Meaning and Emplacement in Expressive Immersive Virtual Environments

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Supplemental volume of the author's virtual environments, including DVD documentation, accompanies this thesis as a separate binding.

Abstract

This thesis focuses on Virtual Reality, specifically on fully immersive VR environments made as Art. I explicate how immersive virtual environments (VEs) differ uniquely in form and function from other digital media or 'cybermedia.' I explain the intrinsic qualities of 'being' in immersive VEs, and how this impacts the experience of the embodied person in the experience. I discuss the inherent spatial qualities of immersive virtual environments and their effect on the embodied person. Finally, I ask if it is possible to identify and demonstrate a primary set of procedures for a new methodology artists could use to create meaningful immersive environments for participants in art gallery settings.

I look at my own work—the virtual environments *Virtopia*, *DarkCon*, and *Memory Stairs*—as well of that of other artists, to support these concepts. My qualitative analysis required an extensive initial survey of the field, as many works are not well documented. My findings are summarized in Appendix B: Chart of Artistic VEs. This survey also revealed that women designed the majority of these works. Feminist theory provides some insights to this phenomenon, as does modern neuroscience.

I maintain the fundamental constitution of VEs is not always a story, but often the more basic idea of the experience, which we later aggregate into our life narrative. I look to a rich legacy of ritual theory to support the use of Virtual Environments to facilitate meaningful and embodied personal experiences.

This thesis locates its primary arguments in Art and Virtual Reality. Cognate disciplines supporting my work include Cognitive Science, Neuroscience, and Perceptual Science (covering many senses), Psychology, Spatial Theory, and Phenomenology—especially Embodiment. Feminist critics contribute to my understanding of those who create these works, and why, and lastly Ritual Studies support my views concerning the potential meaningful nature of VE content.

Acknowledgements

This work was written while I was employed as a Senior Researcher at the Institute for Creative Technology (ICT), at the University of Southern California. I am grateful to the ICT for providing a suitable base to develop the *DarkCon* and *Memory Stairs* virtual art works, the olfactory scent collar and related aspects of my original VE tools, and for supporting my team in assisting on some aspects of the implementation of these two large practical projects.

My colleagues at ICT have contributed greatly to the practical delivery of my VE artworks. However, the works presented and the theoretical ideas expressed in the thesis are entirely my own. I would especially like to acknowledge the amazing amount of support and inspiration from Josh Williams, whose innovative ideas and good humour sustained me on a daily basis. The work of creating immersive virtual environments is a large undertaking, and I could not have accomplished *DarkCon* and *Memory Stairs* to the extent I did without my highly competent teams. My immediate colleagues and collaborators in the early days who were instrumental in the practical implementation of the *DarkCon* environment include Kumar Iyer for programming; Kurosh Valanejad, David Milam, and Aimee Dozois for modelling, graphics, and animation; Donat-Pierre Luigi for technical and hardware support; Larry Tuch for scriptwriting; Ramy Sadek and Dave Miraglia for sound work, and Bill Giorgio for video editing support. All provided excellent suggestions for the practical work, and made for a stimulating working environment at ICT.

Aimee Dozois, David Milam, Jared Leshin, Jeff Lund, and Bradley Newman assisted me on the creation of *The Memory Stairs* art assets. Audio for *The Memory Stairs* was created under my guidance by George Peterson. Sean Bouchard provided dedicated continued programming support. My work benefited from their responsiveness as I explained my vision and my goals for my virtual environment designs and pushed ideas that were challenging to realise.

Early on I was also fortunate to be able to discuss ideas with Jay Douglas, whose own thesis was a beacon for me to follow. My ICT colleagues from the beginning, Paul Debevec, Diane Piepol, and Laurie Swanson, were at most a floor away, and always available for discussions when needed. Sharon Ghamari-Tabrizi, during her stay at ICT, was a friend and a mentor, and I am grateful for her guidance in how to approach writing a work of this size. More recently the encouragement and intellectual stimulation of Sean Bouchard, Danielle Ilan, Jamie Antonisse, Martin van Velsen, Dr. Skip Rizzo, and Mark Bolas have been invaluable.

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The faculty and students at SMARTlab (both at Central Saint Martins 2001-5 and at UEL 2005-7) provided a wealth of academic support and feedback at critical stages of the thesis project. My work was both informed and inspired by their many penetrating questions and thoughtful suggestions.

I am also grateful to the amazing collaborative SMARTlab community, most especially to Dr. Celia Pearce and my fellow SMARTgals and guys, especially Sara Diamond, ANne Nigten, Sher Doruff, Mary Flanagan, Anna Birch, Axle Vogelsang, Gayil Nalls, David Furlow, Daria Dorish, and Cheryl L'Hirondelle. Chrissie Poulter deserves extra thanks for providing a creative and welcoming place for me to write in the final stages of this work. And I cannot forget the rest of the creative SMARTlab team, past and present, who have been so helpful

along the way: Taey Kim, Joy Barrett, Jana Reidel, Clilly Castiglia, Alex Hyde, and Sol Haring.

Many of the ideas for this thesis were vetted in a weekly seminar, *Narrative Unlimited*, hosted by myself and Celia Pearce throughout our PhD time together. I am indebted to the steadfast attendees and special visitors who were part of the *Narrative Unlimited* group, as their contributions to the discussions kept the level of excitement over ideas quite high and stimulating. I especially wish to thank Alex and Judy Singer, Richard Kahlenberg, Josh Williams, Martin van Velsen, and Kate LaBore in this regard.

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I would also like to thank the many artists and audiences who have viewed and commented on my work over the years. It is their interactions and reactions that make creating this art meaningful and rewarding.

Finally, and most especially, I would like to thank my amazing family: Rob, Nan, Amy, John, Katelyn, Sebastian, and Simone, who saw first hand my endless hours of typing, reading, printing, and organizing. Above all I am grateful to my husband Robbie, who kept the world at bay and the good thoughts surrounding me throughout.

Artist's statement

As we, like the proverbial angels, keep being blown backwards by rapid winds into the future, how can we be sure that we know where we are going? Will our progress into the ever-increasingly technological future compromise the softer aspects of our human nature? Or, will such aspects become more important as we surround ourselves with the codified strata of machines, from mega down to nano scale?

I favour this latter view. Technological tools, used for everyday needs like communication, enhancements, extensions, increasing longevity, recreation, and art, have the power to make life better, enhance our mental capacity and physical capabilities, take us other places, and enrich our lives. The paradise that one can envision technology enabling may come to pass, though we may need to take care to remember to breathe spirit into technology's nascent promises. By this I mean fashioning the tools of technology and forming their content in ways that celebrate and allow us to nurture the essences of our human nature.

Often, especially in academic discourse, we attempt to reduce things to abstractions in order to better understand and categorize ideas into philosophies, principles, or systems. The key to being human is still, however, grounded in original experience, in the fullness of what is directly happening to a person. Direct experience means being subsumed in an immediate reality, not an abstraction of that reality. Experience, once encapsulated into language, becomes removed from our self, and becomes something else. As an artist, I am compelled to create in order to provide others with original experiences. Technology allows me to conjure imaginary worlds that others can experience as real. If I can thus compel the fabric of technology to form what I envision, as opposed to simply permitting whatever it does easily, my art will serve to amplify, ennoble, and even humanise the future course of technology.

Statement of originality

Creating a virtual environment is, of necessity, a collaborative venture. I have been fortunate to work with many exceptionally talented people over the years, as I have designed immersive virtual environments—the practice upon which this thesis is based. While I am myself skilled in programming, modelling, animation, texturing, and video production, I find working with a talented crew is not only much more efficient, it also fits my style of mentoring others into the techniques of making immersive VEs.

All the designs in the personal work I present in this thesis are my own. While I work closely with my collaborators, I am responsible for every aspect of each project. With my programming colleagues I suggest how to code certain functions, and help trouble-shoot and debug when things go wrong, as they inevitably will. I design every object within the worlds myself, as well as the layout of the space, and the range of actions that can take place there. I have personally shot, processed, and edited all of the video work used within the immersive environments, as well as much of the texture work. The auditory environments have been done under my direct supervision, and I have been exacting with my designs for ambient, environmental sounds, as well as for the spatialised sounds attached to specific objects and events in the VE. The infrasonic sound used for virtual reality is an original idea of mine, and the infrasonic emotional score was done, again, under my detailed direction, as was the fabrication and design of the infrasound floor. The scent collar is also my original idea, and I oversaw the production of three iterations of the collar during this thesis (the resulting patent is therefore in my name). Finally, I personally mixed each of the scent combinations used in *DarkCon* and *The Memory Stairs* VE projects, going to great lengths to search out and obtain the best olfactory elements from around the world to create my intended effects.

In addition, the arguments in this thesis are wholly mine, informed by my nearly twenty years of practice in virtual environments as well as my extensive readings on topics surrounding virtual reality. I am

appreciative of those authors who have, over the years, written about the virtual reality phenomenon, especially Doug MacLeod and MaryAnn Mosher, who so thoroughly documented the amazing years of the legendary Banff Centre's Art and Virtual Reality Project. Writings by Michael Benedikt, Frank Biocca, Meredith Bricken, Erik Davis, Clive Fencott, Michael Heim, Ken Hillis, Roy Kalawsky, Brian Massumi, Mel Slater, Kay Stanney, and Margaret Wertheim have all contributed greatly to the emergence of virtual reality as a discipline in its own right.

I am indebted, as well, to a number of specific authors in my cognate disciplines. There is not space here to list them all, but I will mention a few key authors along with their disciplines as particularly influential.

Philosophers who have paved the way, often unknowingly, to the discourse surrounding immersive environments include the indomitable Maurice Merleau-Ponty, Jean Baudrillard, Henri Lefebvre, Don Idhe, George Lakoff and his associates, and feminist critics such as Hélène Cixous, who have brought about a more inclusive look at the nature of our world.

Neuroscientists Antonio Damasio, Gerald Edelman, Larry Cahill and colleagues, Fred Previc, Michael Gazzaniga, Joseph LeDoux, Daniel Schacter, VS Ramachandran, and Endel Tulving, have provided some of my most stimulating bedtime reading, no doubt allowing me to incorporate deeply, and perhaps subconsciously, their rich ideas into my own world view of virtual reality.

Notable sensory researchers include scent experts Trygg Engen and Diane Ackerman, as well as Linda Axel and Richard Buck (winners of the Nobel Prize for their breakthrough olfactory work).

