

NARRATIVE PRESENCE IN VIRTUAL REALITY EXPERIENCES

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Dedication

To Noah and Finn, who are a constant inspiration and reminder that your imagination is a real place.

Abstract

The immersive work titled *Story/Space* explores the relationship of setting and story through the technology of virtual reality by creating a participatory experience in digital spaces that recounts a childhood memory. The work proposes a new perspective on the role of the scene in an agency-driven narrative, one that considers the affordances of virtual reality to expand narrative possibilities through a sense of presence and immersion. Through the design of key elements—sound, interaction and visual detail—that are focused on creating presence, the spaces themselves become storytellers. The result is an experience co-authored by artist and immersant that interactively moves through the wonders of a world inspired by childhood imagination, reconciling youthful abandon with mature perspective and insight.

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List of Abbreviations

VR	Virtual Reality
AR	Augmented Reality
XR	Extended reality or "X" reality
MR	Mixed Reality
HMD	Head mounted display
DOF	Degrees of freedom

Introduction

As virtual reality has matured as a consumer technology, the medium is creating the potential for new kinds of storytelling. Key to these narrative experiences is the development of convincing spaces that take advantage of the spatial representation of visual, auditory, and interactive media. While there have been new standards suggested for working with virtual reality--such as reduced latency to mitigate simulation sickness¹--they tend to address technical issues and not the story language of the medium. My immersive work *Story/Space* is an exploration of the relationship between spaces and the stories that occupy them. It is a conversation that centers on sense of presence as a key property of virtual reality technology. This support paper discusses the challenges, and implications for storytelling, of achieving a sense of presence in immersive participatory experiences, from both technical and narrative perspectives.

In *Story/Space*, the virtual space is designed to stimulate a sense of presence that is transportive. Through careful attention to visual detail, auditory authenticity, agency and action and feedback (together interaction), the virtual space

¹ Kjetil Raaen and Ivar Kjellmo, *Measuring Latency in Virtual Reality Systems* (2015).

gains the potential of placeness. Pierre Levy describes the dichotomy of the virtual not as the opposite to the real, but as the precursor to the actual.² The virtual world is an imaginary space that is used to plan or pretend what may be, even if not actualized in the physical world. This does not make the virtual un-real, but rather holds it in stasis where it is continually malleable and full of infinite possibility.

The narrative purpose of *Story/Space* is one of conversion and resolution. It converts the ideas of youth into an experience that, through technological affordances³, can be perceived as tangible. The story reconciles childish abandon with mature perspective by reformatting the tale as a multi-scene virtual reality experience. As a participatory journey, the virtual space is converted to a place of meaning and shared memory through exploration and action. This co-authorship of the story is brought about through a combination of the virtual world and the physical interactions presented by the VR hardware in a way that creates authentic memory; it is actualized.

² Pierre Levy, *Becoming Virtual : Reality in the Digital Age*, trans. Robert Bononno (New York, NY, USA: Plenum Press, 1998).

³ The relationship between a system or object's properties and their use. See Donald A. Norman, *The Design of Everyday Things* (New York, NY, USA: Basic Books, 2002; repr., 2002).

Terminology

Throughout this support paper I use the term immersant to describe the individual who is using the virtual reality hardware to engage with the narrative content of the work. The term has gained popularity in the virtual reality research and design community as it describes a person's role as they experience the technology and the media through the principle phenomenon of immersion. They are an immersed participant.

Another key term that I will use is narrative presence--the feeling of being a part of, or present in, a narrative experience. Whether through mental imaging or sensory stimulation, it is the distinct sensation that one is present in the virtual reality created by the narrative medium. Not to be confined only to the computer-generated worlds of VR hardware systems, this can include the imaginary worlds conjured through the words of a novel, the sights and sounds of a cinematic projection or theatrical presentation, or the digitally rendered environments of a video game. Narrative presence connects the reader, audience, or user with the story world of those experiences.

Virtual Reality

Virtual reality as a technology is in part defined by its ability to create a sense of presence⁴; to afford immersion in a generated space that is convincing to the senses. *Story/Space* is an experience that uses virtual reality as both a technology--to enable participation in a digitally constructed story-world--and as a medium that explores the role of space and presence in narrative discourse.

While the philosophical concepts of virtual realities are centuries old⁵, the technical roots of contemporary computer mediated virtual reality reach back to the 1960s⁶, when computer scientists and engineers experimented with various ways to interpret and display digital information. With the Sword of

⁴ Carlos et al Coelho, "Media Presence and Inner Presence: The Sense of Presence in Virtual Reality Technologies," in *From Communication to Presence*, ed. G. Riva et al (Amsterdam, Netherlands: IOS Press, 2006).

⁵ Michael Heim, "The Design of Virtual Reality," *Body & Society* 1, no. 3-4 (1995/11/01 1995). <https://doi.org/10.1177/1357034X95001003004>.

⁶ Pietro Cipresso et al., "The Past, Present, and Future of Virtual and Augmented Reality Research: A Network and Cluster Analysis of the Literature," *Frontiers in psychology* 9 (2018). <https://doi.org/10.3389/fpsyg.2018.02086>.

Damocles project⁷, Ivan Southerland investigated the means to display digital content in a three-dimensional mixed reality that blended optical information of the physical world with rudimentary computer-generated graphics. One purpose of this system was to find new ways for humans to interact with computer data. In a US Airforce laboratory, Tom Furness created mixed realities using sound and visual information that, for example, allowed pilots to navigate the complex data of cockpit controls and reduce cognitive load of interfaces that were growing increasingly complex.⁸ While different in purpose from the artistic expression of contemporary experiments, these early innovations created a foundation for representing digital information in a spatial manner that mixed it with the physical environment, and the physical presence of the immersant. Expanding computer information beyond the flat screen afforded new interaction possibilities, in terms of organizing and visualizing data, whether this was the position of wall, or indicating an incoming aircraft.

⁷ Rick Van Krevelen, *Augmented Reality: Technologies, Applications, and Limitations* (2007).

⁸ SteveBamburyVR "Interview with the Grandfather of Vr Tom Furness inside Engage *YouTube* video, 1:31:09 March 30, 2019 <https://youtu.be/rGkRdHVChvo>

In the mid-1980s, Jaron Lanier and a team at VPL Research took the methods of visualizing stereographic computer-generated information and added the ability to interact through their peripherals the Data Glove and Eyephones.⁹ This method of navigating digital information relied on building virtual worlds and representing data as objects within that space. It was at this time that Lanier also popularized the term "virtual reality"; a term that became synonymous with the technical systems and the worlds they created.

