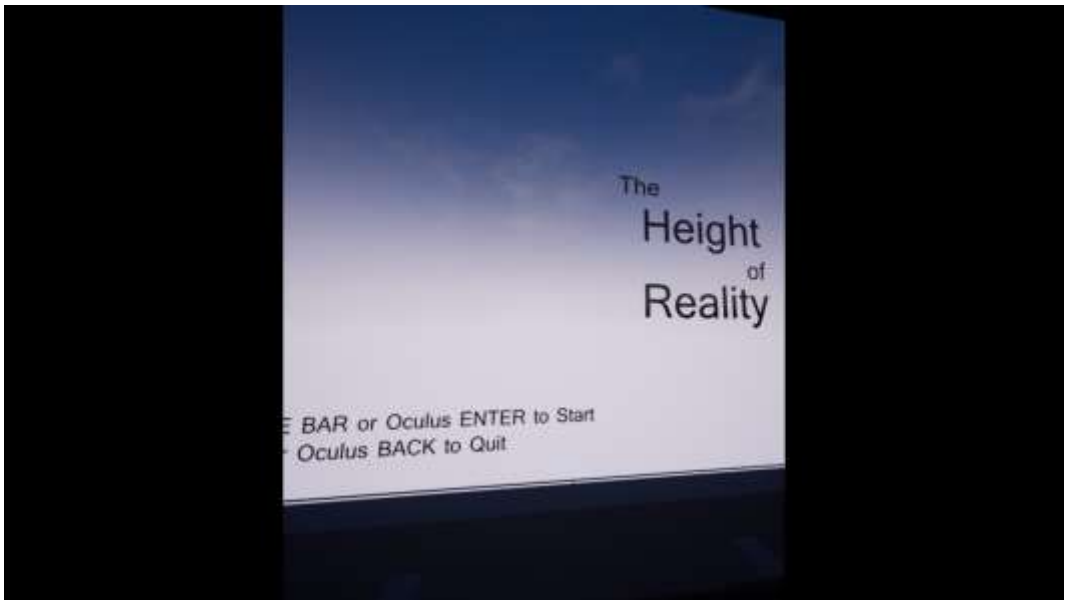


Image 38: *The Height of Reality* - Main Menu

Image 39: *The Height of Reality* – Ground Floor

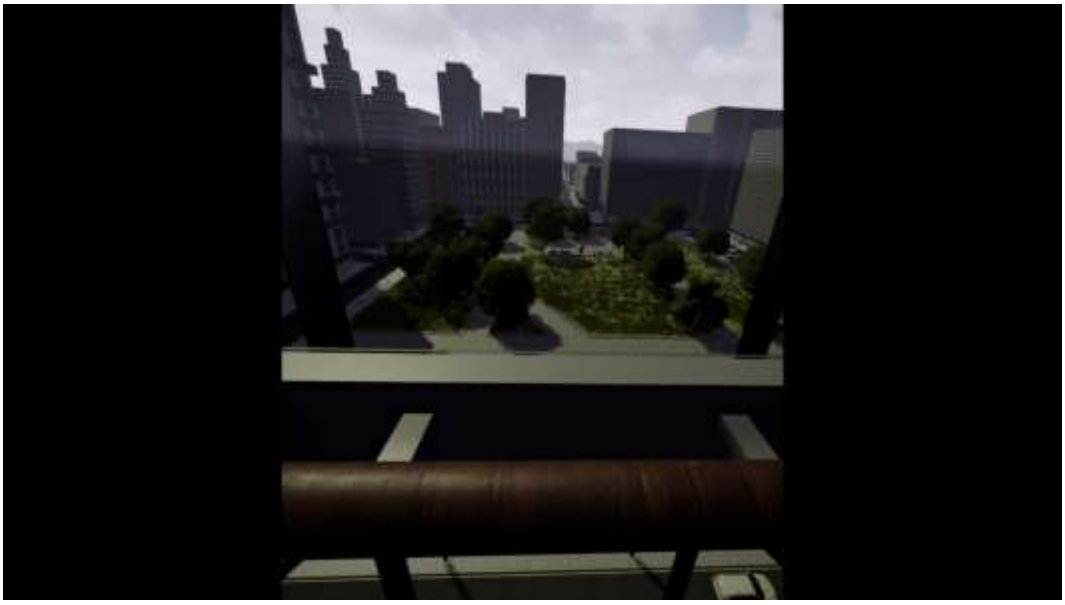


Image 40: *The Height of Reality* –Eighth Floor

Image 41: *The Height of Reality* –Eighth Floor, Right

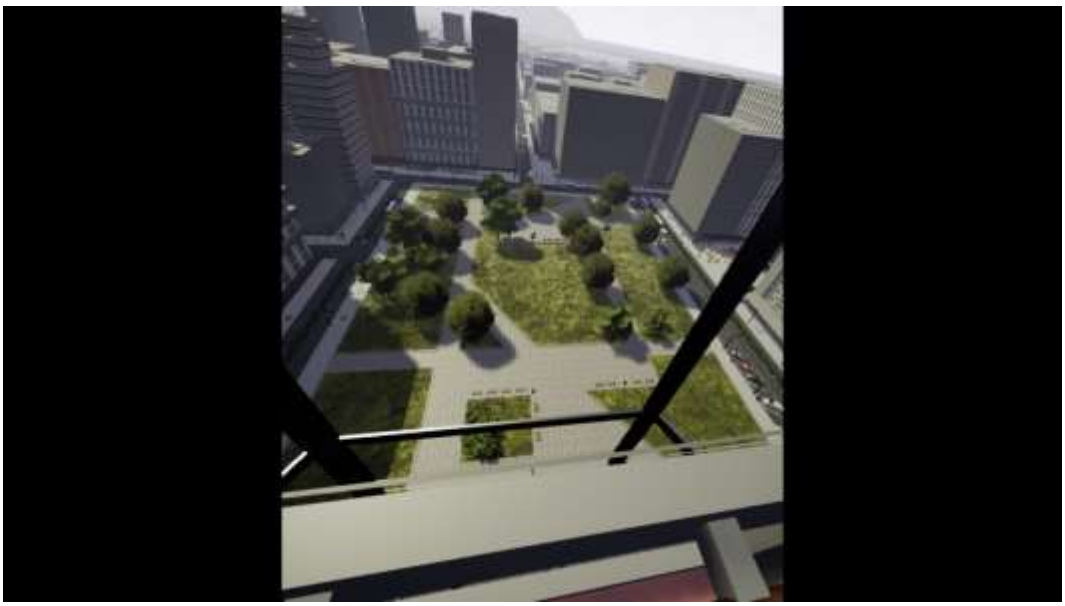