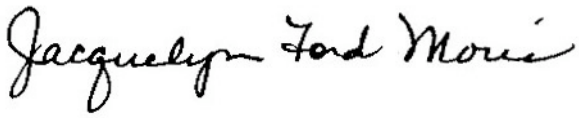
My understanding of the effects of auditory stimuli have been expanded by my readings of Mitch Gaynor, Fred Wightman, CS Harris and his excellent review of all infrasound experiments, and the University of Aalborg's Infrasound research department.

For visual perception I acknowledge the influences of James J. Gibson, Stephen Palmer, Tutis Villis, and for spatial theory, especially Fred Previc, Lars Qvortrup, Frances Downing, Christopher Tilley, and David Carr.

Finally, for my nascent understanding of the many manifestations and importance of ritual, including its overlap with neurology, I have been enriched by my readings of Arnold van Gennep, Victor Turner, Ronald Grimes, Roy Rappaport, Eugene d'Aquili, Barbara Lex, Robert St. Clair, and Cliff Guthrie.

I am beholden to all these authors and their excellent work, which has permitted me a rich springboard for the development of my unique thesis on meaningful immersive virtual environments. I hope my arguments can stand solidly alongside their excellent contributions to this emerging field.

Signed:



Date: September 10, 2007

List of illustrations in the text

Introduction

This thesis studies the unique new discipline, which I refer to as *Expressive Immersive Virtual Environments*.

As my Abstract to the thesis states, I take as my subject of study the VR (Virtual Reality) technology that was first developed in the mid-latter part of the 20th century. That work in VR is now reasonably well known and widely studied. It was created primarily by computer scientists and has been used in a variety of situations over the past few decades, but primarily in training scenarios (whether for the military or for skills training demonstrations for the general public) and latterly also in entertainment settings (theme parks et al.). Most recently, some exploratory work has been done in using VR in medical and healing environments, an area ripe for further study and implementation.

In this thesis, however, I do not focus so much on VR as on its sequent, more developed form: the VE, or Virtual Environment, described here as a three-dimensional construct that can be experienced in place of the real world by substituting normal sensory inputs with those generated via the computer. Further, I am primarily interested in artistic forms of virtual environments that are fully immersive.

My research is practice-based: it has been developed over the course of nearly two decades of my own first hand observation and involvement in the making and testing of immersive environments. I have adapted this expertise to a focused period of study in which I applied and expanded the previous decade's knowledge to the creation of a specialist set of artist-made VEs, created specifically for this thesis. I set out in 2001, when the PhD began, to apply my training as an artist to the making of VEs, and to study the aesthetic and kinaesthetic affects of VE on the general public (as in the participants of VE in an art gallery setting) rather than in the more clinical settings of VR labs.

This thesis sets out to address four primary research questions:

1. In what ways do immersive VE (Virtual Environments) differ in form and function from other types of digital media or 'cybermedia'?

2. What are the intrinsic ontological qualities of immersive Virtual Environments, and how do they impact upon the experience of the embodied person in the environment?

3. What are the spatial qualities of immersive virtual environments and how do they impact the experience of the embodied person in the environment that can be identified as unique to the VE experience, such as embodied space and sensory gestalts?

4. Is it possible to identify, define, articulate, and demonstrate a primary set of procedures for a new methodology that artists could use to create meaningful immersive environments and experiences for participants in art gallery settings?

I address these questions in detail in these pages, and put forward an original argument based both on my years of practical work creating VR environments, and on the scholarly study of the theory and practice of the main artistic VR case studies in this field.

Selecting the case studies was a matter of careful consideration of the context of the making as well as a qualitative analysis of the works. While my focus is on works that are both artistic *and* immersive VR environments enabled by high-end VR equipment, it must be stated that the nature of the technology has, over the years, been out of reach of many artists who would actually prefer to work in the fully embodied VR. Therefore, of the works cited within this thesis, some will have been implemented in screen-based form, hereafter referred to as real-time 3D (or screen-based) virtual environments, or RT3DVEs. These are works that are done by artists and presented typically on very large screens, or wrap-around screens, often with glasses that enable stereo viewing. I have included those that are created with the spirit and design sensibilities of fully immersive VEs, even if their realisation cannot encompass full VR technology for various reasons.

It must also be said that many of the works discussed are difficult to find in the public record beyond a mere mention, and some not at all; unfortunately no complete database of artistic VE works exists. Thus, in this thesis, the qualitative analysis applied had to begin with an extensive survey of the field, and a consideration of works that made a major impact but that were not previously published, as well as those that have been more broadly covered. The material I have been able to find is summarized in my Comparative Chart of Artistic VEs in the Appendices to this dissertation. I have been fortunate to be able to have experienced perhaps a dozen of these works in person over the years, as well as many more Virtual Environments created for non-artistic applications.

While I can attest first hand to my arguments that this medium has strong affective powers, it has been extremely satisfying to find ample evidence through my research that this is so. No other computer-based medium allows one to enter within the digital sanctuary in an embodied form. Besides bringing the sensory elements to a private and personal level, immersive VEs exclude the visuals of the real world, forming an insulated space where the simulated world can play out, unencumbered by reality.

Phenomenological embodiment within VEs arises from the use of the body within a spatial construct that, while virtual, surrounds the participant in three-dimensional space. It is the actions of the body itself in that space that are the causation of change, movement and progression. Thus VEs offer fundamentally different interactive capabilities than any similar content presented on a flat display screen. Consequently they are able to affect a person in a more direct and intimate manner. Recent neurological research points to the importance of the body in cognitive processes and such findings are supporting new understandings of the potential for virtual environments.[1]

The thesis also proposes that the fundamental constitution of such digitally mediated environments is not the story, as much modern research has postulated (See for example (Ryan 2002) (Louchart and

Aylett 2003) (Jenkins 2004) and (Murray 1997)), but rather the more atomic notion of the experience. Experiences are the core events that ultimately become aggregated within our memories into the stories we tell. It is to offering just such experiences that virtual environments are uniquely suited.

Unlike earlier theorists, I do not see the computer as theatre or as a form of narrative or even as mechanism for the phenomenon of role-playing as it exists in (mostly male gendered) computer games.[2] While the computer can indeed be used in these ways, I suggest that VEs are fundamentally different from other modern forms of cybermedia, and that other approaches to explain it thus far, such as Brenda Laurel's *Computers as Theater* (1991) (though providing a convincing argument) do not provide the whole story. For immersive VEs, the primacy of *experience* is the key to understanding their ontological nature. It is, as Erik Davis remarks, a "world of participation." (Davis 1998: 174) I further qualify this by emphasizing the quality of meaning that a virtual experience possesses—how *meaningful* it is. I define *meaningful* as that quality of the experience space that is both cohesive and memorable.

Because of these intrinsic characteristics, fully immersive Virtual Environments are unique among cybermedia for personal, embodied experiences, and may be closer to theme parks, rituals, and sacraments than to any other contemporary media. These concepts also closely align VEs with Victor Turner's concepts of ritual and the *liminoid* over the *liminal* (Turner 1982) with potentially significant consequences for VE creation and construction. As such, I consider this medium a possible means to heal a mind-body rupture that began with the age of enlightenment, by engaging people not only through the mind but importantly, through the fully embodied person. I will explicate how the both the ontological and spatial natures of virtual environments support this full embodiment and provide a wealth of possibilities for how and what we can experience therein.

Recent research in virtual environments has shown that brain responses when people and animals experience VEs correspond with

brain responses to corresponding real world events. (Meehan et al. 2002) (Holscher et al. 2005) In other words, the sensory cues provided by a VE are experienced and mentally processed just as non-mediated (or "real") experiences are. The same brain areas are affected; the same physiological responses occur. We also experience the space of a virtual environment as something that is cognitively real, even though we know at some level we are within a virtual construct. This has untold repercussions for what virtual environments might ultimately be able to accomplish. Neuroscience researchers have found that certain brain changes occur in ritualistic states. As yet, I know of no studies that correlate brain functions of real world ritual experiences with those found in people experiencing similar virtual environments.

This may be due to the fact that memorable and meaningful virtual environments are still fairly rare. I explore several of the ones that have been made throughout the text, and analyze how they create the desired responses in their participants, or *experients*, as I prefer to call them. Perhaps not surprisingly, the majority of these works have been designed by women. Because of this, I examine how feminist thinking is closely overlaid with the creative sensibilities of virtual environments, which are about enabling a space of possibilities rather than more authoritarian presentations such as narrative story-telling, films and game-based media.

To support these ideas I relate examples from my own personal work and that of other artists in this medium over the last two decades. In particular, my practice in building the virtual environments *Virtopia*, *DarkCon* and *The Memory Stairs* (described in Chapters 1 and 2) serves to define a design methodology that supports creation of Virtual Environments as a unique form of cybermedia facilitating meaningful and embodied personal experiences. Within my practice I have strived to create immersive virtual environments to bring us in touch with that which makes us essentially human: our physical bodies, our feelings and our emotions. The potential virtual environments that lie dormant within the form of the medium can be conjured to stimulate and provoke, to guide us down delicate memory trails and poignant

recollections, to evoke feelings both transcendent and striking, and to reconnect to our embodied self.

Digital technologies have provided untapped new realms for creators. These unfolding spheres have stimulated fresh approaches to the creative process. New media tend to build on previously accepted forms, especially in their formative periods. Bolter and Grusin (1999) call this process of formulating creative ideas through homogenization of previous forms *remediation*. Eventually, however, a dialogue initiates among these borrowed forms that leads to something unique. This dialogue eventually motivates a new language—a specialized grammar—fine tuned to the emerging nature of the new medium. Such a grammar can take advantage of the distinctive qualities and potentials expressed or nascent within the media. I believe that the immersive environments thus far created (detailed throughout this thesis and in Appendix B) are beginning to both define that grammar and use it as the underlying structure for design. Chapter 6 presents a design methodology for this medium that I have derived from my own practice (mainly) as well as that of the other artists used as illustrations throughout the text.

This work locates its primary arguments in the fields of Art and Virtual Reality, which themselves comprise and are informed by several cognate disciplines. These include Cognitive Science, Neuroscience, and Perceptual Science, covering not only vision, but other senses as well: olfactory, haptic, and auditory, focussing on a holistic gestalt approach that has its basis in Psychology and the Philosophy of Embodiment. These two areas also elucidate the structure of being within an immersive space. Spatial theory informs the nature of space and place in the virtual environment. Feminist critics have contributed to my understanding of those who create these works, and why. Finally, ritual studies contribute greatly to my views concerning the meaningful nature of its content.