Entertainment designers and the media were enthralled by the novelty of virtual worlds coming to life and the human users being immersed in an infinite digital realm. Through the late 1980s and into the 1990s, various industries, from computer systems designers such as Sun Microsystems to video game console makers Nintendo and SEGA, tried to actualize the dreams of virtual reality. Limited by the power of available computing and rendering hardware, cost, and an underwhelming response from the consumer market, virtual reality did not fulfill the hype of transporting millions of users to a new digital frontier rendered in glorious tangible 3D.

⁹ The VPL Research Data Glove allow users to manipulate digital content using their hands. The Eyephones rendered stereographic images of the virtual world to give the illusion of three dimensions.

Despite its commercial failures, virtual reality maintained a hold on the imagination of audiences through the writings of Neal Stephenson (*Snow Crash*, 1992) and William Gibson (*Neuromancer*, 1984), films like *The Lawnmower Man* (1992) and *The Matrix* (1999), and the famous Holodeck of *Star Trek: The Next Generation* (1987-1994). Fictional media did not lose interest in virtual reality. Instead, like many technologies (robotics, space exploration), it followed a divergent path that better represented the aspirations of VR's use, not the realities of its development. These ambitious works presented both positive and negative views of virtual reality; either a liberating medium for learning and recreation, or a dystopian tool of subjugation. Key to both these visions is VR's power to completely immerse the user in a world that is indistinguishable from the physical. Although these works of fiction tended to focus on the technology central to data access, the Internet, computers and virtual reality devices, they also reveal the desire for transportive and transformative spaces that extend the human experience.

While storytellers and artists experimented with new ways to immerse audiences, development of virtual reality technology continued outside of a consumer electronics context. In the period from the late 1990s to 2012, scientists and technicians pursued the VR goals of earlier pioneers—stereographic rendering, physical interaction, virtual worlds, and simulated experiences.

From military simulation¹⁰ to cognitive research, the affordances of a system that could immerse users in a digitally constructed environment, and enables navigation of those spaces, meant reduced cost, greater safety, and more flexibility in creating scenarios for testing and training.

In 2012, with a very successful crowdsourcing campaign, Palmer Luckey introduced the Oculus Rift. Its demonstrations at 2013 Game Developers Conference¹¹ reignited interest in stereographic head mounted displays and virtual reality in the video games industry. Luckey's innovative technology and previous work, as an intern with VR pioneer Nonny De La Pena, influenced journalists and filmmakers also begin exploring the capabilities of virtual worlds, made possible through the combination of advanced camera technology, game engines, and head mounted displays, for exhibiting immersive content that sought to bring viewers closer to the story.¹² While research in the cognitive impact of immersive virtual environments, influence on behaviour

¹⁰ Ajey Lele, "Virtual Reality and Its Military Utility," *Journal of Ambient Intelligence and Humanized Computing* 4 (02/01 2011).

<https://doi.org/10.1007/s12652-011-0052-4>.

¹¹ Oculus, "Oculus at Gdc 2013," Oculus VR ed. *Oculus Blog*, 2013, <https://www.oculus.com/blog/oculus-at-gdc-2013/>.

¹² Caleb Garling, "Virtual Reality, Empathy and the Next Journalism," *Wired* 2015.

of VR interaction, and physiological response to spatial media had continued throughout the 2000s, this was a significant moment in the next wave of VR technology as it finally realized a primary goal—consumer access. The Oculus Rift entered the consumer market at \$350, a cost that many users could afford. Dr. Jeremy Bailenson, a researcher who had spent the previous two decades working with state-of-the-art virtual reality hardware was able to replace the \$40,000 headset at Stanford's Virtual Human Interaction Lab with a \$350 Rift DK2.¹³ This meant that both developers, designers, artists and storytellers had a new way to construct and share experiences and audiences had a way to access that content. At the dawn of the VR industry, hardware was prohibitively expensive [meaning that] the computer systems required to run even the simplest experience were out of reach for the home user. Now with a modest gaming computer and a developer kit, media consumers could experience the digital worlds long touted as the next evolution of entertainment media. In his TED Talk, Chris Milk, founder of immersive media platform Within, states "...VR is going to play an incredibly important role in the history of mediums. In fact, it's going to be the last one. I mean this because it's the first medium that actually

¹³ Jeremy Hsu, "Virtual Reality Pioneer Looks Beyond Entertainment," *IEEE Spectrum: Technology, Engineering and Science News*.

makes the jump from our internalization of an author's expression of an experience, to our experience firsthand."¹⁴ It was this sentiment, and the early version of the Rift headset, that brought me into the world of virtual reality.

The key elements of virtual reality technology are its design properties—stereoscopic displays, positional tracking, spatial audio. Through stereoscopic display, VR headsets can represent spaces and objects in three dimensions. This has the advantage of making spaces more believable and more functional than their two-dimensional counterparts. Within a stereoscopically rendered 3D space, the user can change their orientation in a natural manner and objects appear authentic through parallax and perspective distortion. Another significant property is the system's ability to track user movement. Early systems could match the physical movement of the user's head to the camera position in digital space with three degrees of freedom, being pitch, roll and yaw. Combined with the stereoscopic displays, this affords a view of the digital world that closely resembles the physical environment creating parallax and perspective. As systems improved, users could also begin to

¹⁴ Dan Isacsson, "Within Ceo Chris Milk Says Vr Will Be 'the Last Medium' at Tedtalks," *digitaltrends* (Blog), 2016, <https://www.digitaltrends.com/virtual-reality/tedtalks-vr-last-medium/>.

translate their position along each axis, unlocking six degrees of freedom and affording comfortable movement through the space. The addition of six degrees of freedom controllers also enabled a new level of interactivity that allowed users to manipulate objects in the virtual space.