Image 42: *The Height of Reality* – Fifteenth Floor, Down

Image 43: *The Height of Reality* – Eighteenth Floor

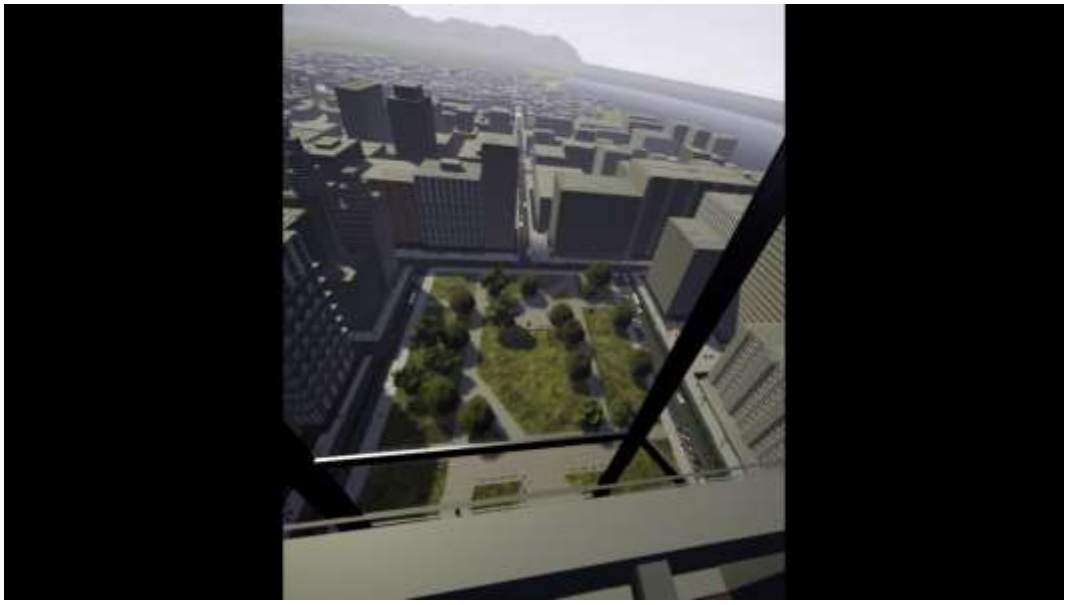


Image 44: *The Height of Reality* – Twenty-Fifth Floor

Image 45: *The Height of Reality* – Twenty-Fifth Floor, Right

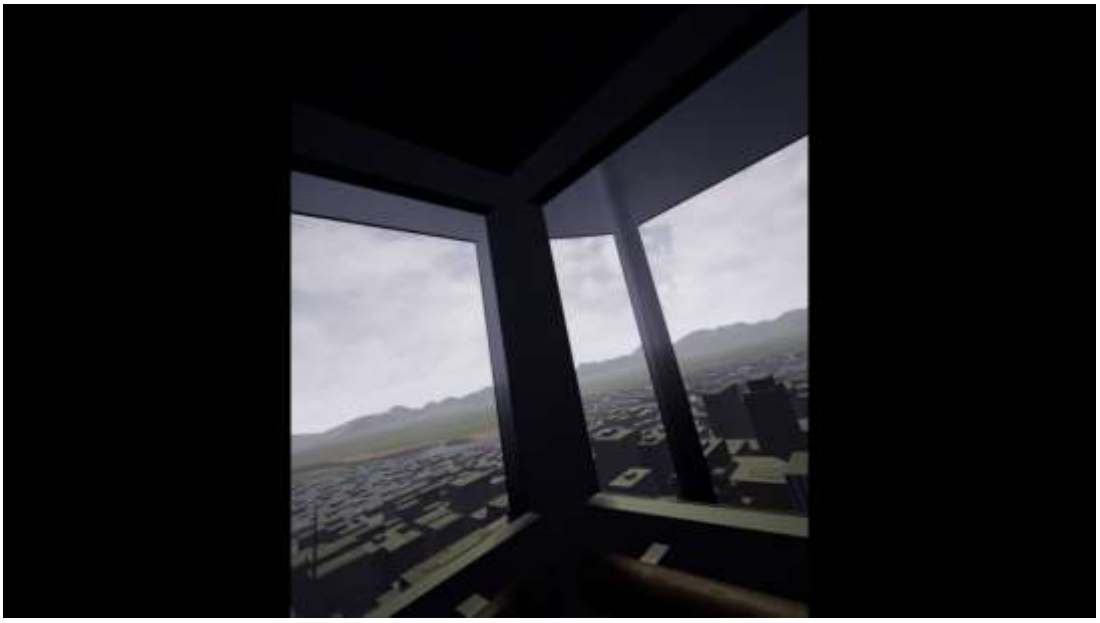
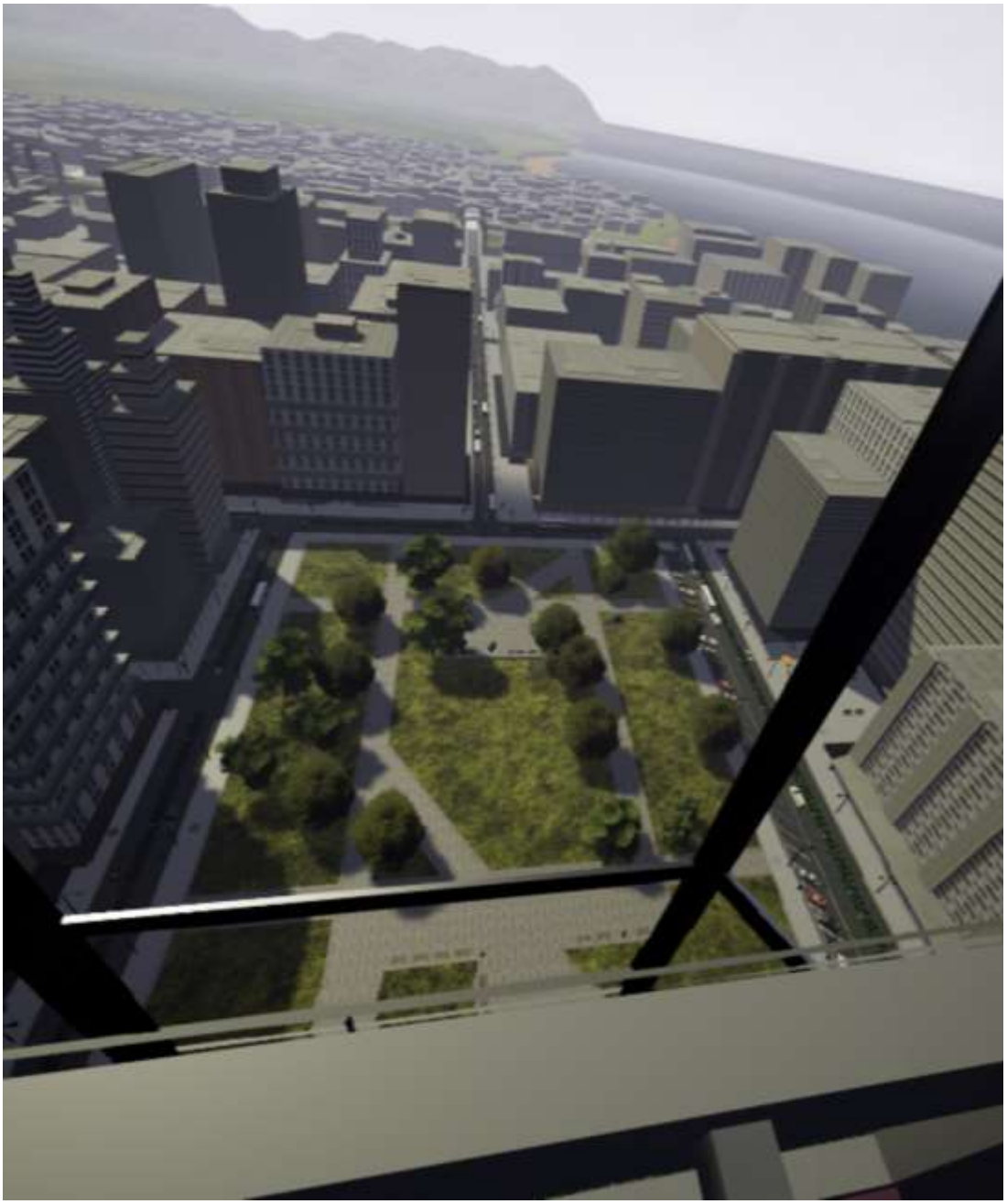