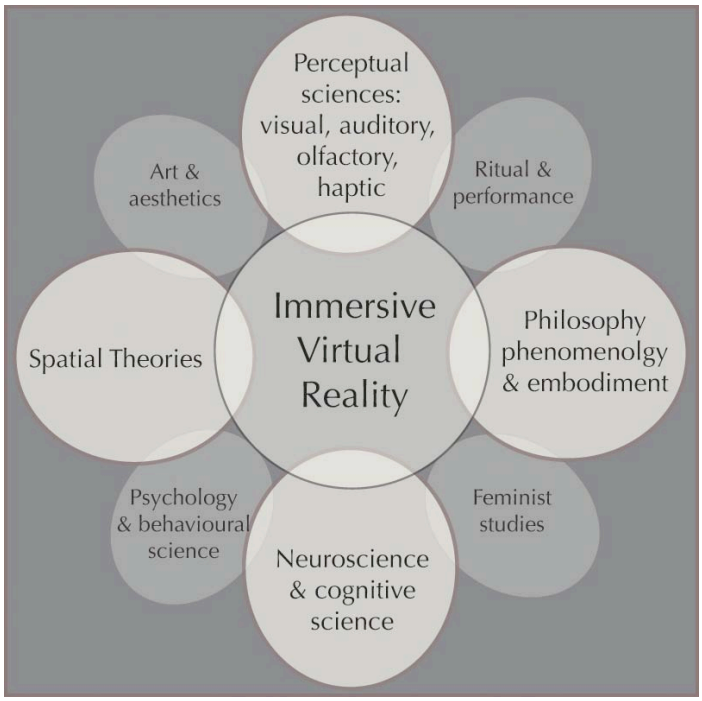


Diagram of thesis field and cognate disciplines

Clarification of terms

Before beginning subsequent sections I must further clarify some of the key terms used in the text. While terms of more general and largely agreed upon meaning are included in the Lexicon in the thesis Appendices, there are a few terms of such critical importance and centrality to this thesis that they must be discussed here.

Many words having to do with digital technologies have, over the last few decades, gained an extremely broad range of meanings. This is primarily due to the interdisciplinary purview and interest these areas have for diverse aspects of our society. The terms cyberspace, virtual reality, artificial reality, virtual worlds, virtual environments, immersion and presence each have different connotations depending on which academic tribe is using them.

Cyber, for example, is an all too convenient prefix to any word that needs to be associated with computers and technology. Its origin was as a prefix in Norbert Wiener's 1948 term "Cybernetics," which he based on the etymological translation of the Greek *cyber* as *steersman.* (cybernetics 1989) Weiner's cybernetics referred to the confluence of humans and machines within communication and control

mechanisms. It now finds its way into a wide range of modern terminologies. Its use in the term "cyberspace" is especially confusing. William Gibson, who coined the term in his early-1980's post-apocalyptic science fiction stories, *Burning Chrome* (1982) and *Neuromancer* (1984), has become the unwitting father of the word, which is conflated with all manner of computer driven media, from text-based chat to the World Wide Web. It is also used as a synonym for virtual reality, virtual worlds, and virtual environments. As such "cyberspace" could be seen as an overarching term that encompasses all such media, and I will also use it in that context on occasion. It may be seen in other contexts within this work, especially in the quotes of others who may be referring to alternative meanings of the term. I will begin such quotes by clarifying the appropriate intent when necessary.

Virtual Reality, or *VR,* is a term coined in the mid-1980s by Jaron Lanier, an early technology visionary and founder of one of the first companies to produce gear that supported computer mediated encounters in simulations. It was the winning competitor to another designation coined by Myron Krueger, that of *Artificial Reality*. Krueger's work in the 1960s and 70s also focused on creating environments delivered by a computer and inhabitable by human visitors, but virtual had a better ring than artificial, and the media seized upon it. In part, it was the media popularity of the term Virtual Reality that led to its adoption by any group or product that wanted either a marketing advantage, or to just look cool and "with it."

Now, at the beginning of the twenty-first century, it is used to describe computer games of all sorts, online spaces, shared software programs and more. I will use it primarily as the meta-term for the **technology** that enables a person to inhabit a simulated world generated principally by computer technology, along with the accoutrements that serve to affect a more encompassing experience.

Virtual Environments, or *VEs*, are, by my definition, the simulated places that comprise the **content** of the Virtual Reality technology. They tend to be the creations of an individual or group, made for specific purposes, and often spanning a range of representational styles

from abstract to realism. I use this term primarily to refer to works that are experienced with VR equipment that surrounds a person with the 3D computer models. However, as previously stated, I will include within this term many illustrations of VEs that are, in fact, *RT3DVE*s (displayed on flat screens instead of the full VR equipment) but which have been designed in a way where they could be experienced via fully embodied immersion.[3]

The original term in common use for the content of Virtual Reality was *virtual worlds*. However, in recent years this designation has been pre-empted by literary theorists as being a specific type of Virtual Reality. Specifically, according to new media scholar Lisbeth Klastrup, virtual worlds must be persistent, contiguous, and accommodate multiple networked inhabitants. (Klastrup 2003: 101) In this view, they need not be encompassing or surround the participant, which the early proponents of VR deemed essential. I will use this word sparingly, and unless otherwise noted, most often in its original allusion to the immersive content of a virtual reality.

Necessitating infinitely more discussion are the terms *immersive/immersion* and *presence*. These words have actually inspired a distinctive group of researchers who delve deeply into the complex ontological and epistemological implications of these terms. (See for example Biocca 2003, Lee 2004, and Vorderer et al. 2003.) I use *immersive/immersion* as the main terms for the encompassing nature of virtual environments that isolate a person from the real world by various means to bring them, as much as is currently possible, *into* the simulation. Immersive in this definition means being able to break the barrier of the screen or other projection device to actually feel as if one has entered into, and is surrounded by, the virtual, computer-generated space. My primary term for this phenomenon is *emplacement*. *Presence*, as I use the term, is defined as the subjective feeling one has when immersion is extremely compelling.

I use the term *experient* for the person undergoing the experience provided via the virtual environment, and *experience artist* or *experience designer* to characterize the person who has created that environment.

Immersion can be *social*, *emotional* or *spatial*, and these states tend to differ considerably, but can be aggregated within the adjective *affective*, referring to any situation, especially virtual, that causes a valenced reaction in the person undergoing the experience. *Valence* itself is used in the psychological sense of something strong or significant, be it positive or negative.

Finally, I use my own original term *cybermedia* throughout the thesis to indicate the broad range of media that are based in part or whole on digital technologies.

Chapter 1 The emergence of Virtual Reality

Introduction

In this chapter, I examine the genesis of Virtual Reality as both a technology and an emerging means of artistic exploration. I discuss important influences on both the understanding and expectations of VR, including the US defence organisations, science fiction writings, entertainment, and academia. I introduce the technology that enables Virtual Reality and some of the probable and implausible expectations that the early uses of VR evoked. I next trace some of the paths that artists took to be able to explore the artistic potential of VR, including my own. Two of my virtual artworks are introduced: *Virtopia*, which was created in the early 1990s, and *DarkCon*, done a decade later, which enabled me to employ the fullest realisation of my approach to creation of virtual environments.

1.1 From defence to dream to discipline

In the latter half of the 20th century, virtual reality technology emerged to meet military training needs, with extensive funding provided by the US Department of Defense. This funding supported early research and development in technologies that would eventually converge to function as training simulators, by replicating discreet segments of the 'real world' in virtual reality forms, for safe, controllable and effective training.[4] Research funding was allocated to universities and research centres to develop more sophisticated computer graphics, sensor-based tracking systems, motion platforms, and new forms of display devices that could present believable situations to the trainee. A history of VR research for better training systems can be found in Kalawsky (1993).

In part due to the extensive media hype about the subject of VR that arose in the popular press in the United States in the early 1990s, it appeared to the general (US) public that virtual reality somehow sprang full-blown from the brow of some technological Zeus. (Wooley 1992) The hype was surprising, yet also understandable to some degree, in so far as the ideas behind virtual reality appealed to many intrinsic human desires: e.g. the wish to experience other realms, the

need to explore the self through alternative forms and levels of representation, engagement with (virtual) others, and even the creative urge of the artist (or the computer scientist wishing to express an aesthetic). In fact, as I argue later in the thesis, it seems that virtual reality gained in popularity in this early stage of its development as a form precisely because it could serve as a blank canvas for the imagination, seemingly encouraging whatever one wished to project onto it. Early VR thus became a framework for myriad idealizations by many different kinds of audiences or potential participant groups, although some of this idealization remained frustratingly unrealised for the masses without access to the then (and still somewhat today) scarce resources of the virtual studio. For many, the growing hype about virtual reality was all that was visible, or directly experienced. VR, as an emerging form, was thus loaded with implicit expectations, generated in large part by a high energy media blitz, and these expectations proved increasingly difficult—if not impossible—to attain and maintain.

What is important to note here is that to some (because of, or in spite of, its associated hype) the concept of virtual reality represented a frontier that was no less important for humankind than physical frontiers, like the environs of outer space or the deep untapped recesses of our planet's oceans. (Krueger 1991) In this regard, virtual reality also became a territory awaiting exploration, discovery, mapping, and meaning. Thirty years later, we have crossed only its initial borders; there are still unfulfilled and uncharted possibilities for this field, which is only now becoming well enough established to consider it as a 'discipline' in its own right.

Oddly, when virtual reality first emerged from its military incubator in the early 1990s, most of its uses beyond training were for disappointingly mundane applications: selling kitchens, playing games, branding perfumes.[5] Many of these applications were created as demonstration pieces intended primarily as sales and marketing drivers for the fledgling technology.

Early virtual reality tools also saw some use in other limited training domains closely aligned with North America's defence infrastructure,

such as the NASA space program, where telepresence—here defined briefly as the ability to perform actions in one place that cause correlated actions in a distant place—allowed trainee astronauts to control robotic arms with their own physical movements. (Fisher 1986) A more recent application of telepresence is laparoscopic surgery, where doctors can operate within the body by manipulating external surgical instruments corresponding to miniature instruments situated within the patient. (Coleman et al. 1994) Contemporary commercial venues for virtual realty include oil companies using virtual techniques as visualization tools (Midttun et al. 2000), psychologists treating phobic patients in desensitization therapy (Wiederhold and Wiederhold 2004), and groups that specialise in re-creations of cultural heritage sites (Addison 2000). These examples—though in themselves useful and admirable applications—are still a long way from achieving some of the more expansive visions of the hype of the early years.