6 Degrees of Freedom

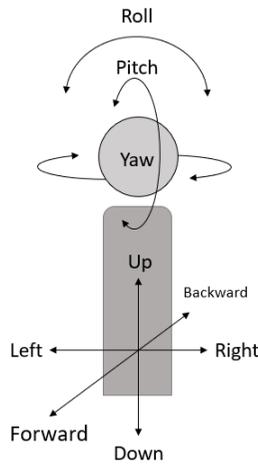


Figure 1 - 6DOF, or degrees of freedom, represent yaw, pitch, roll, and up/down, forward/backward, left/right translation. 6 Degrees of Freedom © Neal Tyler Heaton, 2020)

In the recent wave of VR technology, the Oculus Rift first enabled three degrees of freedom for the head and paired it with controller-based translation of the virtual body position. While this allowed exploration of the virtual space, it was not always a comfortable experience. In later iterations, Oculus developed 6DOF tracking for both the headset and controllers. My first encounter with the Oculus Rift was using the DK2 (developer kit), a 3DOF system that used a web camera to track head movements and

an Xbox controller to move in the space.¹⁵ The experience was a Unity software demo called the Tuscany Villa.¹⁶ The resulting experience was both thrilling and nauseating. I was able to move around a 3D rendered villa. I could move up and down stairs and look out over balconies and through windows. I saw in this simple experience the possibilities of new worlds to explore and interact with. However, there was a disconnect between the motion of my head and the movement of my virtual body position. This disconnect was enough to cause almost immediate motion sickness with the slightest forward or backward momentum. Uncomfortable as it was, the experience inspired me to keep thinking about what could be accomplished. A year later I was again exposed to virtual reality technology, but this time it was to the HTC Vive headset and controller system. An improvement on the early Rift DK2, the Vive used infrared cameras to track not only the roll, pitch and yaw of the head, but also the position and translation of the physical body in space. There was no need for a console

¹⁵ The Oculus DK2 system was being used by University of Lethbridge Graduate student Bryn Hewko, who facilitated the demonstration in his studio.

¹⁶ Peter Koch, "Getting Started with Unity and Oculus Rift Sdk 0.4.0," *Tales from the Rift*, July 28, 2014, <http://talesfromtherift.com/getting-started-with-unity-and-oculus-rift-sdk-0-4-0/>.

controller to move the avatar body. Instead the controllers represented my hands in the experience as they too were tracked by the IR cameras. The digital world that I was presented was of a similar nature to the Tuscany demo – an architectural rendering of a San Francisco penthouse.

However, on this occasion I was struck by a different realization. While the space was rendered using textured materials and a realistic style, it was not the surface detail that caught my attention. Rather, it was the size and placement of the furniture. As I moved through the virtual space by walking in the physical room, I did my best to avoid running into the virtual furniture. I instinctively stopped as I approached a virtual table, turned sideways and shimmied along its edge. It only took a moment, but I was convinced that this table and apartment existed as a part of my physical reality. I had experienced a pronounced sense of presence in that virtual apartment, and it was not due to the textures and materials of the models, but how the world was ordered that convinced me of its “realism”. Throughout the design process of *Story/Space*, I reflected on this experience often.

Beyond the combined technology that enables immersion into mutable digital spaces, is virtual realities potential for narrative experience. Virtual reality is transportive. During a

podcast interview with Kent Bye¹⁷, virtual reality game developer Ana Ribeiro described it aptly as a time machine and a teleporter—humorously referring to other fictional devices whose presence in science-fiction has long held audiences' fascination with being other places or manipulating reality. Indeed, a system whose affordances allow one to see faraway places or into other strata of time can transport that immersant. It also can fulfill a key component of narrative discourse, establishing the story world.

All forms of narrative rely to a certain degree on establishing the setting of the story in which the actions of the characters transform that world through the course of the story. Through camera lenses, descriptive text, and digital bytes, virtual realities are created that immerse the reader, the viewer or the player in the sights and sounds of the story world allowing them to experience the events from a variety of perspectives. As narrative media has developed and evolved, each new technology has created opportunity for storytellers to add novel and engaging elements to the story experience. With virtual reality technology, I was eager to leverage the affordances that

¹⁷ Kent Bye, "'Pixel-Ripped 1989': The Sound Design of a 2d Game within a Vr Game," in *Voices of VR* (2019).

made physical interaction and sense of presence a part of
Story/Space.

Narrative Presence

Story/Space represents a memory, it was therefore important to me as the designer and storyteller that the immersant felt connected to the story world. As the events unfolded, I wanted them to believe that they were a part of the activities rather than just observing the events as if happening to someone else. To achieve this goal, it was necessary to create an effective sense of presence using key design elements—visual design, sound design, and interaction design. Virtual reality production borrows elements from other media. There is the visual and auditory stimulation used to engage audiences in cinema. Video games utilize programmable interaction to communicate story and meaning through game play. From installation art VR borrows the arrangement of objects in space that attracts the audience and invites them to explore. In novels presence is achieved through crafted text that paints a vivid scene in the imagination. I was inspired by these forms of presence, combined into a medium that afforded a participatory experience. This represented a new level of immersion. It would be naïve to assume that VR technology on its own would account for immersion and sense of presence. It holds that potential, yet it takes deliberate planning, design and production to create an experience that captivates the senses to a degree of authenticity that I could present the story as a shared memory.

Presence in virtual reality -

Immersion in virtual reality is achieved through its combination of technologies--stereoscopic visuals, spatial audio, tracked movement of the head, hands and body, and interaction. Looking at some definitions of presence--the perception of non-mediation, or awareness of mediation fading in favour of the content--VR technology goes a long way in establishing this feeling. In the production of virtual reality content, in addition to the technical representation of stimuli, there must also be a focus on the content or the meaning of the virtual environment. According to Coelho et al¹⁸, this focus adds to the sense of presence felt in the virtual reality experience because it creates in the immersant a sense of connection to the events or environment.

¹⁸ Coelho, Carlos et al. "Media Presence and Inner Presence: The Sense of Presence in Virtual Reality Technologies." In *From Communication to Presence*, edited by G. Riva et al. Amsterdam, Netherlands: IOS Press, 2006.

Virtual Reality as Narrative

For an agent embodied in a multidimensional environment, exploratory and ontological interactivity can no longer be rigidly distinguished because being-in-a-world is a way to make this world flow out of the acting body; a way to create it.

--Marie Laure-Ryan, Narrative as Virtual Reality 2

Story/Space, as the name would suggest, begins with a story. As a child of eight years, with a longing for adventure brought on by summer days and cinematic inspiration, I convinced a friend to journey with me some fifteen kilometers into the countryside in search of a top-secret computer base. Fueled by imagination and false promises, we walked the distance to a property on the outskirts of our small village in search of the compound, one that I assured my friend was hidden underground in a field. The end result of this journey was not the incredible tale of two boys discovering a long-forgotten bunker filled with cutting-edge technology that allowed them to become super spies or computer hackers. Despite my youthful aspirations, the consequences of this trip were an embarrassing moment of acquiescence, and a phone called to my very surprised parents.

This memory is a complex web of emotions and events. There was the excitement of adventure into the unexpected tempered sharply by the shame of the admitting my deception. There was the physical distance we travelled, where each step brought us closer to an outcome that could only be actualized through physical interaction. It is these elements that I wanted to draw upon when

exploring the potential of virtual reality and presence in storytelling. I wanted to access the imagined potential of this venture in a physical way that brought to life what I had intended three decades earlier.