Image 46: *The Height of Reality* – Twenty-Fifth Floor, Left



Acrophobia User-testing

The third and final of user-testing was focussed on the practicality and functionality of the simulation and the effect it has on anxiety. Before each testing session, each user-testers was subjected to a questionnaire to ascertain their level of anxiety and their innate response to certain situations.[101] The questionnaire posed four scenarios to the user, and their responses recorded in the questionnaire helped to categorise the users into three groups. Group One consisted of five users who showed little to no anxiety level when faced with situations involving heights, reporting below twenty-five percent and therefore was the control group for this user-test. Group Two included ten users who reported a moderate amount of anxiety when confronting a high altitude. On the visual analogue scale, this group reported a twenty-five to fifty percent for their level of anxiety. Group Three included a total of ten users, including Miss T. who reported a high level of anxiety when faced with situations involving heights. This group consists of users who reported above fifty percent on the visual analogue scale. The highest response on the Heights Interpretation Questionnaire was Miss T. who reported approximately seventy-five percent on most the questions. Although fully acrophobic participants would report a higher level of anxiety to the questionnaire, it would be unethical to perform preliminary tests on highly acrophobic people. Following the questionnaire, users were tested in the simulation for a maximum of ten minutes to avoid any chance of motion sickness. The users were free to leave the simulation early if they wanted to. Afterwards, the tester was required to complete the same questionnaire again and asked several questions about their emotions and experiences in the simulation. Several days later, users were asked to experience *The Height of Reality* again, then fill out another heights interpretation questionnaire. The purpose of requesting the users to fill out multiple questionnaires is to ascertain whether there is a change in anxiety experienced. Due to time constraints, users were unable to complete multiple sessions over an extended period of time. Therefore, any change in the level of reported anxiety would be considered a positive result.

User results

The following results were collected from Heights Interpretation Questionnaires (HIQ) and user feedback. The users who were part of Group One reported the same amount of anxiety after experiencing *The Height of Reality* simulation. There was no noticeable change to the level of anxiety, indicating that there is no harmful effects or unintentional spikes in anxiety when experiencing the simulation. Group One reported that although they could see the benefit of the simulation, the overall benefit was not applicable to them. They responded however, that they understand the effect and benefit of gradual exposure therapy.

[101] Inspired by Steinman & Teachman's Heights Interpretation Questionnaire. Figure 1.2.

These users believe that the simulation itself would be more interesting than experiencing simple height *in vivo*.

Group Two reported a minor change to the overall anxiety felt after experiencing *The Height of Reality* simulation. The average response before experiencing the simulation was thirty-seven percent anxiety. The lowest response in this group was twenty-six percent, averaged over all the questions. Following the second session of user-testing, participants in Group Two reported a minor decrease of between three and eight percent each. The users of Group Two did not report much anxiety to begin with, therefore, the change that they reported was impressive. The users experienced two ten-minute long sessions in the simulation. When compared to traditional gradual exposure therapy which can last as long as six to eight sixty-minute sessions, the overall improvement users experienced in *The Height of Reality* proves hopeful. Participants responded that they could feel vertigo when looking down in the simulation. However, despite the measurements being accurate, it did not feel like the elevator was as high as stated. The simulation was designed specifically to be used for acrophobic participants in future developments. Because of this, Group Two reported that the overall progression of the simulation was too slow.

Group Three reported the most change overall compared to the other user-testing groups. The average level of anxiety reported by Group Three in the HIQ before experiencing the simulation was sixty-four percent. This was brought up somewhat by Miss T. who reported an average of seventy-three percent anxiety in a majority of the situations. Following the two ten-minute sessions in *The Height of Reality* simulation, the reported average of anxiety reduced by eight percent. This left the overall from Group Three at an average of fifty-six percent. Miss T. responded that she experienced vertigo and began sweating uncontrollably when the elevator was nearing the top of the simulation. However, she reported that over time Miss T. began to feel more comfortable with the heights. The gradual progression of the therapy helped with this feeling as well. Other users from Group Three reported that they experienced vertigo that slowly subsided over time, while in the simulation. This indicates that an increase in anxiety is being induced in *The Height of Reality* that is slowly reduced through the gradual exposure nature of the simulation.

Conclusion

Phobias are a large part of everyday society and have been proven to disrupt life on a day-to-day basis. Over the past two decades research has shown how virtual reality can be used to treat psychological phobias instead of *in vivo* and imagination treatment. Through the four conducted interviews, gradual exposure therapy and response prevention were established as currently the best methods to treat psychological phobias. Virtual reality has proven to be a strong platform on which to perform therapy experiments, due to the innate sense of immersion and motion-tracking capabilities. Existing experiments have shown an increasing success in VR treatment, demonstrating that virtual reality therapy is just as effective as regular therapy. *HITLab VR Therapy for Spider Phobia* is an ongoing experiment that has, in the past, treated patients who suffer from arachnophobia. At the end of the treatment, the patient had reported a lower level of anxiety than that of the test group participants. This result was considered a tremendous success and a glowing recommendation for VR as a platform for exposure therapy. *The Height of Reality* takes great inspiration from this project in particular with the hope that results would be similar.

When designed well, a VR therapy simulation could show results extremely early. As shown by the existing programs and the results of the user testing for *The Height of Reality*, VR is a convenient and conducive method to treat phobias. *The Height of Reality* was created with inspiration taken from successful and existing programs such as *HITLab VR Therapy for Spider Phobia*, *Bravemind VR*, which treats psychological with hands-on help from a therapist, and *Fearless VR* which treats arachnophobia without the interaction of a therapist. The simulation has been designed to treat acrophobia, to which no commercial programs are currently dedicated, despite approximately three to five percent of the world's population being diagnosed with the phobia. With input from Miss T., whose acrophobia is self-diagnosed, four concepts were designed with a heavy focus on the use of gradual exposure therapy. The concepts included a hot air balloon, a window washer's box, a location-based concept and an elevator. The elevator was considered to be the safest and most comfortable by Miss T. and was therefore chosen to be developed further into a VR simulation.

To develop this simulation, specific design techniques have been considered. It is important consider the advantages and disadvantages of techniques such as immersion, body presence, design style and physical support to develop the simulation to have the most therapeutic effect. Above all, the experience of the simulation must be as immersive as possible. This can be achieved by ensuring the design style is realistic, which helps to create a believable environment for the user. *The Height of Reality* was designed to have realistic textures and was created with an even and measured scale. The environment was based on the existing cityscapes of Palmerston North and New York City. These were chosen because of their large parks and grid-iron street style. By basing the simulation on existing cities, it created a more relatable and realistic location. The inclusion a of physical support for the

users increases the immersive experience and the feeling of safety and comfort to which a therapeutic simulation should adhere. *The Height of Reality* includes a virtual handrailing in the simulated elevator, and a physical handrailing exterior to the simulation, providing the user with four points of contact: both their feet and both their hands. This acts as an object of comfort for users and helped if the users experienced an intense anxiety reaction.

During the development of the simulation, it underwent three phases of user-testing. The Alpha and Beta user-testing were conducted to develop the visual design of *The Height of Reality*. Users provided feedback through a brief questionnaire and aided in the further development of the simulation. The third phase of user-testing focussed on the effect of the simulation. Responses were collected through the Heights Interpretation Questionnaire, before testing and after testing. The results confirmed that acrophobia can in fact, be treated through gradual exposure VR therapy. The user-testing concluded that an eight percent reduction of anxiety was achieved over two sessions of therapy for cases that reported a high level of anxiety in the Heights Interpretation Questionnaire. These results show that, when designed well, a VR simulation can be incredibly conducive to the treatment of psychological phobias.