The reasons why virtual reality has not progressed into more diverse realms seem, at one level, to be fairly obvious (at least to those who have worked in the field and been tested by the limitations of the tools and of the perceptions of humans who, after all, form part of the 'feed-back loop' in any VR project). Market forces, of course, played a pivotal role. General access to the technology has been limited due to cost or institutional privilege. Most of the equipment for virtual environments resides in the labs of scientists, with little opportunities of access for the non-scientist. The value of artists in these laboratories has been infrequently acknowledged, to the detriment of more nuanced advancements of the technology. [6]

I was in the unique position during that time period to be employed by a central Florida virtual reality research institute (the Institute for Simulation and Training, or IST).[7] It was truly unique in that IST was at the time one of the few VR labs working at this level anywhere, and I was a senior artist working directly with the tools and the content. My perspective brought a female approach, as well as an artistic sensibility combined with a computer science perspective, that was exceptional for that time. Thus, my personal experiences and senses of

discovery (and also of frustration with the initially limited applications I saw in common usage) were difficult to assess objectively, without any parallel sets of observations with which to compare them.

Virtual reality as a form, or genre, (on the way to becoming a 'discipline' in the scholarly academy) has indeed crossed several thresholds, yet it still awaits the fulfilment of its original promise. It has great potential as an extraordinary medium, exceptionally distinguished from other forms of digitally based or cyber media (to which I shall hereafter refer as *cybermedia*.) The technologies that enable virtual reality are continuing to progress, for the most part in quiet or discreet bursts of activity and discovery, often in those same labs, with the same rarity of access. With this unique cybermedium, we see ever-increasing means to form a simulacrum of human perceptual systems. Much of what we can perceive from the real world—by means of smell, sight, sound and touch—may now be replaced by synthetic counterparts, which come to the market in new forms with varying degrees of verisimilitude. These new digital forms of perception provide a plasticity to these perceptual modalities beyond what was previously possible.

As William Gibson—the acknowledged inventor of the modern term cyberspace—observed in his novel, *Burning Chrome*: "The Street finds its own use for things." (Gibson 1986) The crucible of "the Street" catapults development in unforeseen ways. VR is not yet out on the Street. Yet it is important for purposes of this thesis to ask: if it had been, what uses might it have seen? I would argue that, because VR has not yet hit the Street, it has been artists rather than either scientists or 'your average person on the street' who have served this function of bending the technology to alternate uses and forms. Nonetheless, the Street is still relatively sparsely populated, even for artists.

Digital technology holds, or perhaps hides, a certain sacrosanct nature at its core, with its continuing advancement in the hands of scientists serving to further divide the levels of play, as computer scientists and technologists are viewed as 'high priests' of sorts. Two decades ago, it was mandatory for aspiring computer scientists to take a college course

in 'assembler code'—that most arcane of languages that remains closest to the language of ones and zeros that machines 'speak.' A quote from Erik Davis is extremely pertinent here: "The logic of technology has become invisible—literally, occult. Without the code, you're mystified. And nobody has all the code anymore." (Davis 1998:181) Today, computer science students rarely study assembler code. Substituted instead are "high-level languages" such as Java, serving as the average student's introduction to the computer science discipline. (Cunningham 2000) What has been lost or gained in the process? On the one hand, the core code or base language upon which the system relies is beyond reach, with the effect of making the system itself seem less accessible, or 'harder' as science. On the other hand, increasing levels of familiarity with Java and related higher-level languages has opened the way for greater access to computer science, and computer programming beyond the elite. This trend has made the price of entry into the digital realm more reasonable for many, including artists who wish to work with technology.

1.2 Multivariate origins of virtual environments: a brief genealogy

Tracing the roots of virtual reality requires multi-disciplinary exploration. It relies heavily, first of all, on the discipline of computer graphics, coupled with new forms of computer hardware. It is no surprise that the same visionary was responsible for advances in both areas. This was Ivan Sutherland, who was a young doctoral student at MIT in 1963 when he created the quintessential forerunner of all interactive computer graphics systems: *SketchPad*. (Sutherland 1964) *SketchPad*, running on an early behemoth computer, the Lincoln TX-2, permitted a user to draw lines, circles, and other geometric shapes by indicating points with a light pen, and telling the computer how to connect them. These shapes could also be manipulated—moved, rotated, scaled—using Sutherland's code with technology borrowed from the SAGE Air Defense system. (SAGE 1958) In SAGE, a device called a "light pen" was used to select and follow radar blips on a cathode ray tube, or CRT. In Sutherland's work, the CRT was pressed into service as a visual output device, or monitor, for the results of his

graphic code. This was a radical advancement in the early 1960s, as such visual monitors were not part of computer systems: a computer's calculations were typically output onto paper via a Teletype or line printer. (Dorf 1972: 257)

Taking a quantum leap forward, Sutherland envisioned a startling future for his creation. In a 1965 article entitled *The Ultimate Display*, he defined the basic concept of computer-mediated virtual worlds. "If the task of the [computer] display is to serve as a looking glass into the … wonderland constructed in computer memory, it should serve as many senses as possible." (Sutherland 1965) His first work in creating a display to meet this description was for the US Department of Defense's Advanced Research Project Agency, or DARPA. (Kalawsky 1993) This display coupled two miniature CRTs in a helmet that could be worn on the head, thus gaining the common name *Head Mounted Display*, or HMD. Sutherland's prototype was so weighty that, in order not to cause neck strain, it was supported from the ceiling and thus earned the nickname, "the sword of Damocles." As training devices were the ultimate goal for his sponsors, Sutherland continued research into this topic and eventually formed his own company, Evans and Sutherland, which became one of the premier flight simulator companies for over a decade. Fight simulators such as the Evan and Sutherland device were the very first versions of virtual reality. Pilots could be immersed in a believable situation with a wide field of view simulating what would be seen from a cockpit, sounds of radio traffic, and six axis motion platforms that enabled every vibration and bump to be bodily experienced.

DARPA scientists were not alone in their visions of simulated worlds. Writers and entertainment visionaries were also travelling similar paths. Out of their imaginations came conceptually different ideas about re-creating the world as a simulation. Morton Heilig, an entertainment visionary, built a multi-sensory entertainment machine he called *Sensorama* in the early 1960s. Looking much like an overgrown motorcycle, *Sensorama* allowed the participant to feel as if she were driving down a New York City street. As scenery sped by, wind blew

and smells were automatically released at key points, such as when you passed the pizza parlour. (Heilig 1997) *Sensorama* was ahead of its time, and never a commercial success, but uncannily complete as an early incarnation of a virtual environment.

Ray Bradbury's 1951 short story, *The Veldt*, also prefigures VR, and is widely acknowledged as its first literary incarnation. (Bradbury 1951) Parents who spoil themselves and their two children buy them the ultimate media nursery for their amusement. The nursery walls project images, reminiscent of the television screen that was beginning to increasingly populate American family homes. George and Lydia Hadley are the quintessential mid-twentieth century parents providing nothing but the best for their offspring.

> They stood on the thatched floor of the nursery. It was forty feet across by forty feet long and thirty feet high; it had cost half again as much as the rest of the house. "But nothing's too good for our children," George had said. The nursery was silent. It was empty as a jungle glade at hot high noon. The walls were blank and two-dimensional. Now, as George and Lydia Hadley stood in the center of the room, the walls began to purr and recede into crystalline distance, it seemed, and presently an African veldt appeared, in three dimensions, on all sides, in color reproduced to the final pebble and bit of straw. The ceiling above them became a deep sky with a hot yellow sun. (ibid.: 15-16)
>
> He knew the principle of the room exactly. You sent out your thoughts. Whatever you thought would appear. (ibid.: 20)

Through his series of modern novels, author William Gibson expanded this concept from a single room to a full-fledged matrix of shared virtual places: "infinite reaches of the space that wasn't space," all connected and inhabitable. (Gibson 1984 and 1986) Rather than entering a room or donning equipment, Gibson saw the ultimate interface as being direct brain stimulation, achieved via a plug placed in a person's skull that, when connected, permitted the user to neurologically "jack into" the virtual world being run on a network of computers. Because the resulting experience was virtual, Gibson

defined it as a "consensual hallucination." (Gibson 1984) His influence on contemporary visions of cyberspace has been immense, and many still expect that one day we will bypass the esoteric equipment for a cleaner, and more direct, brain interface.[8]

Other approaches that converged to form the modern arena of Virtual Reality include that of Fred Brooks at UNC who in the early 1970s saw in the technology the possibility of "intelligence amplification" (Pizer 2003: 3); Myron Krueger, an artist/scientist who designed intelligent interactive room spaces where the user was unencumbered by heavy equipment like head-mounted displays in the late 1960s (Krueger 1983); and entrepreneurs like Jaron Lanier, who started the first company in the early 1980s to commercialise personalised versions of virtual reality technology. Lanier's "Reality Built for Two" system (Lanier 1990) offered full body *data suits* that captured a user's movements. These were transferred to a graphical model of the human (commonly known as an *avatar*) in the virtual world. This resulted in a shared virtual reality complete with body images that each person could equate to the other in this common space. (Blanchard et al. 1990) In the 1990s, Carolina Cruz-Neira and colleagues at the University of Illinois, Chicago Circle, invented The CAVE (Cave Automated Virtual Environment) that implemented much the same concept as Bradbury's nursery room. (Cruz-Neira et al. 1992) A CAVE consists of three to six walls on which the virtual imagery is rear projected. The participant stands in the centre, surrounded by the projected VR environment. Others can share the experience being presented in the CAVE as spectators, watching what happens due to the actions of the person chosen to control the single interaction device.

While these approaches all furthered the development of VE solutions, this thesis focuses on virtual experiences that are most similar to Sutherland's original vision, those that use the HMD and other technology to truly separate the experient from external sensory inputs and provide a truly immersive experience. In the following section I present a brief introduction to the basic enabling equipment for this type of fully immersive virtual reality.