Space is a critical component of the title and experience of this work. The spatial nature of the narrative arrangement necessitates an environment in which to tell the story. I wanted this world to exist beyond the imagination. My approach to narrative relies on the functionality of computers and applications to create digital navigable spaces. Furthermore, the virtual reality hardware enables the immersant to navigate the space in such a way as to heighten the immersion in the story. A two-dimensional representation of the space or even three degrees of freedom media, such as a 360 still or video, would not have the same possibilities for unveiling parts of the story as they would be too close to the immersant and would not allow them the self-directedness needed to explore this co-narration through spatial dispersion of detail.

The idea of creating a virtual world for the story to take place is nothing new in narrative practice. Spoken word, written text and cinematic exposition all rely heavily on differing methods of representing the setting, whether through detailed description in a spoken or written text, or through imagery and sound in cinema. In new media narratives it is the interactive nature of story worlds that allows for new kinds of narrative.

Digitally created spaces such as websites, hypertext fiction, and video games are flexible; they expand and contract, they are spatial. Not only in the sense that they can describe a setting for the sake of the narrative, but that they take on an additional dimension as parts of the story are separated and distributed through interconnected networks or nodes that a user navigates through a web browser or game console. Narrative relies on time to reveal the events that form the story. As Jerome Bruner states, it is "irreducibly durative"¹⁹. The time dimension in a spatially dispersed story changes the narrative discourse. The sequencing of the narrative is no longer dictated by the page or the frame. Instead the immersant is free to move about the story world. While it is certainly true that the pages of a book can be skipped or the frames of a film advanced, this is not the way that they were meant to be read. The meaning of the text is bound to its sequence.

In *Story/Space*, the meaning of the text is bound to its spaces, and not a strictly linear order of moments. *Story/Space* is constructed as four scenes--the Imaginary Grove, the Liminal Void, the Cortex, and the Fireside. Within these scenes are interactive moments that take the place of linear events. In

¹⁹ Jerome Bruner, "The Narrative Construction of Reality," *Critical Inquiry*, no. 18 (1991).

their arrangement and duration, the worlds that the immersant experiences most closely represent the typical narrative structure of a motion picture or novel. They sequence my journey as a child from the field to the grove into the computer base and back. However, in each scene or space the sequencing of moments becomes looser and connected to the overall size of the space. The options for exploration move from a macro level in the grove to a micro level in the computer base. This connects to the interiorization of the memory, as I recall the freedom of the initial tale and its procession to the trap of the lie. There is a representation of my psyche in the way that the spaces are portrayed—their size, style and available moments. In the Imaginary Grove, the space is open and free. While there is a path marked on the ground that can be followed directly to the hatch, there is no restriction of movement to the rest of the world. As the immersant moves to the Liminal Void, that freedom of movement is reduced. It has a stark contrast in both the visual aspects of the world, with its suddenly dark environment and nebulous structure, and in the way that the immersant can move in the virtual world. In the Imaginary Grove the immersant can teleport and move great distances while also being able to walk short distances constrained by the boundaries of the tracking space in the physical world. In the Liminal Void, the Cortex and the Fireside, the immersant loses the ability to teleport. Because of its size relative to the exhibition space—

the Cortex for example is a 1:1 mapping of the tracking space--it would be natural to walk within the virtual spaces of the Cortex and Fireside. This is part of the design of the experience, that immersants engage their bodies in exploring the virtual space. However, as the immersant moves from the Imaginary Grove to the Liminal Void, whose expansiveness would certainly call for teleportation, they are constrained. Suddenly they are forced to walk the distance from their entry point to the glowing orbs and portal that moves them on to the next scene. This stark contrast in visual appearance and movement are connected to the story. As I moved from a position of imagination, where I had at any moment the freedom to change the direction of events, to a position of facing the reality of my actions, I was constrained in my options. I was trapped, and to an 8-year old child, the only path was forward into the unknown consequences. This decision is represented on the computer screens of the penultimate scene of the Cortex. It is here that my feelings oscillate between guilt, shame, and mature reflection on the nature of childhood imagination. As the scene fades, a final resolution is reached. Perhaps imagination is not as simple as truth and lies, but like Levy's definition of the virtual, imagination is the precursor to the actual made manifest for the beholder through uninhibited action.

Virtual reality technology was a method to investigate these factors in the artwork. I constructed the virtual

environments using the Unity Software (Unity) game engine. With the ability to combine visual and auditory media, to program interactions, and arrange objects and sounds in three-dimensional space, the game engine is a fitting backdrop for media's turn toward immersion and participation. Like the move of VR technology towards the consumer market, game engines have become more accessible to novice developers over the last decade. Their interfaces are user friendly, and there are large communities supporting feature development and learners new to content creation.

With this technology I was able to design and construct a three-dimensional digital world that could be freely navigated. My approach to design took on two roles. One being the technical design of the virtual environment and exhibition, the other considering the narrative structure of the work. From these two perspectives I approached the design with three key elements in mind—visual style and detail, sound design, and interaction.

Production Workflow

Contemporary computer-generated imagery affords precise control over the placement of pixels, rendering of lights and surfaces, the straightness of lines and the symmetry of shapes. To achieve a minimalist and imperfect look and feel essential to the story world, I wanted tools and methods that constrained the modelling process. The virtual reality application Blocks

provided such a tool. Working with basic geometric shapes and a limited set of tools for editing geometry, I was able to model most objects found in each scene. There was an added benefit to using a VR application for modelling. From within Blocks, I was able to preview the scale and shape of each object as it would appear in the virtual world directly using a head mounted display. Throughout the production process, this became a way to quickly check the feel of an object, or to rough out a space and conceptualize the spatial relationship of the room.



Figure 2 - The user interface of the Blocks VR modeling application. The model of a computer console is at a 1:1 scale with the user. (Wargames Console © Neal Tyler Heaton, 2019)

Producing a virtual reality world accomplishes two principle tasks. Firstly, the environments and objects could be fashioned in any way that I wanted because they are digital. As

Lev Manovich describes, a primary property of new media is that it is digital and digital is mutable.²⁰ This flexibility affords customization of the story world, and in a manner that is feasible. As a physical installation, *Story/Space* would have been an environment complete with forest, caverns, rooms without doors, and stacks of computers for immersants to wander through. Using virtual reality, I was able to build something not feasible on my budget or within the constraints of space and time. Based on the DICE acronym coined by Jeremy Bailenson at the Stanford Virtual Human Interaction Lab, it follows an established axiom: if it is too dangerous, impossible, counterproductive or too expensive, virtual reality is a solution.²¹ Secondly the digital story world is explored by moving through the virtual spaces. Translation of physical and virtual self is a key component of the narrative experience. It is a metaphor for the emotional state I experienced at the time of the event. This method of mediation and interaction offers a new kind of presence that is important to the overall experience. Through the heightened sense of presence felt in virtual reality, I am challenging the presence effect of earlier media that situated the audience as

²⁰ Lev Manovich, *The Language of New Media* (Cambridge: MIT Press, 2001).