Although the results were extremely advantageous, the designed simulation is a prototype and not a completed simulation. There are future developments that could increase the effectivity of the simulation and improve the design. This thesis explored the use of body presence; however, no form of user body was used in the prototype of the simulation in the future. The simulation could benefit from the use of body presence to increase the immersive experience for the user. The visual design of the simulation could also be refined and animated further to make the city feel more alive. Leap Motion could be used to increase the interaction between the user and the elevator in the simulation. With these future developments, the simulation can be improved, increasing the positive effect *The Height of Reality* could have on future participants suffering from acrophobia.

Terminology

Acrophobia: *Noun.* Extreme or irrational fear of heights.

AQ: Acrophobia Questionnaire.

ATHQ: Attitude Towards Heights Questionnaire.

ERP: Exposure therapy and Response Prevention.

HIQ: Heights Interpretation Questionnaire.

HMD: Head Mounted Display. A head-mounted display is a type of computer display device or monitor that is worn on the head or is built in as part of a helmet.

UE: User Experience. *Noun.* The overall experience of a person using a product such as a website or computer application, especially in terms of how easy or pleasing it is to use.

UI: User Interface. *Noun.* A computer program designed to allow a computer user to interact easily with the computer typically by making choices from menus or groups of icons.

VE: Virtual Environment. The environment within a virtual reality experience that the user can interact with.

VR: Virtual Reality. *Noun.* An artificial environment which is experienced through sensory stimuli (such as sights and sounds) provided by a computer and in which one's actions partially determine what happens in the environment; *also*: the technology used to create or access a virtual reality.

VRT/VRE: Virtual Reality Therapy/Virtual Reality Exposure Therapy. The use of virtual reality technology for the treatment and desensitisation of psychological phobias.

Appendix

Questionnaire 1.1. Alpha Development Questionnaire

The simulation is currently in Alpha, what is your opinion on the current design of the simulation?

Did you find the controls for the simulation were easy to use?

What changes do you think would improve the design of the simulation?

What is your opinion on the sound effects involved in the simulation? Could they be improved in any way?

How did you feel in the simulation? Do you think it could have a therapeutic effect on users with a fear of heights?

Questionnaire 1.2. Heights Interpretation Questionnaire

Situation #1

Imagine that you are climbing a ladder that is leaning against the side of a two-storey house. As you move from one rung to the next, you feel the cold metal beneath your hands. You pass a window on the first floor of the house. You continue to climb, feeling the wind on your face. You pass a window on the second floor of the house. You look down and the ground looks very far away.

Mark the line to indicate how likely is it that…

	Not Likely — Very Likely
1. You feel faint	
2. You feel like you may fall	
3. You feel like you may hurt yourself	
4. You feel unsafe	
5. You feel a strong sense of anxiety	
6. You feel a strong sense of discomfort	
7. You feel like you may freeze	
8. Being on a ladder is dangerous	

Situation #2

Imagine you are climbing a set of stairs. You can feel yourself slowly getting higher and higher. You reach a point where instead of a solid wall beside you, there are windows looking out over the city. The street below is slowly getting further away from you and the people are looking smaller. You are beginning to see more sky around you. You know you are completely safe within the building, however you can see you are high off the ground.

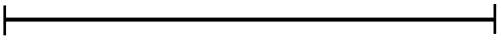
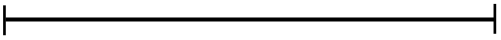
Mark the line to indicate how likely is it that…

	Not Likely — Very Likely
1. You feel faint	
2. You feel like you may fall	
3. You feel like you may hurt yourself	
4. You feel unsafe	
5. You feel a strong sense of anxiety	
6. You feel a strong sense of discomfort	
7. You feel like you may freeze	
8. You feel a strong sense of vertigo or your head is spinning	

Situation #3

Imagine that you are on a balcony on the 15th floor of a building. As you hold onto the warm metal railing that comes up to your waist, you feel the heat of the sun on your face. You listen to the sounds of cars and people down below. You look down and the people and cars on the ground seem small and very distant. Even the tree tops down below seem far away.

Mark the line to indicate how likely is it that…

	Not Likely Very Likely
1. You feel faint	
2. You feel like you may fall	
3. You feel like you may hurt yourself	
4. You feel unsafe	
5. You feel a strong sense of anxiety	
6. You feel a strong sense of discomfort	
7. You feel a strong sense of vertigo or your head is spinning	
8. You feel like you may freeze	
9. Being on a balcony is dangerous	

Situation #4

Lastly imagine you are in a glass elevator. You begin on the ground floor and gradually begin to move higher and higher. The elevator is whirring around you as you move up past the first, second and third floor. Gradually, everything below you become smaller. People begin to look like ants. Trees appear tiny below you. As you move higher and higher, you move past the rooves of buildings that towered above you on the ground.

Mark the line to indicate how likely is it that…

	Not Likely — Very Likely
1. You feel faint	
2. You feel like you may fall	
3. You feel like you may hurt yourself	
4. You feel unsafe	
5. You feel a strong sense of anxiety	
6. You feel a strong sense of discomfort	
7. You feel a strong sense of vertigo or your head is spinning	
8. You feel like you may freeze	
9. Being in a glass elevator is dangerous	

Table 2.1. Floor Script

G	Welcome to *The Height of Reality*. You are currently on the ground floor of this simulation. When you are ready to move up, press the up arrow. If you ever feel the need to, or if you move on too fast, you can move down a floor with the down arrow. Spacebar will pause the simulation.
1	First Floor. You have made your first step to helping with your fear of heights.
2	Second Floor.
3	Third Floor. Take your time, look out over the park. You are in control.
4	Fourth Floor.
5	Fifth Floor. You are approximately 20 meters in the air. Take a moment to tell me how you are feeling.
6	Sixth Floor.
7	Seventh Floor. If you are feeling up to it, look down over the park below. Know that you are safe within the four walls of the elevator.
8	Eight Floor.
9	Ninth Floor. Remember there is a hand railing in front of you if you need to hold on to something.
10	Tenth Floor. Congratulations, you're doing amazing. You are now approximately 40 meters in the air. Take a moment to tell me how you are feeling.
11	Eleventh Floor.
12	Twelfth Floor. You are now high enough to look out over the buildings. You should be able to see the countryside. Focus on it.
13	Thirteenth Floor.
14	Fourteenth Floor. Take your time. Focus on a point on the mountains in the distance.
15	Fifteenth Floor. You are now approximately 60 metres up. Take a moment to tell me how you are feeling.
16	Sixteenth Floor.
17	Seventeenth Floor. If you are feeling up to it, look down at the city. Focus on a point. A roof, a building. You are safe.
18	Eighteenth Floor.
19	Nineteenth Floor. If you are feeling faint, remember there is a hand railing in front of you. You are in control.
20	Twentieth Floor. Congratulations, you are now approximately 80 meters up from ground. Take this moment to talk about how you are feeling.
21	Twenty-First Floor.
22	Twenty-Second Floor. You are safe. Move at your own speed. Only a few more floors to go.
23	Twenty-Third Floor.
24	Twenty-Fourth Floor. Only one more floor to go. You are doing so well.
25	Twenty-Fifth Floor. Well Done! You have reached the top of the building. You are approximately 100 meters in the air. Look out over your achievement. Take a moment to talk about how you are feeling.