1.3 A brief introduction to VR technology

An immersive VR system makes extensive use of specialised equipment to emplace a person within a virtual environment. Head-mounted displays, mentioned previously, are the primary visual conduit of the virtual images to the user's eyes. Computers with graphic hardware and software compute rendered images of constructed 3D models as distinct sequential images, and deliver them to the eyes at anywhere from 10 to 60 frames per second, depending on the processing power of the computer combined with the density of the scene. In full-featured VR, the images are computed twice, one image for each eye, to provide binocular vision. Audio is handled via headphones (often attached to the HMD), or external speakers, that deliver stereo or multi-channel sound to the ears. Exactly which visuals and sounds are sent to the end display units is controlled by the visitor's virtual position within the environment. Information about this position is enabled by a positional tracker. Several types of trackers exist, magnetic, acoustic/inertial, and video, but all send the same type of information to the simulation. Based on a pre-determined starting point, where the visitor is placed as they enter the simulation, changes are recorded in x, y and z positions (corresponding to moving forward/back, left/right, and up/down) and rotational yaw, pitch and roll information (mainly for head movements: tilts, neck turns and shoulder-to-shoulder movement). It is this tracking information that allows the computer to calculate the correct perspectival images that will be sent to the eyes.

Navigation is accomplished via several methods. Natural walking is the most desirable, but technically impractical, as the experient is typically tethered to the computer and peripheral devices via thick cables. Many types of navigation systems have been implemented, including walking on a treadmill (Brooks 1986), a bicycle-type standing chair (Hollerbach et al. 2000), an experimental omni-directional treadmill (Darken et al. 1997), trampolines (Hansson et al. 1997), and instrumented gloves (Pausch 1991). The simplest and most widely used method for navigation remains a simple joystick or game

controller. In this system, two of the tracker's degrees of freedom are mapped onto the back/forth and side-to-side motion of the joystick. Speed of walking can be correlated to how far the joystick is pushed, and while not totally intuitive, is readily mastered by most people. In most VR simulations, the up/down motion tracking is kept connected to head movement so it follows such actions as bending down or standing on tip toe to see better. Rotating the head from side to side is also typically mapped to the corresponding head motion.

Other senses can be incorporated into the VR simulation. The release of smells can be triggered by objects within the environment as the experient nears them, and can add greatly to the believability of the virtual world, though such use is not yet widespread. The sense of simulated touch, or haptics, is still in the formative stages, but much research is going into improving the realism and resolution of devices that can deliver a haptic perception. Of all the senses, only taste seems to lag behind. It is doubtful that simulated environments will conquer this sense without some form of direct neural stimulation. These interfaces will be explored in more detail in Chapter 2, where I discuss how they each contribute to the unique qualities of VR as a cybermedium.

1.4 Speculation and effect: virtual reality prophecies

The early days of virtual reality were the wild west of speculation. VR was touted as the answer to almost everything, from a place we might populate in the dystopian aftermath of the apocalypse to the most effective marketing tool ever created. Writers such as Michael Heim emerged as self-proclaimed philosophers of VR, attempting to establish balance between the realities of our current physical, and increasingly virtual, lives. (Heim 1993)

One of the earliest pioneers of virtual reality, as well as its foremost acknowledged prophet, was artist and musician Jaron Lanier. His company, VPL Research, marketed a Data Glove,[9] stereo display goggles (a lighter form of HMD), and a body suit that enabled a participant to interface with a 3D virtual world (part of the RB2 system

mentioned previously). Jaron made several VR installations, but little is written about them. One of the earliest allowed the experient to create art out of the virtual objects around him or her. He also had a VR game called *Moondust* done in 1983. (Lanier n.d.) In 1992 he gave a performance from within (wearing the HMD) of his virtual worlds at a SIGGRAPH Conference. It was entitled *Music from inside Virtual Reality: The Sound of One Hand*. Jaron used his gestural Data Glove to play virtual (and otherworldly) instruments he had scattered within the 3D environment. Each instrument made a unique sound. He played for about fifteen minutes, seemingly oblivious to his audience. What we, the audience, watched was a performance that seemed to border on religious ecstasy. Several years later he also created a *Virtual Puppet Theater*, where the puppets took on political personas and had terrible or righteous things happen to them, depending on your point of view. (Lanier n.d.)

However, Lanier may be most famous for his many pronouncements of what the virtual world would mean for humans. He postulated that virtual reality would move us into an age of what he termed *post-symbolic communication*. In such a world, we could communicate via 3D objects or experiences rather than with words. (Lanier and Biocca 1992) He also saw VR as a way to expand the mind in ways similar to the effects of mind-altering drugs.[10] This fringe application of VR never fully developed but it did open new potentials for the technology. Far from mechanistic flight and tank simulators, simulations of a softer nature suddenly seemed within reach. Jaron, with his large frame, dreadlocks, alternative thinking, and brilliant mind, ushered in VR as the logical and legal successor to the psychedelic movement. This leftist leaning may well have hindered the full acceptance of VR by more establishment types.

1.5 Expanding the vocabulary: From spectacle to art

Virtual Environments are still somewhat rare, perhaps even more so now than in the early days. Those that reached the public eye in the beginning were novelties, not to be taken seriously. In the first decade of virtual reality, most of its constructs—beyond military uses—were

just such novelty events. However, virtual environments proved malleable. Some did make it into commercial entertainment realms, such as Disney's *Aladdin's Adventure* (Pausch et al. 1996) or the short-lived *BattleTech* location-based installations. (Jacobson 1993) Yet, few VR applications crossed over into the art realm.

Michael Heim, in his book *Virtual Realism*, discusses the difference between concepts of VR as spectacle, entertainment and art:

> A spectacle is a one-shot deal that everybody wants to see—at least once. Entertainment, on the other hand, calls for repetition, but repetition becomes cloying if it does not nourish. But to fascinate for the long haul, that is the task of art. The art of virtual reality holds a fascination akin to the flickering shapes projected on the cave walls of the Pleistocene period, 500,000 years ago. (Heim 1998: 55)

The virtual environments I explore in this thesis are the ones that speak directly to Heim's concept of nourishment. There have been few works addressing the unique artistic potential of fully immersive sensory experiences: meaningful constructs emerging from creative instincts of artistic vision. One of the chief reasons has been the problem of access. Few artists have been able to convince the technocrats at the gate that there are valid reasons to allow them to create content for these systems.

1.6 Artists' early use of the medium

Some artists were both determined and lucky, however, and before long art began to be created for virtual environments. It is unfortunate that a full record of artistic virtual environments is not readily accessible. This is due partly to the fact that, though this medium is barely thirty years old, no history of the era has comprehensively included the work of artists. The paucity of records is also due to the inaccessibility of the tools and equipment of virtual reality. Most such systems were the purview of scientists in well-funded (and often tightly regulated) laboratories. Lucky artists would work within such unfamiliar settings just to have access to the technology and to develop their ideas about how to expand VR into creative realms. Because of

their cooperation with military or government-sponsored labs, and their isolation from established artistic channels, such artists often received no recognition from the larger artistic community. From the scientist's viewpoint, the contribution of the artist was rarely clear or appreciated, being considered orthogonal to scientific aspects of VR research. Artists were more concerned with qualitative rather than quantitative matters. Scientists found it difficult to incorporate the insights of artists into their more empirical vision of VR. As a result, artists working in this realm had to follow a path that was outside of both artistic and technical ambits. They were rarely included in the published records of the labs in which they worked, and the established art world rarely, if ever, acknowledged them. Most of their works died a premature death in the Petri dish of their generation, forgoing the wide audience they deserved. The exceptions were notable.

Nicole Stenger was a French artist who was able to talk her way into the University of Washington's HIT Lab in 1989, which may make her the earliest formal artist to work in virtual reality. Her short stay there resulted in a unique immersive virtual world entitled *Angels* (or "Les Recontres Angeliques"). *Angels* (1992) was a beautiful story about two ethereal beings that find each other and come together to make a whole creature, completing each other. Stenger called this work a "VR Movie," and indeed, it had little interaction, being instead an unfolding story with original music by electronic composer Diane Thome, where the viewer co-habited the environment with the virtual characters. It was shown publicly at the Biennale des Arts Electroniques in Paris. (Popper 1993: 102-103)

In the early 1990s, The Banff Centre in Alberta, Canada, hosted an exceptional Art and Virtual Environments Project, which became a locus for vanguard artists eager to take rein of these technological chariots of creation. A total of nine projects were created at Banff in the years 1991-1994. (Mosher and MacLeod 1996) The importance of the Canadian government's support of this fledgling medium cannot be overstated. At no other time has a concentrated group of artists

been given the resources and support to shake loose the possibilities in virtual reality. The work done by this fortunate group forms the largest single corpus of artistic forms of expression in virtual reality.

Several of these nine pioneering works were immersive VEs that I will describe here. The first was created by a traditional artist from Canada's First Nations, Lawrence Paul Yuxweluptun, entitled *Inherent Rights, Vision Rights* (1992). Yuxweluptun decided to re-create a spiritual experience of his culture: the long house and the ceremonies enacted within. His challenge was to overcome an inherent cultural bias in the tools of virtual reality and bend it to a re-creation of something that was faithful to the spiritual aspects, yet accessible to a diverse audience. He avoided the use of speech or dialogue and instead used sounds from animals and musical instruments to underscore the ritual nature of his world. The experient, using a specially constructed stereo viewing device, first passes through a threshold that retains sounds of the external world (car doors slam, an airplane buzzes by), and then enters a space beyond everyday awareness that westerners only rarely have glimpsed. (Yuxweluptun 1998)

Another Banff work was a collaboration[11] led by a sophisticated technophile named Brenda Laurel, with partners Rachel Strickland, Rob Tow, and Michael Naimark. This piece, called *Placeholder* (1992), had several innovative aspects undreamt of by commercial and military concerns. Two players, wearing HMDs, were networked together in the virtual space, which was augmented by a physical stage set that supported the performative aspects of the work. Each experient could take on the persona of a spirit animal, such as a snake, spider, raven, or fish. To counteract the possibility that the participants would simply wander in the environment, Laurel, whose background was in theatre, provided direction to the experients in a role she refers to as the "VR Dominatrix." One of the unique aspects of *Placeholder* was that people could leave vocal traces within the environment in a mechanism called *Voicemarks*. Iconic shapes signalled to the user that a Voicemark was in one of four states: asleep,

awake and ready to accept a voice recording, filled with a message to speak, or actually delivering the message. (Laurel et al. 1994)

A work by Toni Dove and Michael McKenzie, *Archaeology of a Mother Tongue* (1993), mixes several media, including laser disk, computer and photographic imagery, narrative voice-overs, and interactive sound. Dove describes *Archaeology of a Mother Tongue* as a "virtual reality murder mystery." Participants could look through a camera to view the virtual world, wear a data glove, and see a disembodied virtual representation of their own hand that allowed both navigation and interaction with objects. (See Figure 1.1.) Focusing around the murder of a child, it features the main characters of a coroner and a pathologist. Three environments take the experient through a dream, a ribcage that functions as a transport device, and finally through the geometric structure of a hand and a skull both full of memories. This very ambitious piece used dreams and memories to associate the experient with hidden thoughts, motivations, and details that related to the overall narrative. It is significant for its length: it required forty minutes to experience the whole mystery. (Dove and Mackenzie 1996)

The early works described above all borrow from earlier artistic forms: performance, ritual, narrative, theatre, and cinema. Lanier's work used the medium as a mechanism for performance. Stenger's work was a romantic narrative. Yuxweluptun sought to re-embody his native rituals in a virtual space, while Laurel's group used a theatrical paradigm. Dove's work emulated a narrative cinematic experience, including approaching the length of a screen film, something well beyond the scope of most VE works, which typically provide 5-15 minutes of immersion.