²¹ Pamela Hogle, "Dice Guides Decision on When and Why to Use Vr for Training," (2019).

observers, and instead pulling them in as participants in the memory. The work creates a melding of child-like thought, through sensory details of the virtual world, with adult comprehension.

Visual Design

The visual design element of *Story/Space* encompasses several aspects. First is the visual style of the virtual world. When considering the story, I wanted to create the world in a style that was reminiscent of childhood and memory—nostalgic, simple and imperfect. I decided on a visual style called low poly.²² Low poly, or polygon—referring to the points and lines that are used to create shapes in computer graphics—has gained popularity as a visual style in the games development²³ and graphic design fields over the last decade as a “retro” style that recalls the constrained look of early 3D computer graphics, when hardware was only able to render simple shapes, colours and

²² "What's the Deal with Low Poly Art?," Notes on Design (Website), 2015, accessed September 4, 2020, <https://www.sessions.edu/notes-on-design/whats-the-deal-with-low-poly-art/#:~:text=Simple%20geometric%20shapes%20placed%20side,early%20days%20of%203D%20animation.>

²³ "Why Are So Many Devs Employing a Retro Low-Poly Mid-1990s Aesthetic? ". Gamasutra.com, 2016, https://www.gamasutra.com/view/news/273904/Why_are_so_many_devs_employing_a_retro_lowpoly_mid1990s_aesthetic.php.

animations.²⁴ In the beginnings of consumer-based VR experiences that ran on smartphones, reduced polygon modelling was necessary due to the lower power CPU and GPU available in these devices to render the graphics. The low poly visual style was often used in these experiences for both its distinctive look and graphics efficiency. Low polygon modelling is a technique often used to achieve optimization in computer graphics. I employed this modelling technique in the creation of my models, but without adding textures or surface detail, which is commonly paired with low polygon models to give them a higher fidelity appearance.

In *Story/Space* the basic forms are intended to connect the immersant to the mindset of a child, who sees the world as blocks and blobs, where computer systems are boxes with lighted windows rather than complex electronics. Though my deliberate distortion of trees, rocks, vehicles, and computers, these objects appear as faceted caricatures of their real-life referents. Throughout *Story/Space*, low poly style objects appear exaggerated, and I have used a limited colour palette to highlight this perspective. The simplicity of their surfaces and geometry reflects the limited comprehension of each object's inner workings. The low

²⁴ W. Zhang, S. Xiao, and X. Shi, "Low-Poly Style Image and Video Processing" (paper presented at the 2015 International Conference on Systems, Signals and Image Processing (IWSSIP), 10-12 Sept. 2015 2015).

poly style does not lack detail, rather it reframes it in a way that communicates the referent in a whimsical manner.

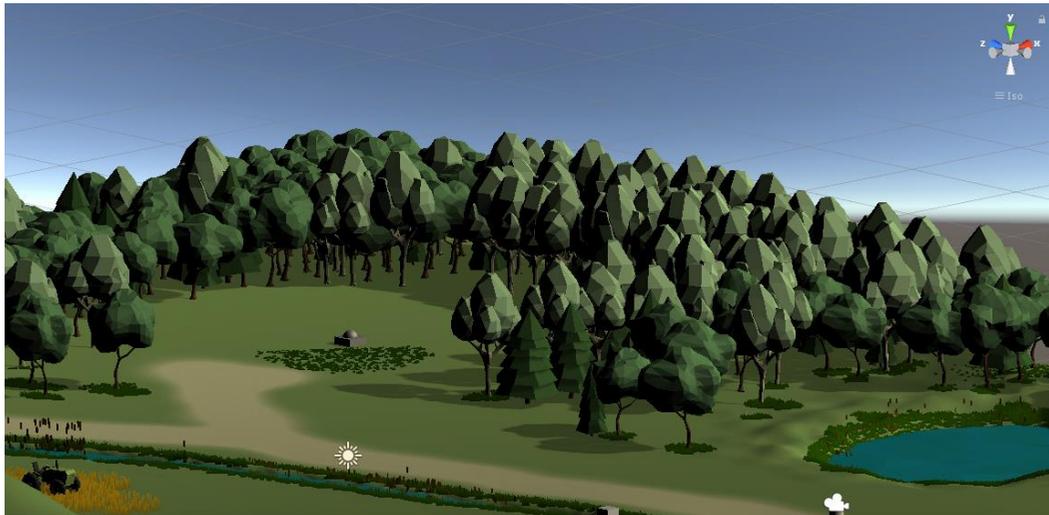


Figure 3 - The Imaginary Grove, a bird's-eye view of the opening scene of Story/Space. The visual style is low poly. (© Neal Tyler Heaton, 2019)

So, it would seem that despite trends in computer graphics and assumptions that tie the idea of presence to a high degree of verisimilitude, the initial impression of presence in a scene can be created with a low level of visual fidelity. As I had experienced in the HTC Vive demonstration of the penthouse apartment, objects with basic textures, colour, shape, and spatial arrangement can create a convincing sense of presence. This choice allowed me to focus my visual design around the low poly style and production techniques—using Blocks VR to model content—that I had been exploring, while maintaining the sense

of presence for the narrative, being the primary goal of the experience.

The minimalist aesthetic did not diminish the importance of object detail as it related to storytelling. Treating the overall scene as a caricature, elements were highlighted for narrative impact. Objects in the scenes were chosen and created to communicate aspects of the events as they were, and as I aspired them to be. For example, the fence line, the tractor, and the wheat field place the events in a rural farming community. Along with the cattails and canal ditch running through the landscape, they create a setting that is idyllically agrarian. Without these details, the trees, rocks and grass could have just as easily placed the story in a forest without the biographical background of my experience. As the participant moves to the penultimate space and climax of the story, the computers that are scattered about the underground base use actual 1980s personal computers as reference. Combined with the low poly style, which already evokes feelings of nostalgia, the dated computers situate the events of the story in a particular decade.

To increase the sense of presence, content needs to attract the attention of the viewer.²⁵ In the early stages of planning and

²⁵ Coelho, Carlos et al. "Media Presence and Inner Presence: The Sense of Presence in Virtual Reality Technologies." In From Communication to

design it was paramount to this experience that it should not be a technical demonstration of the affordances of virtual reality technology. It was to be an exploration of the use of a technology and the resulting medium to expand narrative potential. The objects that populated my virtual world are not gratuitous; they have contextual meaning described through geometric detail, light and shading.