Interview 3.1. Dougal Sutherland Interview Transcript – Clinical Psychologist

Q. As a professional what is your experience with any phobias?

A. The most experience I've has is probably with panic disorder and agoraphobia because they would probably be the most debilitating. Over time have seen a reasonable number of people with a variety of specific phobias. Fear of heights would wall into that sort of specific category. I've seen people with a fear of vomiting, fear of spiders, fear of hospitals. A lot of panic disorder and agoraphobias.

Q. So have these sorts of people been seeking treatment?

A. Yep. Seeking treatment, seeing them before assessments and usually some sort of follow up for treatment around the phobia.

Q. So how long would that kind of treatment take?

A. It's a little bit like how long is a piece of string. It depends on the severity of the phobia and also how much work the client does in between sessions. A standard rate would be eight to twelve sessions of treatment.

Q. Those would be weekly sessions?

A. Yeah weekly sessions. But it could be a lot longer, it could be a lot shorter. Depending.

Q. What kind of reinforcement are patients expected to do between sessions? In terms of homework.

A. The general principal for exposure based therapy is getting closer and closer to the thing you fear using some sort of hierarchy or ladder, with the most feared at the top and the least feared at the bottom. The general rule of thumb is don't progress up from one step of the ladder to the next step until your anxiety is about a zero or one out of ten from whatever it was previously. So, I'm no longer anxious about that and will go onto the next step. The rate that people progress up that ladder depends really on how repeated they engage in the exposure type situations outside of therapy. That's probably the main thing that would govern how quickly they will progress through. There can be a variety of factors that get in the way of doing that. Time, motivation – because it's a bit scary anyway, willingness, ability in some ways. If you think about a fear of flying – eventually you're going to get to a point where you'll need to go to an airport and go near a plane, and that's not necessarily possible for everybody. Fear of heights I guess it would be how close are you to something that's really high that you could get to the top of. So, it's up to them how many times they'll practice it between sessions. The more they practice, the faster they'll improve.

Q. Have you dealt specifically with acrophobia?

A. Not with fear of heights in a clinic situation I can remember. Part of that is probably most of my career I have been in the public sector so that's seeing people with moderate to severe mental health problems. People with a fear of heights may not fall in to that category. Partly because they may just stay away from heights, so it doesn't create a massive amount of problems in their lives. I think phobias tend to only crop up for treatment when it comes to the crunch for somebody. An example would be somebody with a fear of flying suddenly gets a job where they're required to travel and they think "oh my

god I've got to get over this fear of flying". But they would spend a lot of their life avoiding jobs that come into that category. Same with fear of heights I suppose. You don't go in to become an abseiling window cleaner if you have a fear of heights, it just doesn't come up for you. So, I can't recall seeing anyone for fear of heights. However, the treatment method for any specific phobia is the same.

Q. What kind of treatment is that?

A. That would be graded exposure. So, you're gradually getting closer and closer to the thing that you fear the most. Coming into the contact with it. The background theory being that you've learnt to, over time, avoid coming into contact with the thing you fear. Because it provokes an anxiety response in you. The fight or flight response gets stimulated. And that makes you go "oh my god" and that's the anxiety. To reduce the anxiety, you get away from the thing that you think is causing that anxiety. So almost the reverse of that is graded exposure where you get closer and closer. One of the tricks is you need to stay in the feared situation long enough for the anxiety to drop down again.

Q. Is that response prevention coming into effect there?

A. That is response prevention. The response would be getting out. Because that would create an immediate drop in anxiety. Which is sort of self-reinforcing. But you'll probably never learn that the situation is not inherently anxiety provoking. So, you'd have to stay in that anxiety provoking situation for long enough for the anxiety to naturally reduce. Which it does eventually but it can take a little bit of time. So, the response prevention is, at an overt level, not escaping the situation. But if you think about it at a cognitive level, you've got to focus on the situation that you're in. because for example I could have a phobia of chairs and be sitting in a chair. I'm not escaping it, but I'm not thinking about it either. I'm thinking "look at the lights, look at the lights, look at the lights, look at the lights" and then "yeah I've done it!" but I really haven't done anything. Because my mind hasn't been focussed on what I'm worried about, my mind has been focussed on something else, which is a sneaky way of avoidance really.

Q. So you specialise in cognitive-behavioural therapy?

A. That's the primary training that I've had and the primary training we do here.

Q. So could you explain that in layman's terms a bit?

A. So in some ways it's quite simple. Cognitive-behavioural therapy. Cognitive is just thinking. What you think to yourself and behaviour is what you do. For phobias, a cognitive-behaviour theory, which would then flow on to the therapy, the theory would be that there may be a genetic predisposition towards being anxious, or to have some sort of anxious temperament where you're naturally the sort of person to be hesitant to do new things. So, you potentially have a bit of a predisposition towards it. But over time you have learnt, probably mistakenly, that coming into contact with a particular thing causes you anxiety. And some people have, you see in the movies, some people might have a potentially terrible traumatic experience with say, a pen, and then become phobic after one occasion. But that's not usual. Most people would develop it over time and with a little bit of social learning and social reinforcement, seeing other people being anxious, having other people saying, "oh you look a little anxious" and taking you away from the situation. So that gets reinforced so they learn to associate the thing, and it could arguably be anything, for this

example heights, with being anxious. So then in future whenever they come into contact with that thing it provokes an anxiety response, the fight or flight response within them where they get a whole lot of physiological symptoms. Heart beating fast, sweating, and dizziness, numbing or tingling in hands or feet just as their autonomic nervous system brings activity into the centre of the body as a protection system. It just wants your heart and lungs to be right because you've got to escape or you've got to get ready to fight something. That sort of response happens when they come into contact with the feared situation. Then because they want to reduce those symptoms in themselves so they then get away from that thing they're afraid of or they just learn to avoid it because they have that feeling. Moving on from that, the therapy is saying "hey, actually, there's inherently nothing dangerous about this situation. What your body has done is almost giving off a false alarm every time you're coming into contact with it." What do you do when there's a false alarm? You figure out it isn't real and you stay in that situation. If you stay in that situation for long enough for your anxiety response to reduce and you learn that that situation no longer is associated with anxiety. You're breaking that commotion between that situation and the anxiety response. Or to put it another way, you're learning a new connection i.e. there is no connection. Or the connection is in fact with calmness or boredom. Because often people say when they're doing exposure therapy "I'm just kind of bored now". That's fine. So, the new connection is I'm just bored with it rather than being anxious about it. Probably one of the difficulties with fear of heights is there is some inherent danger in a fear of heights and in some ways, it is adaptive and functional to be afraid standing on top of a really tall cliff or the top of a building. That's adaptive. I guess when it is less extreme, when you become fearful of standing on a desk or getting up a ladder. You might think actually that doesn't make any sense really.

Q. Have you seen some phobias connected to other phobias? For example, fear of heights stemming from fear of flying.

A. Not those two in particular. Phobias often get grouped together. The basis for grouping is around how natural it is to be afraid of those things. There is a blood/injury/needle type phobia group. People who have those phobias can get a specific physiological response. Either a massive increase in their blood pressure or a massive decrease, which can end up with them fainting. So, you have to know what their blood pressure is doing. The other ones are animal/natural/ environment, blood/injection/injury and situation. I haven't necessarily seen heaps that are together but sometimes it's not necessarily the phobias that presents itself. People don't necessarily rock up saying "I've got a fear of vomiting". We see quite a few kids here at the clinic that have what we describe as fussy eating. They would only eat a very select range of foods. And for some of them, once we dig in to that actually they've got a phobia of vomiting. And they're worried that eating or trying a new food is going to end up with them vomiting and therefore they avoid all sorts of new food and gradually narrow down the food they eat. So, in that case it's not like there's multiple phobias connecting together but it's not like the phobia itself is the presenting problem. Another client I saw was verging on having agoraphobia, a real fear of going outside or into public places.