Figure 1.1. Frame grab from the prologue of Archaeology of a Mother Tongue

This was an extraordinary beginning. Many artists expected other funding sources would open up as a result. This proved not to be the case, however. Individual artists had to continue to find their own means of realizing their VR visions. Notable artists who were able to create VR works in the final years of the twentieth century include Janine Cirincione (1994), Char Davies (1995, 1998), Josephine Anstey (1997), Rita Addison (1994), Margaret Dolinsky (1997, 1998, 1999), and Maurice Benayoun (1997), whose works will be presented as illustrations throughout this thesis.

My own pathway to virtual environment creation is characteristic of the complicated means needed to gain access to the tools of VR creation, and will be described next.

1.7 Virtopia*: a personal practice case study*

In 1990, I visited the Institute for Simulation and Training (IST) at the University of Central Florida and became very excited by what I saw. The researchers at IST's Visual Systems Lab (VSL) were just embarking into virtual reality, and I knew this was where I wanted to be. The visionary director of the VSL, Dr. Michael Moshell, believed that there was much I could contribute to their efforts. One of the labs early funded projects involved testing the validity of virtual reality technology for the Army's training purposes.[12] With this focus, we built

simple environments that allowed us to quantify such things as visual acuity, colour perception, and way finding in VR settings. (Lampton et al. 1994) As a long-time practicing artist, however, what excited me was the potential I saw for this technology to be the foundation of a new art form.

A fellow researcher, Mike Goslin, joined us in 1991. His background was in psychology, though he was now at the University of Central Florida studying computer science. We discovered that we had similar enthusiasm and complementary talents for this new medium of VR. Together we embarked on an after-hours project to create several immersive worlds designed to evoke emotional responses from the participants. Loosely grouped together under the designation *Virtopia*, these worlds were designed specifically to evoke strong emotions such as fear, angst, nostalgia, and longing. What we were creating was very different from our daily work, even though we were using the same hardware and software. The main difference was our approach. While our daily work was constrained by the demands of the Army-funded research, our after-hours project was not. We came from two disciplines considered by many of our colleagues to be "soft:" psychology and art. Yet, our combined approach, and the fact that we had rare access to the VR systems, gave us a privileged place from which to create.

We were able to use the tools and testbeds developed for the funded projects to implement our virtual environments. This jump-started the work. Common 3D modelling tools that I used to teach computer animation classes at the university were utilised to create the environments within *Virtopia*. Programming was developed as extensions to the Army project's test-bed functionality. Had we had to build the elements that enabled the *Virtopia* project from scratch, it is unlikely we would have been able to complete it.

We were able to premier the *Virtopia* worlds at the 1993 Florida Film Festival at Orlando, as well as a more mature version at the following year' festival, and a widely experienced showing at the annual SIGGRAPH 1994 Conference held that year (conveniently) in Orlando.

One environment that we created, *The Conversation Room*, seemed to connect strongly with many visitors to *Virtopia*. (See Figure 1.2.) This virtual space consisted of a small table in the middle of an empty room. The room was filled with the sounds of a crowd of people talking. On the table was a photo album. Its pages would spontaneously turn every time you moved near it, revealing not only new snapshots, but also snatches of audible conversation someone might have had about the photos on the page. On each wall was an abstracted animation of a conversation. Moving near each wall would cause a recorded fragment of conversation to play, standing out from the background aural landscape.[13] These interactions provided experients with a sense of agency in the environment—the feeling that their actions had an effect. The result was haunting and people tended to spend a great deal more time in this environment than in any of the others we had built. (Goslin and Morie 1996)

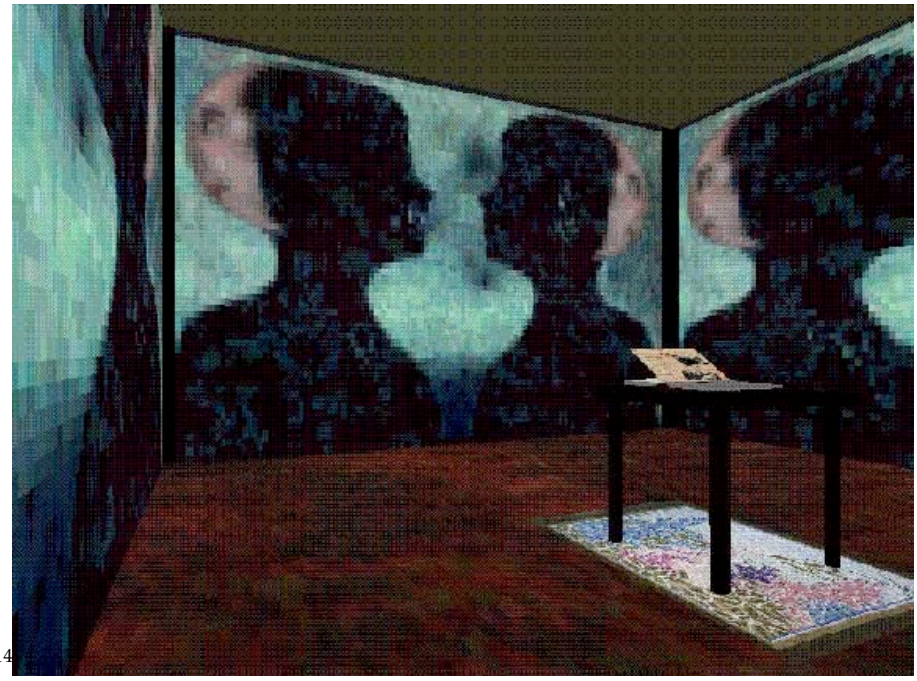


Figure 1.2. Image of the Conversation Room from Virtopia, 1992-1994

1.8 DarkCon*: further discoveries in VE creation*

A more recent virtual environment project of mine, spanning the years 2001 to 2005, and done at the USC Institute for Creative Technologies (ICT), was based on a more realistic world with a twofold emphasis: to

create emotional responses (as in the *Virtopia* work) and to do so in a more cognitively real setting. I named this environment *DarkCon* because it simulated a nighttime reconnaissance mission, and as such, it actually had a minimal narrative (unlike my other virtual environments) presented in the form of a back story. The experient played the role of a solitary scout, whose instructions were to determine the potential threat from inhabitants of an abandoned building complex near a river (a task they could chose to follow, or not). The choice of a nighttime setting was made explicitly to impose difficulties (obscurity, concealment, etc.) on the person's observational tasks, as well as to elicit a sense of unease and make the environment more mysterious. I began the design process by considering each element of the virtual world through its denotative and connotative perceptual affordances: the sights, sounds and smells of this specific virtual environment, with their emotional impact in mind.

For example, the first segment of the experient's journey was to occur in a dilapidated culvert. I mentally placed myself in the culvert and described it in evocative sensory terms, answering the questions: What is in the culvert? What noises do I hear? What does it smell like? What has it been used for? How do I feel when I am here? I imagined the culvert with mossy, crumbling brick walls, a trickle of sluggish water, edged with fetid muck, running down its centre. There would be detritus: flotsam carried by the rushing waters of the rainy season and deposited here: bits of tree limbs, old bike wheels, a rubble of rocks, abandoned water bottles, and miscellaneous indeterminate garbage. I conjectured elements of a waterworks infrastructure: hissing pipes, thumping generators that powered sputtering red lights, seeping spigots, and shadowy alcoves. What creatures might populate such a culvert? Small ones like bats might hang from the ceiling pipes, dropping pungent guano into the mud. Rats would certainly be skittering amongst the debris searching for scraps. Humans would have left their mark in this culvert too, with bits of cultural refuse. Over there a worn suitcase, its contents spilled out into the grunge, over here a photo album with forgotten faces; and all left to the fate of the elements.

Now, to make it more evocative and heighten the cognitive realism: the bats should be disturbed if one passes too near; the rats scatter to hiding places. There might be evidence of violence: blood stains on the walls, bullet shells in the mud. The culvert itself would add a sonorous reverberation to the sounds of trucks and other vehicles travelling on the road above. These could shake loose bits of wall and rock, possibly to startling effect. Mysterious creaks and rumbles not easily identified would punctuate the aural curtain, as would sounds from the exterior: distant trains, dogs barking, the barely perceptible gurgle of a river, chirping crickets. In this way, I envisioned the world in my mind, and set about to recreate it in the sensory modalities of the virtual world.

I used standard tools to create the visuals and sounds conjured by the imagined descriptions: 3D modelling, texturing and animation software, and digital sound mixers. Every object had to be created as a graphic element: each tree, bush, and building. Applying painted or photographic textures, essentially 2D images, to each object's surface gave me a wide palette with which to create the feeling of believability. Many techniques to simulate lighting, reflections, dirt and water (none of which my engine could do well) had to be developed. Sounds were created in a variety of ways, from recording voices shouting and arguing, to setting up a Foley stage, as is done for films, to record my feet walking in mud, water and dry sand. (See Figure 1.3.)