Sound Design

One of my first attempts at creating a virtual reality space was to solve some technical issues related to sound propagation in the scene. Using the Unity game engine, I was investigating the way audio sources were perceived through the VR HMD in relation to head position or the movement of the immersant through the space. Early prototypes were basic scenes with tables full of objects, some of which played sound, an important distinction from score and ambient sounds, considering that in a digital environment the sound can emanate from anywhere. It was crucial to me that the sound come from the object that it was logically linked to just as it would in the physical world. This connection affords authenticity, as it confirms the immersants expectations of a physical object or environment. Another piece

Presence, edited by G. Riva et al. Amsterdam, Netherlands: IOS Press, 2006.

to this experiment was that the sound moved with the object—in this instance a simple radio—as the immersant moved within the space or moved the object around their head. A tangible sensation of localization came from the audio source’s subtle spatial cues. The space came alive in the virtual reality headset. Sound created a depth and realism to the space that was not present with just the visuals.

In a later experience titled Picnic²⁶, I deliberately created two versions of the same visual scene in order to test the effect of audio on the audience. In one version the audio was stereo and did not respond to the immersant’s head movement. I refer to this as stereo-headlocked. It is much like wearing a pair of headphones while in the virtual world that played a soundtrack of the space. All the sounds in the scene passed to the listener without localization or changes due to movement. The immersant became the locus of the sound reception, and as they moved, that locus moved with them. In the second version of the space I attached sounds to objects and adjusted audio properties that made them respond to the immersant’s distance from the audio source and the orientation of their head, such as bugs buzzing

²⁶ Picnic was exhibited as part of my presentation on perceptual fidelity in virtual reality experiences during the 2017 Meeting of the Minds event at the University of Lethbridge.

around a bug zapper, birds in trees or the rippling sound of water moving over rocks. I asked immersants which experience felt more real. Their choices were based on seeing the same visual world but each with distinct audio propagation. Immersants almost unanimously chose the spatial audio experience as feeling more real. What was valuable of these early experiments is that they affirmed, for me, the effect of spatial audio on presence in the virtual world.

Using authentic arrangement and manipulation of audio to create a sense of presence allowed for more believability in the experience. When creating the illusion of space using sound it is vital that the audio behave according to the rules of physical sounds. There are three key properties of sound that must be approximated in the virtual world to create an authentic auditory experience.

Amplitude

This is how loud the listener perceives the sound to be and the rate at which that level increases or decreases relative to their distance from the source. As the immersant moves closer to the sound of a bird chirping in a tree, the expected effect is that the sound grows louder. If the sound stayed at a consistent level such as with the stereo-headlocked example, the perception of that sound would seem unnatural and perhaps jarring to the listener. This has a negative effect on presence as it draws awareness to the artificial propagation of the audio through the

digital interface. However, if the volume increases or decreases along a specified curve, the result is authentic and "realistic" because it mimics the perception of that sound in a physical environment for most listeners. In *Story/Space* this property is used to give the scenes a sense of volume—the dimensions of height, width and depth—that convinces the immersant that the space truly exists around them.

Frequency

Along with the change in perceived loudness, sounds also undergo attenuation and transmission, a change in perceived frequency as the source increases or decreases in distance or as the sound propagates through different media respectively. Higher frequencies will fall-off at a faster rate or be absorbed or reflected by materials. Lower frequencies tend to remain present over distance or transmitted through various media. In a virtual reality auditory experience this means that the quality of the sound will change in relation to the immersant. Except for pure tones, sounds are a complex combination of frequencies. The perception of their quality varies greatly relative to the listening environment. To create an authentic auditory experience in virtual reality it is critical to replicate the physical properties and behavior of sound.

Reflection

The way that sound bounces off some surfaces and is absorbed by others gives auditory cues about the size and composition of a space. In *Story/Space*, these physical properties of sound were modeled through the game engine software to give the spaces a realistic feel. The Unity game engine, along with additional software plug-ins made specifically for processing spatial audio, afford this structuring of authentic sound listening.

In *Story/Space* I used the same sound design approach as *Picnic* to add depth and texture to the virtual world. I brought it to life by adding the familiar, both in terms of sounds that one would expect, given the visual cues, but also in the way that they are arranged in the space and respond to the immersant. Spatializing the audio creates a natural sound environment.

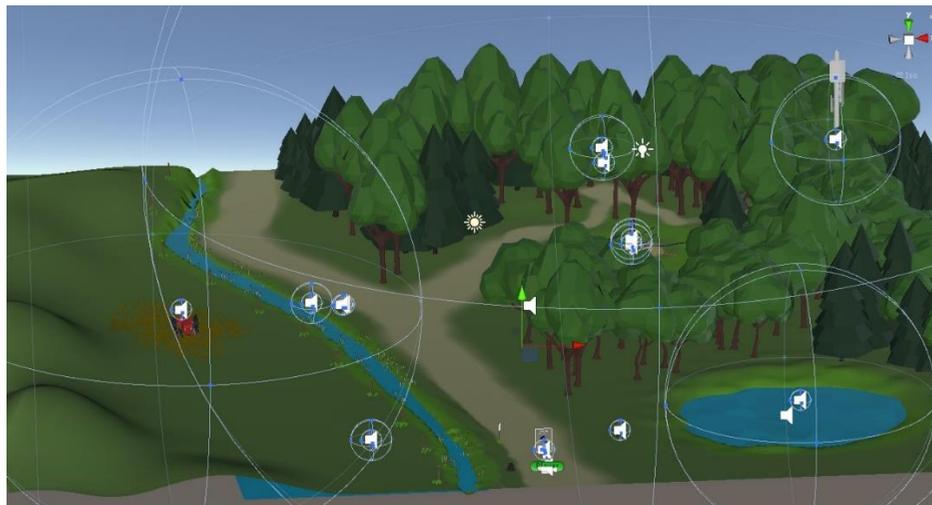


Figure 4 - A screen capture of the project from within the Unity editor. This image shows the audio sources and the valences that indicate distance and falloff of the sounds. (© Neal Tyler Heaton, 2020)

Additionally, I was selective about the types of sources used in each space to give it authenticity and to connect the virtual world to my memory. For example, the bird calls heard near the canal ditch are the red winged blackbird. This is a bird common to the prairies where I grew up and one of my favourite birds. Thus, the sound is authentic and enriches the narrative environment with auditory stimuli and is relative to the story in a way that is deeply meaningful to the storyteller. Without discussion of these facts in the experience proper, one may question how the immersant is supposed to know or understand their significance? This point is one I will discuss later.