When we sort of broke it down with her, an example might be her saying "I could never go out to lunch with my friends."

I said what would be so bad about that?

She said, "well imagine if I had something that choked on?"

What would be so bad about choking on something?

"They might have to call the ambulance!"

What would be so bad about an ambulance being called?

She looked at me light I was stupid and said "then I'd have to go to hospital! And I can't stand the hospital! They're the worst places in the world."

So, underneath all that was a phobia of going to the hospital. Shed had some bad associations. People, family being rushed to the hospital and dying and particularly as she was growing up and having those experiences as a kid where you don't really fully understand what's going on. All you know is "Uncle Dave went to hospital and died". "I saw Uncle Ian and he has really bad cancer and was in the hospital and died". You can sort of naturally see how a worry of this particular place may mistakenly rise. She's just lived with that. Often, it's not always the phobia that is presenting, it might be some other anxiety response.

Q. Is it generally easy to break it down in that way?

A. It can be. I guess with anything psychological it can get more and more complicated because of, if you like, the offshoots of that. Thinking about the woman I described earlier with the fear of hospitals, she didn't present with that, but she did present with a fear of going out and a lot of medically related concerns. She was doing a lot of monitoring of her own body and becoming worried about "oh my god I noticed I had really sweaty hands yesterday, could that be glandular fever". That then gets more and more complicated. Then she might get depressed about the fact that she's having all these medical complaints and can't leave the house. It can potentially mushroom out. In those situations, it would take a while to pick that apart. I think it underlines the importance of doing a thorough assessment and not just jumping in after one session and thinking you know what's wrong with them. I think that's something that people will have to come to terms with then they come to see a clinical psychologist – is that the assessment phase could take a while. It's not like seeing your doctor for ten minutes, getting an assessment and off you go. It can take 2 or 3 sessions of fully understanding what's going on with you. That's largely because we can't really do any testing. A medical doctor can test you for diabetes and say, "look you've got diabetes, I've got the results". But we don't really have a test that says, "you have a fear of flying". So, we have to ask questions and people answer us. In its more complicated forms it can be quite difficult to unpick. Sometimes it's simple because people come along and say. I think we had a referral a month or so ago. Somebody for a fear of flying. They'd got a new job and had to fly to the other side of the work in six months' time and could we help with the fear of flying. So sometimes it's really simple, sometimes more complicated.

Q. Going back to the cognitive-behavioural therapy, does that work to determine what kind of fear the phobic person has then move on to exposure therapy, or does cognitive-behavioural have its own kind of therapy?

A. The view I gave you about the development of phobias would be the cognitive-behavioural theory on how phobias develop. That naturally lends itself to a cognitive-behavioural treatment. That treatment would be gradual exposure. Based on the underlying idea that actually over time you've built up an association between your anxiety and this thing, whatever it is, say a clock. I see a clock, I get anxious, and I avoid the clock. The

reverse of that is actually learning that the presence of a clock is not in itself dangerous and your anxiety response will go down. There are of course alternative views of how a phobia might develop and that would lead you down a different path of treatment. You may go see someone else who has a different theory about phobias and you may not get offered graded exposure therapy. As clinical psychologists we say "what's the treatment that has the most evidence that it works? What does scientific literature say about what the most efficacious treatment?" and for phobias that is very clearly is cognitive-behaviour therapy. Cognitive-behaviour therapy is a bit of a broad term. Within that you've got cognitive-behaviour therapy for depression, cognitive-behaviour therapy for anxiety and a phobia is classed as a form of anxiety. Graded exposure is a type of cognitive-behaviour therapy. Quite heavier on the behavioural side than the cognitive. Whereas depression you might have a much more of an emphasis on the cognitive side i.e. what do you say to yourself in your head? What do you believe about the world around you?

Q. In terms of outcomes, are they all generally positive? Have you had anyone who doesn't respond as well?

A. They're not all generally positive. The literature will tell you it's useful, 70 to 80% of a specific phobia will, in a sense, be cured from that phobia with graded exposure. The thing about psychological therapies is you have to be active in the treatment, as opposed to medication. I mean, you still have to be sort of active. You just need to take the medication. It's not just a physiological response. Surgery, you just have to lie on the table and fall asleep, right? In psychological therapy, you need to be a lot more involved and active. That relates back to how much homework you do in your own time. There can be a lot of things to get in the way of treatment success. And it could be easy to blame the person with the phobia, "They're not very willing to do it" "they're just not motivated". But they have come and seen you about it so they are pretty motivated. The person themselves have quite a big role in their own treatment.

Q. Have you had any experience using digital technology for treatment?

A. Not personally. I'm aware there is quite a growth for virtual reality in psychological treatment. Things like phobias and PTSD. But I haven't had any experience myself. The closest I would have come would be in the treatment of say, spiders, using a video clip of a spider as part of the graded hierarchy. But that's a fairly mundane version of a digital technology.

Q. That's all the questions I have, thank you for your time and your information.

Interview 3.2. John McDowall Interview Transcript - Psychologist

Q. What have your experiences with phobias been professionally?

A. As a psychologist, I've dealt with people that suffer from phobic disorders and involved in the treatment of those disorders.

Q. What phobias have you dealt with?

A. Heights, animal phobias, specifically spiders and creepy crawlies, and insects and stuff like that and the fear of enclosed spaces

Q. Those three are quite common, aren't they?

A. Yeah, they are

Q. So you have dealt with acrophobia specifically?

A. Yeah

Q. So what kinds of triggers and causes could cause someone to have acrophobia?

A. Well we don't know the origins of any phobia, but just about anything could become the object of a phobia. There are just different models and views. The prevailing one is the behavioural one which says these things are learned. Meaning that at some point some frightening or aversive experience has been paired with some object. So, for example you're walking down the street and you fall down a big hole and you're very frightened as you're falling and at the same time you fall down the hole a big spider walks up your head the behaviourist would say that that spider has now formed a conditioned response. In other words, the next time you see a spider you're going to feel frightened about it. In and of itself that's too simple for a number of reasons. Firstly, the vast majority of people that have phobic fears cannot remember any specific aversive event to do with that object. They'll tell you "I've always been afraid of that object". The second this and undermines the simple behavioural model is that the objects of the phobias are not randomly distributed in the world. If they were just the result of pure conditioning you'd expect lots and lots of people for example to be frightened of glasses or a ballpoint pen or bits of paper because they're common objects but it's unusual to be frightened of these things. People have looked at the types of this that people become phobic about and they're creepy crawly things, spiders, wetas and snakes, heights, enclosed spaces, feelings of being trapped. Now all of those things have survival implications. Some of those things could kill us. So, heights, you don't want to be careless around heights. Most spiders are harmless but some of them can kill us. It doesn't seem helpful for us to be hardwired in a way that we need to decide by trial and error which ones are harmless and which ones are deadly. So, it seems that for some of those things we're easily conditioned and seem to be hardwired to be cautious about those things. The people that develop the phobia about them are on the extreme end of the continuum, as most people are about wary about say spiders that wouldn't fill the criteria of a spider. The ones we're talking about are way up here, but it's the same thing. So, conditioning will play a part but some objects by nature of their evolutionary significance would be easier to condition a fear in us.

Q. Have your phobias been genetic? Like if a parent is phobic of something would they pass that on to their child through experience?

A. A behaviourist would say you don't need to have the aversive event yourself. You could look at your mother screaming every time she sees a spider. That's called observational learning. It's shown to exist. But there are also studies suggesting like most things, there are a genetic aspect to them.