Figure 1.3. Author creating Foley sounds in mud for DarkCon footsteps

Smells were not so straightforward. Each odour in the real world is a complex and distinct amalgam of molecules and compounds that must either be purchased or mixed from scratch. Disseminating these smells at the time *DarkCon* was started (2001) involved releasing odorants into a room via a large dispensing unit. The use of these devices raised issues, not the least of which was clearing a smell out of the space at the conclusion of its use. To facilitate use of scents as a more personal VE experience, I devised a collar with four chambers that could each hold a unique scent. (See. Figure 1.4.) In the prototype, chambers are triggered individually to release a specific smell when the wearer enters a specifically marked location in the virtual terrain. Because of the proximity of the collar to the wearer's nose, only miniscule amounts of scent are required, and these can be more rapidly dissipated, thus solving a key problem associated with scent use in virtual environments.[15]

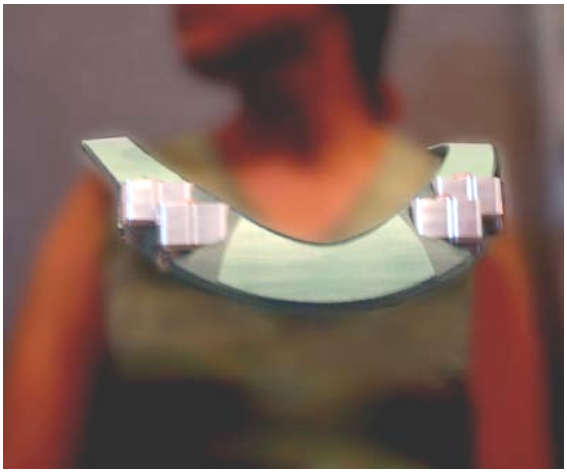


Figure 1.4. The scent collar, version 1

I also developed a special form of passive haptics for *DarkCon*, provided by a specially constructed floor capable of creating vibrations ranging from 4 to 20 Hertz, below the threshold of hearing. These infrasound vibrations are triggered by environmental events and experient action, and are perceived as tactile or haptic sensations more than actual sounds. I used them to provide an almost imperceptible score (as for a film) to accompany the experience which (to my knowledge) ever never been done before. These mostly unconscious

perceptions could be used to augment the feelings of unease referred to earlier. Conversely, infrasound could be used to lessen such unease by being suppressed, as desired. (Backteman, Köehler and Sjöberg 1983) Judicious and careful use of infrasound in the virtual environment can therefore be used to elicit a mysterious anxiety in the experient.

As mentioned, the *DarkCon* experient is ostensibly a lone reconnaissance scout sent to report on a suspected rebel hideout. To engage the person more fully into that task, a three-screen video of the commander giving the mission briefing is depicted at the start of the immersive experience, once the experient has entered into the culvert, as shown in Figure 1.5. This briefing is not direct, but created to appear as how one might *remember* the original briefing.

Figure 1.5. Memory Briefing image showing three screens within the culvert

The purpose of this "Memory Briefing" is therefore not only to provide detailed facts and figures for the scout, including a map of the territory about to be explored, but also to acclimate him to the dangerous state of affairs in this part of the world. The scout has been told to pay close attention to everything he sees, as anything might be important, and to use a specific local culvert to get close to the suspected enemy camp.[16] Not all the images shown to the experient in the briefing session are necessarily contemporary with the current situation. Several may

instead be triggered from old memories, such as images of helicopters from Viet Nam, accompanying the commander's voice saying, "We will helo in" to a specific location. My aim was to combine recent and associative memories, along with the critical mission information. This introductory briefing was key to setting up the sense of danger and foreboding I wanted the experient to feel as they took on the role-playing.

Figure 1.6. Bats in the culvert

I used the *DarkCon* world for experiments relating to arousal states and memory retention in immersive training from 2003 to 2005 at ICT. Beyond that, and more importantly for my artistic practice, it stands as an exemplar of a fully implemented, multi-sensory virtual environment, and a test-bed for incubating many of the design ideas in this thesis. The lessons of the *DarkCon* design include a focus on emotion as the primary means of engagement, and the importance of attention to key techniques, having as an end goal the formation of a sensory gestalt capable of evoking the essence of a place through corroborative detail and sensory orchestration. This gestalt approach serves to create what Norberg-Schulz (who saw architecture and land-scape, earth and sky, as interlocking to form Gestalten qualities) calls "a phenomenological comprehension of place" which enables the intrinsic identity or "atmosphere" of the environment. (Norberg-Schulz 2000: 85-86)

All these techniques also contributed to the cognitive realism goal of *DarkCon*, provided expected details that concurred with real world expectations, and created a powerful sense of presence. However, the same techniques are also useful for creating phenomenological believabilities relevant to more inventive and aesthetic VEs.

An important goal of *DarkCon* was to see if aspects of the experience could be measured in some quantitative way. Participants were outfitted with devices taking two forms of physiological measures: heart rate and skin conductance. Continuous readings were taken throughout the experience to determine if the emotional cues we designed into the experience were eliciting affective responses from the participants as intended. While actual emotions could not be deduced from the readings, amount of arousal could. Therefore, intensity could be distinguished, but not qualification or the valence of the response. Results indicated that participants did experience increased arousal states correlating to the design. Details of these experiments are outside the scope of this thesis, but can be found in (Tortell and Morie 2006).

In a study on arousal states using the German film *Der Schneemann* (*The Snowman*), related in Brian Massumi's *Parables for the Virtual* (Massumi 2002: 23-25), researchers found that arousal was often confounded with pleasure, especially by children. In the study, participants indicated more enjoyment as the amount of emotional affect was increased, even if it was of negative valence. Massumi termed this the "primacy of the affective" and found that it was most pronounced when the images shown contained no voiceovers or linguistic elements. Likewise, in *DarkCon*, once the Memory Briefing concluded, I eschewed language as a primary information channel. Language, I felt, would be distracting to the immersive experience, due to its cognitive and interpretative nature. I wanted the affect to be processed directly by the senses, and those parts of the brain that can experience them firsthand, not as processed signifiers that directed the attention to literal interpretations steered by the meaning of words. Massumi's statement applies here:

> The relationship between the levels of intensity and qualification is not one of conformity or correspondence, but rather of resonation or interference, amplification or dampening. Linguistic expression can resonate with and amplify intensity at the price of making itself functionally redundant. (ibid.: 25-26)

As a functionally redundant element, linguistic expression was not necessary, and instead I built upon primary sensibilities beyond language, to create a stronger primary affective impact in the experience.

1.9 Conclusions

In this chapter I have traced the early history of VR from its incubation in military research laboratories to its adoption by more commercial concerns. I have argued that the excitement surrounding early virtual reality was not enough to protect it from falling early victim to its own hype.

I have looked at contributions by dreamers, explorers, writers, entertainment inventors and academics that have helped bring VR past the hype of the early 1990s and to its current stage of development in 2007, and briefly introduced the enabling equipment that supports a fully immersive virtual experience that separates one from external influences.

I have also argued that lack of wider entrée for artists to scientific establishments, as well as VR's association with well known counterculture gurus, may have delayed a more nuanced expansion of possible content and potential. Taking a cue from philosopher Michael Heim, I believe VR's potential lies in its role as a nourishing and meaningful art form.

I have described how a few artists, especially those who were part of the Banff Centre's Art and Virtual Environments Project, were able to take VR towards this very goal and inspire new directions. Their unique works enriched the vocabulary and potential of the technology, transforming it from a curiosity and spectacle to an emerging discipline.

I have introduced several VR-related terms: cyberspace, cybermedia, Head Mounted Display (HMD), data suits, avatar, direct brain stimulation, CAVE, Data Glove, cognitive realism, passive haptics, infrasound, phenomenological realism, and Massumi's term, "primacy of the affective."

Having introduced the basic history and terminology of Virtual Reality technology, and presented some excellent early examples of artist-created virtual environments, including my own, I will next progress to describing the specialist virtual environment I created specifically for the practice component of this thesis: *The Memory Stairs*. As this comprised a set of purely artistic immersive environments, I was able to apply not only my developing methodology for creating VEs (which will be detailed in Chapter 6), but also my aesthetic interests in portraying memories and emotion, with the goal of making evocative, meaningful, and transcendent experiences.

Chapter 2 The creation of *The Memory Stairs*

Memory is the narrative that hovers above us and shadows every new event. (David Carr 2006: 117)

Introduction

The concepts for my next series of artistic virtual environments, *The Memory Stairs,* were inspired by my deep and ongoing interest in the interrelationships between memory and emotion. The design ideas for this project started to come together in 2002; implementation began in earnest in 2004; and the first memories were ready to be shown in 2006. Taking what I had learned from and developed for the DarkCon environment, I turned to what I hope would be more personally evocative scenarios based on memories. It was exciting for me to be able to use scents as part of the palette for this work, along with rich graphics and sound, as scents are strongly linked to memory formation. (Engen 1991) In this chapter, however, I will not so much focus on the technologies employed (those will be covered in Chapter 3) or the methodologies of creation (which will be delineated in Chapter 6), but rather the particular ineffable sensibilities I hoped to convey to the experients of these immersive environments.

I first cover the background for *The Memory Stairs* overall concept, and then describe the physical installation, desired and actual. Next I relate the sights, sounds, and smells of each of the implemented memories. I close this chapter with my own reflections on how well the work achieved my artistic goals.

2.1 The design concepts for The Memory Stairs

My artwork has always strived to evoke intangible connections to the observer/participant, by incorporating triggers that might relate to their own stored memories. Emotions evoke memories and memories themselves, because of how they are encoded, evoke emotional responses. According to modern neuroscience, memory formation is enhanced if the experience has a strong emotional valence, and emotional events can trigger deep memories of past occurrences possessing similar affect. (See, for example, Cahill and McGaugh 1998)

and Damasio 1999) Our rational apprehension of the world may be quickly altered by an emotional connection, as exemplified by the famous Proustian effect.[17] Jean-Paul Sartre calls this emotional basis of being the 'original magic' upon which we construct "superstructures laboriously built by reason." (Sartre 1948: 85) He notes, "The passage to emotion is a total modification of 'being-in-the-world' according to very particular laws of magic." (ibid.: 93)

Immersive virtual environments, due to their embodied nature (which will be discussed in more detail in Chapter 4) also facilitate artistic modification of 'being-in-the-world.' They allow for a created space within the space of the real world that can be any aesthetic the creator envisions. As works of art, they can provide a more direct passage to emotions, less encumbered by rational 'superstructures.'