Interaction Design

Story/Space is designed to explore the narrative impact of presence and the transformation of space to place. Through participation in the space the immersant has a role to play in that conversion. The story is told through interaction with the virtual world. This is done through several means.

Movement

The first is navigation. That act of moving from point to point within the space unlocks story events. Like page turning of a spatial book, as the immersants explores the dimensions of the virtual world, they move the story timeline. However, this movement is not linear in the sense of cinema or a novel. Rather it is an interconnected web of story moments more akin to an open

world video game or branching hypertext fiction. Each time the immersant enters and interacts with the virtual world, there is the potential for a new path or combination of the story moments. For example, in one session of the experience an immersant may choose to go past the pond, through the woods and to the antenna before arriving at the hatch. Marie-Laure Ryan describes a form of interactivity called The Network.

In this architecture, the reader's movements are neither completely free, since they depend on links, nor limited to a single course. The formal characteristic of a network is that it contains circuits and consequently allows nodes to be accessed through different routes.

Marie-Laure Ryan, *Narrative as Virtual Reality* 2²⁷

Speaking within the context of hypertext fiction, Ryan's nodes represent webpages, and the course between them are hyperlinks. In *Story/Space* the nodes are each of the moments of divergent interaction. They are spatial positions that have distinct options for action or sensory stimulation. Though each path ultimately arrives at the same destination, the order in which each node is encountered creates variation in the narrative structure.

²⁷ Marie-Laure Ryan, *Narrative as Virtual Reality 2: Revisiting Immersion and Interactivity in Literature and Electronic Media* (Baltimore, MD, USA: Johns Hopkins University Press, 2015).

The creation of the four spaces—The Imaginary Grove, the Liminal Void, the Cortex and the Fireside—is tied tightly to an unfolding of specific events which reconstruct a new telling of this memory. The story moments reveal narrative details. Their placement within spaces encourages exploration. The walkie talkie in the Imaginary Grove, the orbs in the Liminal Space and the speakers in the Cortex become unifying elements that connect the immersant to the story events through audio while also giving them the agency to navigate the space in their own time and direction. They act as a diegetic narrator. Similar devices are used frequently in interactive fiction. In the VR game *The Gallery: Call of the Starseed* (Cloudhead Games, 2018), the player is given narrative clues by way of a tape player and cassettes scattered throughout the virtual world. Upon discovering the narrative details contained on each tape, the player is encouraged to seek out more cassettes to further unravel the story. It is only through meticulous searching and interaction with the virtual world that the complete story is reconstructed. In this way the narration is a diegetic element rather than an external voice that can disrupt the immersion of the VR experience, and exploration of the world becomes an essential function of the narrative. Without the spatial dimension and depth of the 3D environment, combined with the interactive affordances of the medium, the story could not be told with the same impact. Simply listening to the audio played back in a

linear fashion would not engage the immersant in the same sense consuming manner.

Object interaction

To engage the immersant in the narrative world, there are points of action scattered throughout the space. The purpose of these moments is two-fold: to help move the story forward, such as the opening of the hatch, or clicking of keyboards, and to aid the immersant in feeling like they were a part of the story world. A design strategy that I used to enhance immersion was to employ only gross motor movements. These large movements such as throwing rocks or the lifting of the hatch door, encourage the immersant to move in ways that are similar to the physical world. Avoiding interactions that require pressing controller buttons to activate an object, for example opening a door, actions take on a familiarity and mediation recedes.

With visual design, sound design and interaction design, there was a matter of finding a balance to create a sense of presence in the virtual world while staying true to the story. I could not focus solely on any one element hoping that it would carry the immersant through the experience. While I favour sound design's strong influence on the perception of space, to abandon shape and detail, or ignore movement and interaction would be not have been appropriate in the creation of this work. A holistic approach to designing the virtual reality experience results in a

convincing and authentic feeling world; one that works as a foundation for storytelling using the environment.

Environmental storytelling

To aid in converting space to place, I use what I call moments of divergent interaction to invite of the exploration of the narrative content. These are spatially positioned actions or stimuli that do not have a specific order. Rather, they are intended to give narrative variety without redirecting the overall sequence of events. The narrative purpose of these moments is to give each immersant a slightly different experience of the story through freedom in the virtual world to explore and interact with the content, be it stopping to listen to bird song at the irrigation ditch, throwing rocks at the tractor, or scattering paper around the Cortex. Each of these moments imparts details which add to the individual construction of the story experience.

In *Story/Space*, the environment hints at meaning without being explicit. For example, the treehouse in the woods invites further investigation (yet there is no vocal or written narration that explains its meaning). It is something both expected and unexpected. It matches the narrative context of a child's journey. It is reminiscent of the carefree summers of youth where play and leisure dominated the day's itinerary. Like the world in which it has been placed, it is a structure that is built from the necessity to fulfill imagination. It is also abandoned, and inaccessible other than to observe it from a distance. The treehouse, like carefree youth, has been forgotten. It evokes

feelings of nostalgia, perhaps joy, or sorrow. That is open to everyone's interpretation. Through these immersive encounters and interactions with the story world, the space is converted to a place. New experience brings new meaning. The meaning of each encounter is formed by a fusing of the immersant's past experiences, the qualities of the current interaction, and author's expression through media.



Figure 5 - The treehouse is viewable from the ground but inaccessible. (© Neal Tyler Heaton, 2020)

Each scene in *Story/Space* carries additional narrative meaning in the visual details and auditory scenery delivered through the VR HMD. The Imaginary Grove is the introduction to the virtual story world. It institutes the ground rules for movement and interaction in the experience and sets expectations of the visual and auditory style. While serving this technical function, the digital vista also establishes the narrative

setting. A green rural landscape ringed by trees and cattails, with the sounds of an irrigation ditch and distant tractors, the Imaginary Grove situates the immersant in an agricultural location. The openness of the scene speaks to the loosely contained potential of imagination—the “anything is possible” mantra of ecstatic youth. The sharply cut edges of the virtual world represent a moment carved out of time and placed like a diorama on display. The boundaries signify that the immersant will engage with a singular memory that is only a small part of a broader world of life experience.

The Liminal Void is a transitional corridor from the familiar woods and fields of the Imaginary Grove to the caricatured Cortex room, with its exaggerated stacks of personal computers, heavy industrial ambience and enclosed area. It is a darker, dreamlike void with undefined boundaries. An environment that at first pass could feel unsettling, it is populated with the comforting sounds of wind chimes, a metaphor for my mother calling me home.