Q. Okay. What kind of treatment methods have you used or seen people used?

A. Treatment methods I have used, seen people use and are written about are all the same for all the phobias. That is Exposure and response prevention. What that means in terms of heights, to expose a person to a height and the response prevention means "don't you run away". Because what happens is, it's easier to work this through with a spider. If you come across a spider the first thing you do is run away. Running away reduces the level of anxiety, so a behaviourist would say running away is reinforced. So, every time you see a spider you'll run away. The only way you'll ever deal with the fear is to expose yourself to the spider and not run away. In a real-life setting, against dealing with spiders, you'll bring someone into the room and sitting on the other side of the room in a jar is a small spider. You get the person to walk towards it, if they feel anxious they can stop, catch their breath, relax, and then continue on to the spider. The next time the spider might be bigger, but also still in a jar. And so on and so forth. Until you're getting to a point where the spider is no longer in the jar. Then finally you get to the point where the person can tip the spider out on to their hand and they feel not relaxed, but okay with that experience. That is gradual exposure in a safe sort of environment. But it's exposure and response prevention. The odd self-help book I think there's one called "Feel the fear and do it anyway" and that sort of sums up the exposure and response prevention. Feel the fear but don't run away. Stay there. What you find of course, over constant gradual exposure, is the fear dissipates hugely. Now they're never going to be relaxed around the spider. But they're not going to panic. Which is what they would do if it was not treated. Which is not a problem, most times a lot of spider phobics would never appear in a clinic because they usually just put up with is. Because you don't really see spiders that often, and you'll avoid going to where they might be.

Q. So is it more the extreme cases that would be treated?

A. Well for example if you've got a phobia of sparrows, you can't avoid sparrows. You go outside they're everywhere. That's what brings people into treatment. The consequence of the phobia is so severe. Another one is fear of flying. They'll come to the clinic and say, "look my daughter has just given birth in London and I'd love to go see her but I can't." It's the consequences that make people seek help but with spiders you can easily avoid them.

Q. For the example of heights, would you be able to provide a step by step? Similar to the spider situation. What kind of step by step system would you use for heights?

A. Yeah. Well the first one is steps. Steps is something you can introduce the person to, stopping at the first landing and looking down. Going all the way through to modern buildings that have glass floors. That would be a very final end point, getting the person to step out onto the glass and stay there. That's the response prevention again, stay there. I doubt you'd get a real height phobic person engaging in say a bungie jump, even if you have treated them.

Q. So it's still sort of there even though they have been treated?

A. Yeah, it's more manageable. That's what you're doing now, you're managing it. And if you do a proper treatment the anxiety will go down, hugely. But you're never going to like it. You're never going to like the budgies, the sparrows, the spiders, the heights. It's basically getting people to be able to cope with it. It's quite a successful treatment.

Q. What kind of outcomes have you seen from the treatments? Positive and negatives?

A. I haven't seen any negative outcomes. I suppose the problem with some of the treatment is some people will refuse to follow up with coming to the treatment sessions because the first one was too scary. Which then you need to think "did I make it too scary for them?" but if you can get past that, most of the outcomes are positive, people will report that they are less anxious now, that they can carry on doing normal tasks where before they were avoiding them. Yeah there is a very good outcome. It's one of the clear outcomes of mental illness. If you can call it an illness, it's more of a disorder. Good outcomes.

Q. Have you had any experience using digital forms of treatment?

A. No. But I know of someone who has had that over in Britain with virtual reality and spider phobias. I've read a little bit about it and it looks quite good.

Q. Do you know anyone that you could put me in contact with that does have experience with VR therapy?

A. I don't know anyone is New Zealand. But there might be, I'll have a look for you.

Q. Cool thank you. Because that's another avenue of questions I have to go up. You know there's the questions for people who have experience with treatment like you and then people who have experience with VR. I want to see whether they vary at all.

Q. Do you have any professional advice for the development of my project?

A. You'll need to use a very sensitive measure. Id imagine any effects that you get, if there are effects, between your three groups, would be smalls. Questionnaires can sometimes be a blunt instrument. A better one would be a visual analogue scale. A VAS is used all the times for that kind of thing. It's just a line, that's all it is. With two anchor points on either end that might go from not at all scared to terrified. And the participant is asked "where are you on the scale?" And they might say here. That's the beauty of VAS. It's sensitive to very small changes. Because you're not going to have huge changes in that.

A. The effect sizes may be small and can easily be washed out with a blunt questionnaire. I think a VAS would have a higher chance to show small changes. You could put it on a computer. One of the problems you might have is that the second group for example, have a very small room to move downwards. So, you're already starting with a flooring effect. What you really want is people who are really frightened because they have lots to move. You're control group is good because you need that as a baseline, but I would recommend getting your second group higher and the third group even higher. You still wouldn't have people who qualify as phobic but try and get that third group us as far as you can because they have the most room to move.

Q. Cool. That is all the questions I have. Thank you for your time and information.

Interview 3.3. Caroline Miller Interview Transcript – City Planner

Q. Can you tell me a bit about the history of Palmerston North and the Square?

A. Around the 1860s Palmerston North was developed as a government settlement and it was very strongly related to the development of the Wellington/Manawatu railway line. Essentially its layout was planned in the 1860 by a Mr Stuart who was a surveyor. So, he was given some sort of general instructions of what he was supposed to do with laying the city out. That is how we have the Square as big as it is. I think he got a little carried away with that. Other than that, the rest of the layout is a modified grid system. Its modified because the square became the central point and you have the four streets leading out – Rangitikei Line, Fitzherbert Avenue, Main Street and the other end, Cuba Street. So essentially it was intended that that would be the centre of the city but initially the railway ran through the middle of the square. That essentially cut the square into two pieces. Then the square also became the place where you put commemorative pieces – The statue of Tewhiti, Te Aweawe and the fountain that was put in to celebrate Palmerston North becoming a borough, which meant you were climbing up the local authority system when you became a borough. So, the square essentially ended up as a sort of bisected entity. There were a lot of floral decorations – flower beds etc. But you had the noise and disruption of the train coming through.

In the 1970s approximately, the government decided having a railway line going through the middle of the city was a bit daft, especially when it was freight trains and mixed passenger trains. So, they buy up land and divert the railway around the edge of the city so it goes out to Tremaine Avenue which was basically out in the country at that point. That left a big chunk of land in the city, a bit ribbon line right through the middle. And that's where the train stop there so that's why all the hotels are along Pioneer highway because that's where people stayed. That land suddenly was ripped up, taken out and you have a whole big empty space. Now part of it became the new location for the new City Council building. Which believe it or not, was a product of a building design competition.

Q. Really? The building has the overbridge leading into the Square, doesn't it?

A. Yes, it does. It has the linkspan that goes across. It was I assume an attempt to connect the council to the square. The square has always been contentious since the time the railway line was pulled up and there was land. The question was what do you do with it then? Because it's actually very big. And I think if you went to the archives at the Palmerston North City Council you'll find a huge amount of reports that try and address 'what should we do with the Square'.

Q. If I remember correctly its around 200 meters by 250 meters?

A. Yes, it is very large. In terms of squares its very large. And because the railway ran through it, it never really had any central points in it either. So, they've mucked around and then the clocktower was put in as a sort of centre point when the railway went. I'm not completely sure the recent designs where you've had this Nuremberg square created has been particularly well used. What has happened is the square has been eroded away into parking. Because we have this idea that people must be able to park as close to where they want to shop as possible or else they won't come. The development of the Plaza has sort of upset that balance a bit. But it means that Palmerston North has a very spread out CBD for a

city of its size. But equally it has managed to keep a lot of retailed concentrated in the central city, included supermarkets on the fringe of the central city. In a way that you would rarely see these days. Most of the time that stuff is flown out onto the edge in malls and the sort.