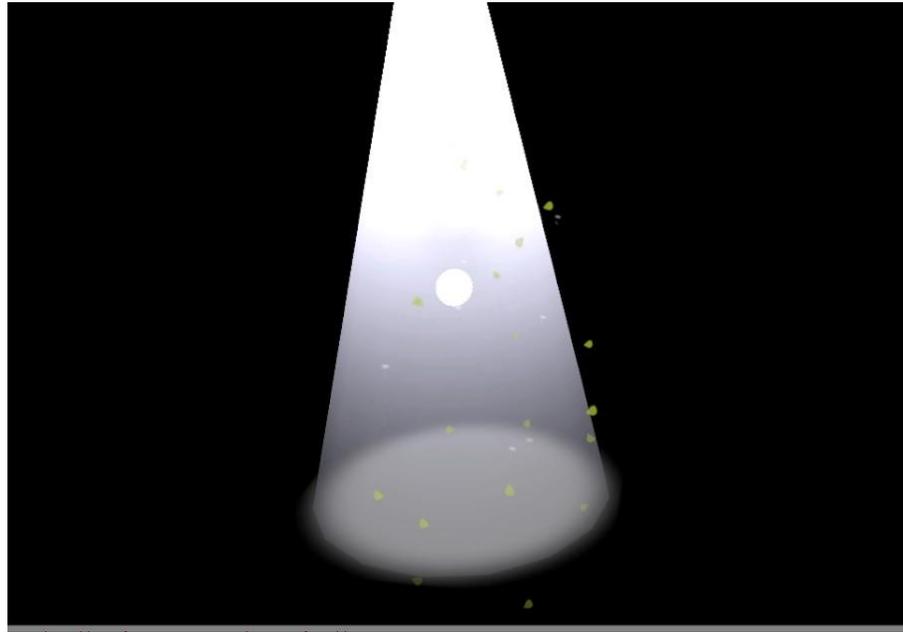


Figure 6 - The Liminal Void, while at first unsettling, offers comforts that reflect the author's childhood home. (© Neal Tyler Heaton, 2020)

The Cortex is the deepest part of story, both in a spatial sense and in a narratological sense. The confined space, cluttered with computers and old file boxes, represents my mind. It is the seat of imagination. The source of the fabrication. Both the beginning and end of the journey. The vintage personal computers relate the setting to the decade of my childhood. They are modelled after the machines which would have graced the shelves of Radio Shack and the desks of teenage computers hackers in popular films. The large console itself a direct reference to terminals used in the film *Wargames* (1983). The mechanical soundscape mimics biological rhythms; the eb and flow of blood

through the veins, the steady in and out of breath through the lungs.



Figure 7 - The Cortex represents the climax of the story. It is the goal of the journey and the deepest location, both spatially and narratively. (© Neal Tyler Heaton, 2020)



Figure 8 - The Fireside is the final scene. It offers a less fantastic version of the physical setting of Story/Space. (© Neal Tyler Heaton, 2020)

The final scene shakes itself free of all the imaginary elements of the story and returns to the "real world". At the conclusion of the narrative experience, the Fireside brings the immersant back to a familiar space; it is a place that they have visited before in the opening scene, and it also contains elements that would be expected in a similar physical setting. The calm scene affords a moment of quiet reflection. It is a metaphor for the mature contemplation that I underwent while making this project. It is the final resolution of the old memory with a bold perspective; one that sees the virtual and imagination as more than flights of fancy, but as the precursor to new and innovative ways of expressing ideas, dreams, solutions and stories.

Conclusion

In *Story/Space*, the interplay of the actual and the virtual presented in virtual reality is a similitude of the resolution of my childhood embarrassment, brought on by this moment of exuberant deception, through contemporary reflections on the nature of reality. I was able to bring to life the imagined reality that was key that past experience, to be engaged with in a visceral way that created new positive memories; memories that now include a "real" space and experience. It is through virtual reality technology—its details and affordances--that such a resolution was possible. Through creating an explorable story world and conceptualizing space as a narrator, I suggest that virtual reality technology and the accompanying medium are challenging authors to reimagine the roll of the audience in the narrative experience. Sense of presence is an essential phenomenon to this new narrative paradigm. Achieved through focused design practices—visual design, interaction design and sound design—presence in immersive virtual worlds will connect immersants to the story, allowing them to feel more a part of the story world, and giving them a deep narrative purpose that is participatory rather than observational.

In *Story/Space*, I conceptualized the space as a narrator. To illustrate how the design elements of the experience contribute to the "space as narrator" concept, I will refer to an example of the red winged blackbird call found in the Imaginary

Grove. The question remains how moments of divergent interaction become meaningful to the immersant? The bird song makes the space feel more authentic, due to its volume and positioning. Whether the immersant finds the bird call pleasing, distracting, or outright unpleasant makes it part of their memory of the experience. Their reaction to the audio could come from a variety of unknown predispositions. The bird call creates a point of divergence within the narrative space for the immersant without explicitly breaking the linear story events. Therefore, what is a part of my memory becomes a part of theirs even though its meaning is not the explicitly the same. I recall the bird call fondly because of the positive association with where I grew up. I also associate its presence in that scene with the negative memory because of the events that followed. The bird call is intended to enhance the spatial presence of the moment and add interest to the scene, while holding meaning for the author. How the immersant receives it is unpredictable, yet it is this variable state that makes the moment interesting from a storytelling perspective. The virtual environment holds the possibility of shared experience but does not expect shared significance. This does not suggest that the meaning is not present or that it is insignificant. Rather it suggests that the immersant can find new meaning within a shared context. The shared context is presented as the story world. The space creates the potential for new meaning and in so doing it is converted

from space to place. The virtual environment performs its role as a communication medium activated by the immersant, and the virtual reality technology allowed me a more immersive way to present this content.

Virtual reality as a storytelling medium is expanding narrative potential using spatial media, sense of presence, full body participation, programmable interaction and agency. It is made possible through the affordances of virtual reality as a set of technologies. It is realized through the design of experiences where the goal of the storyteller is immersion and interaction with the story world to involve the immersant in the telling, creating a sense of narrative presence. Virtual reality narrative relies on the conversion of space as a container of story events to a place full of meaning through moments of divergent interaction. The immersant becomes co-narrator of the story through a new perspective that does not merely observe the story, but as Ryan suggests, helps to create it. In its current state, virtual reality takes advantage of the power of digital production--it can be changed with relative ease and in response to immersant interaction such as data input or direct manipulation of objects.

I have enjoyed working with virtual reality as a transportive medium that ponders what is possible by experiencing the seemingly impossible. For me, *Story/Space* is the beginning to a new way of looking at authorship and experience design. I look

forward to expanding the narrative possibilities of all spaces,
both virtual and actual.

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