Q. Was there any intention around the 70s to just fill in the square with buildings and do away with it?

A. There have been various attempts but generally it has been accepted to be retained as some form of open space. But over time some parts of it has been surrendered as parking. It's partly because its legal status is quite interesting – in as much as it's not all in one title. I think some of its in old deeds which is a system that preceded our present titling system. It's basically a bit of a mess and everybody has different ambitions for the square in terms of it and what it represents. Also, you have had the unfortunate, I'll be very plain about this – I do not believe in the concept that you can prevent crime through design, that every bush could harbour a criminal. Well yes it could, but life is life and if somebody is wandering drunk through the square at three o'clock is anything going to save them? I doubt it. In fact, there has never been any proper evaluative work done on the reduction of crime that has resulted from it. So, a lot of it was a sort of form of moral panic. Essentially some of the more pleasant features of the square was hacked out on the basis that it could harbour criminals. So apparently, it's now safe to cross the square at 3 o'clock blind drunk. Well, yes, it may or may not be, but I've never really seen any proper evaluation of it. It was terribly fashionable and people wanted to be safer than safe. So that in some extent has shaped the square to be what it is now. Essentially most of the square doesn't get a lot of use. And taking out a lot of the trees has reduced its use further. I think also the Plaza centralising retailing in a corner hasn't been a great thing. And things like the post office, Palmerston North had a really big central post office but those kinds of things don't really exist anymore.

The square tends to evolve, but it has a very wide perimeter. In terms of the CBD, probably the planning has focussed on trying to keep it operating as a vibrant CBD so it doesn't empty out to the fringes, which you can kind of see in Hamilton – if you walk down Victoria Street which used to be the premiere street, well now its empty and everything is out at Terapa. I was a planner at the city council for many years and that's what we actively pursue a policy of trying to keep things in the central city. And largely we succeeded. The square and the whole CBD remains vibrant, Broadway has turned into an evening street with restaurants. In terms of the rest of Palmerston North most of the early development was gridiron, so lots of intersections and that fell out of favour and you turned to more curvilinear streets. You'll see that from probably the 50s and 60s onwards. As you move out of the CBD you'll see more variety, more cul-de-sacs. Now of course cul-de-sacs have fallen out of favour as well. However, the public like cul-de-sacs and urban designers don't. So, developers still tend to provide them because that's what people prefer.

Q. What about the rest of the city? The residential areas?

A. In terms of the rest of the city, perhaps the most interesting and most obvious developments is Savage Crescent which stands out. It was designed in the late 1930s as about the third of the major state housing developments. So, it's a very early example. It has features in that you will not see in later development. It was designed in a complete package. The layout of the central reserve and the subdivisions of the section off it was all

designed. The subdivisions all opened up to the reserve at the back. There's a number of housing designs on Savage Crescent you won't see elsewhere. There's a greater variety than you'll see in later state housing developments. Savage crescent is a little integrated gem in itself. It has heritage protection since the early 1990s. Basically if you wander around savage crescent you will see that it's pretty well cared for.

Around the 1980 it was clear the city was going to expand across the river to this area called Summerhill because some of the growth paths were compromised by things like flood hazards and avoiding high quality productive land which was a requirement under the town country planning act. So, it was known that development was crossing the river so the planning department did a basic structure plan of the Summerhill area. Identified a commercial centre of some sort, a walkway system that will link that area to the university and the walkway along the Manawatu River. The land was subject to hazards and stability, so it took a while for the land to be developed.

Q. What sort of time was all that developed?

A. It developed around the 1980s and it's still being developed, you can see it now. The Riverbank road was swept away by the river but there was a plan in the early 1910 to develop that land, but most of it started in the late 1980 – 1990s onwards. Ruapehu Drive was developed in two pieces because there was a big gulley that they had to bridge. But that area is well populated now.

That's essentially how Palmerston North was developed. It grew mostly after the second world war. Prior to that it was probably smaller than Wanganui for most of the time. While the Wanganui port was operating it was quite a prosperous time. When the university was established in Palmerston North it started taking off. It all changed the nature of Palmerston North and created a lot of growth.

Q. Is it still growing at a steady pace now?

A. Yes, it is. The new national policy statement on urban development applies to about six cities in New Zealand and Palmerston North is one of them. After Hamilton, Palmerston North is the next biggest city. We have an odd urban hierarchy in this country because of Auckland being so much bigger. Essentially it goes Auckland, Christchurch, Wellington, Hamilton, Dunedin, Tauranga, Palmerston North. Palmerston North is bigger than Napier and Hastings which are often bracketed with. The central city has changed a bit but mainly it's the taking away of the railway. The rest of it has just been steady growth.

Q. Jumping back to the road layout, why did it change from being grid layout to more curved?

A. Grid layout are fine where you have low traffic density and slow traffic. Gridiron creates a lot of intersections and so it was considered that there were traffic issues with it. But also, it was just a change in fashion. There is a fashion sense in subdivision layout as there is in anything. Curvilinear streets are seen to be better and more elegant. You get these sweeping curved streets and everything. Also, it became more possible because of improvements in pipework. In the Victorian era, everything was cast iron so you really need to be laying it in straight lines. If you've got a curvilinear street you actually create a whole lot of very expensive piping. As we move from cast iron to concrete the whole process became more sophisticated and pipes could be created more easily. It is a fashion issue. If

you sit around long enough everything will come back. They are deciding gridiron layouts are actually better and more permeable. Once it's made, that is how it will stay. It will be too expensive to rip it up. You end up being able to date the road layout.

Q. Because Palmerston North was based on a central point, did it expand quite evenly?

A. Yes. One of the things that we talked about in the 1980s is that when you describe the city is it's a very compact city. I think that's because it expanded very steadily. You never had to boom bust. From the late 70s, 1980s onwards it had a council that was very interested in planning. Had a very strong planning department and actually had a national reputation. The district plan under the town country planning act which determined what you can and can't do, tried to promote that compactness. Also remember if you grow steadily gradually outwards it is the cheapest way to expand. The city tried to ensure the city expanded evenly.

Q. Does the fact Palmerston North is located on a plain change how it expanded?

A. Yes, well it made it very easy to expand. But there is a downside. That meant that all those areas were prone to flooding. But it meant that there was no rush to gallop off in any particular direction.

Q. For places like the airport and more industrial areas, what was the planning behind their locations?

A. What you need to do in planning is separate incompatible activities. At the basic level, residential and industrial. However industrial areas need more than that. They do not want neighbours. Because residential neighbours create problems for them. But they also need access to an arterial road or railway access. This meant industrial land in this city was on the fringes where it connected into the new route for the railway. Tremaine Avenue became an arterial road for industrial. Palmerston North was never meant to be a manufactural area, it was more a distribution centre. That involves large scale warehouses. You're not doing any activities that is creating a lot of noise or smell or that sort of thing. That is not the function of Palmerston North. In the 1980 – early 90s it promoted the city as a distribution centre. But they tend to be very benign industrial activities. The only problem is they work 24 hours a day so you get problems with light and sound. To some extent separating industrial has worked well.

Q. Is it a distribution centre because of its location in New Zealand?

A. Yes, because there is no easy land available in Wellington. I believe they can load up a truck here at night and it could catch the first ferry to the South Island. It is reasonably central because it has the space available.

Q. That is a huge amount of information, thank you very much.

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