The concept for *The Memory Stairs* came from my intense interest in, and understanding of, memories and emotions as lifelong companions. I am especially interested in how memories and emotions can be illustrated in an aesthetic construct. For *The Memory Stairs* I envisioned a series of virtual memories that traversed various experiences in the phases of life, some important, some ordinary. As life is a journey, *The Memory Stairs* was also designed to represent a symbolic journey. I decided on the form of stairs, as stairs are often used as a metaphor for life (See, for example, Lindenberger and Staudinger 2003: 483-494.), with each step corresponding to a developmental motif. I wanted the experiences in *The Memory Stairs* to start before birth and go to near death. Thus *The Memory Stairs* comprises a selection of fictitious memories representing several stages of life. The experient encounters these memories as a series of immersive "snapshot" experiences designed to be both evocative and elegiac.

2.1.1 Physical installation description

My original concept for the installation envisioned a specially constructed set of physical stairs. Each step taken by the experient on these stairs would trigger the next memory in the sequence. Cost and space constraints ultimately prohibited the construction of the physical stairs, as many safeguards would have had to be implemented to

ensure the safety of the experient who would both be wearing an HMD and walking up the stairs. A concept image of the envisioned staircase can be seen in Figure 2.1.

Figure 2.1. The original concept rendering for The Memory Stairs staircase

In the end, we were limited to showing *The Memory Stairs* in the various public locations provided, which did not afford much opportunity to tailor the space. These included the 2006 Presence Conference in Cleveland, Ohio (a separate dedicated room at a university), a showing for Los Angeles SIGGRAPH members (an outside space with visuals also projected on a wall for spectators), and the ICT setting (a separate enclosed room).

Figure 2.2. & 2.3. Two experients experience The Memory Stairs at a Los Angeles SIGGRAPH showing. What they see in the HMD is also projected on a wall for other audience members.

2.1.2 Description of specific memories

2.1.2.1 Embryonic Chamber: Awaiting

I wanted this world to summon up deeply stored, pre-linguistic memories of the time before birth. While there is much debate over whether a pre-natal being can form memories, or even have thoughts, my decision was to side with those who do believe in the active mental world of the yet-to-be-born baby.[18] To determine what sensations a late term foetus might perceive, I consulted several scientific works. (Piontelli 1992) (Maurer and Maurer 1988) (Mancia 1981) (De Casper and Spence 1986) These authors agree that touch is one of the first senses to develop, as is taste (as the baby is aware of the ever-changing makeup of the amniotic fluid in which it dwells). Beyond these two sensations (which could not be adequately captured with VR technology) it is clear that the developing human can hear both internal and external sounds, and also see, even if dimly in this pre-natal state.

This first *Memory Stairs* environment, called *The Embryonic Chamber*, is a roughly spherical space, close and confining, dark and womb-like. There is very little to see but dim shadowy shapes, the vaguest shadows. There is no colour in this dim world.

Figure 2.4. Shadowy scene from The Embryonic Chamber

The most important sense in this inner space environment is sound. Noises and voices permeate the liquid world, traversing and being changed by tissue and fluid, through indistinct walls of which the experient (as a pre-natal being) has no knowledge or understanding. Sounds that filter into this world are voices, a mother humming a lullaby, a fight, and a gurgling silence—the long silence a baby would experience when its mother is sleeping, accompanied by the sounds of bodily functions. The most salient sound is a distinct heartbeat—the baby's own, or perhaps its mothers', or both hearts beating together in synch—responding to emotional influences of the world outside passing wordlessly into the inner chamber.

2.1.2.2 Just New: Arrival

Although the world of the newborn baby is a sensible place, it does lie on the far side of a looking glass. (Maurer and Maurer op. cit.: 6)

It is likely that most of us, as adults, do not remember the experiences we had as babies. We know that impressions are made on a baby's mind, yet these happen before language provides a storage scheme to codify events that happen and permit conscious recall. So, if memories are formed, they may be encoded in ways that we cannot access. I hoped that the virtual immersive experience of being a baby in a crib, having limited motion, and seeing the world from an infant-like perspective, might allow some access to those typically irretrievable early memories.

The most important object in the world that a baby focuses on is a person's face. In fact, we seem to be hard-wired to respond to the elements that form a typical face—two eyes, a nose, a mouth. Babies, given a choice, will tend to spend more time looking at a jumble of shapes that resembles a face over shapes that do not.[19] Shortly after birth, a baby can recognise its mother, probably as much by smell and voice as by sight, but by three months of age, it can differentiate visually between other family members. (Naime 2006) The images in the *Just New* experience are all faces that come to you, look down towards you, and seem to glide in and out of view.

The scene starts with a view of a crib from the inside, looking up. A mother's face, soft and unfocused, appears and floats closer and closer as her voice is heard making cooing sounds. You can smell her perfume as her face smiles down at you. In this memory you cannot navigate physically as you haven't yet learned to walk; you cannot leave your crib, but you can look up and turn you face to follow hers.

A three-dimensional colourful mobile comes into your field of view; it tinkles gentle music as it hangs over your world. More people come in and out of view: children, grandmothers, couples. The world seems bathed in the smell of baby powder. All the people coo and murmur at you, smiling, and then your eyes start to close as you fall asleep. The world goes dark as the mother's murmurs fade out.

Figure 2.5. The mother's face looking down on the experient as a baby

2.1.2.3 The Forgotten Rooms: Looking Back

The Forgotten Rooms are made of memories. They are old, and still. They exist only as phantoms; no one has walked these floors for decades. For this experience I wanted the experient to feel as if they had stumbled upon a place that seems familiar, comfortable, remembered, but not quite there.

Everything in the two rooms is from the 1930s, the magazines, images on the walls, and furnishings. The place smells old, with hints of fires

long extinguished in the fireplace, pipe tobacco scent lingering in the air, age vapours permeating all. The lugubrious sound of a clock ticks away the seconds, so slowly, it seems—counting ages, not seconds, as T. S. Elliot describes:

> *The ticking clock:*
> *The tolling bell*
> *Measures time not our time, rung by the unhurried*
> *Ground swell, a time*
> *Older than the time of chronometers, older*
> *The time counted by anxious worried women*
> *Lying awake, calculating the future*
> *Trying to unweave, unwind, unravel …*
> *T. S. Eliot in the third of his Four Quartets (1941)*

If you wander around these rooms, you may encounter traces of those who might have lived here. A small boy rocks in his painted rocking horse; a shy girl stands by the curtains listening to the sounds of children playing outside.

Figure 2.6. The ghost girl of The Forgotten Rooms fading in as experient approaches

Figure 2.7. The Forgotten Rooms: A view into the living room from the dining room

The living room contains an old, early television set; ethereal moving images of a woman lost in reverie are playing on it. The music that she hears is poignant, and makes the house seem less empty, less deserted. Eventually the music stops, and you are left alone, with the endless ticking, in the empty house.

2.1.2.4 Release: What Lies Beyond

The final *Memory Stairs* environment, *Release*, is about transcendence. This is a place of endlessness, timelessness. One can travel forever here, slowly in a vast bubble of dreams, all written on the ocean floor with delicate traceries of light. The subtle scent of the sea is everywhere.

My intent in this experience was to create a transitional space that seemed both tranquil and expectant. The bright light far above the experient denotes the predominance of upward bias with the sacred in most cultures.[20] It is bright, and beautiful, and draws one to it. As this is the final experience before the experient returns to the other world, I wanted the experience to transpire in a place that was both comforting and calming. I selected the ocean as the perfect enclosure. Not only does it poetically speak to our origins in the sea, it also brings the experient full circle—back to the water in which they began their *Memory Stairs* journey.

Figure 2.8. Looking up through the water to the supernal bright light

This is the last step before what lies beyond. Far above there appears a light: supernal, bright, white, beckoning, but it so far away. Music, soft at first, crescendos, and collapses into tinkling notes, floating away. The dream is done.

2.1.2.5 Unrealised experiences

Several experiences were conceived for *The Memory Stairs* for which time did not permit realisation. These include a *Childhood Experience* with the smells of crayons, swirling colours, and a sense of wonder in being able to create; a *Birthday Party* that embodies a ceremonial transformation from childhood to adulthood; a *Liminal Ritual Experience* that one must reach by traversing a deep, ominous forest of dark and twisted trees. If successful in this passage, one finally sees a clearing lit by fires amid darkness, and can join in the chanting and dancing. I hope to yet realise these additional experiences within my future artistic practice.

2.2 Fate and future

As can be inferred from the previous section, I consider *The Memory Stairs* an unfinished work. The most satisfying aspect of having created the environments of *The Memory Stairs* was listening to people talk about their experiences afterwards. Each experient brought something unique to his or her time in these virtual spaces. Many of their comments can be read in the supplemental volume that

accompanies this thesis, which chronicles all of my artistic Virtual Environments. As I view the experient as an active experient in the creation of the work, the real closure for me came each time my work was experienced, I was able to see the formation of a completed artistic circle.

It is somewhat disheartening, however, to realize that most people will come to know *The Memory Stairs* only by reading about it in these pages, or through viewing the images and video recordings that accompany this thesis. The reading and the viewing are their own experiences, to be sure, but they are not the ones I most hope to share. In the end, experience is the elemental aspect of our living being, and it is to a future where these vital immersive creations can be more widely shared in their experiential forms that I offer this work.

2.3 Conclusion

I believe that the human imagination never invented anything that was not true, in this world or any other. Gérard de Nerval (Aurélia 1855: 41)

In this section I described the concepts for my virtual environment work for this thesis—*The Memory Stairs*. I did so in language more poetic than concrete, though neither form would do them justice, as these experiences are designed to penetrate deep into our pre-linguistic memories and emotions. Only the direct experiences themselves, at once real and dreamlike, can bring the feelings to surface I wished to convey. This evocative nature speaks to the uniqueness of the medium of immersive virtual environments.

The next chapters of this thesis concern what it is that makes immersive virtual environments unique, and how and why this medium affects us as it does. Answers to these questions are ongoing areas of research and are to be found in the intricate embranglements of subjects as diverse as has human physiology, perceptual science, neuroscience, art, architecture, feminist theories, ritual and performance, philosophy, psychology, and behavioural science. I will attempt to relate these areas to the nature of the virtual realm that is enabled by virtual reality technology. My aim is to begin to explicate

the unique nature of immersive virtual environments, especially those that are both artistic and meaningful, by examining how they are informed by these fields of study.

In the next chapter I turn to the subject of what qualities and enabling technologies make virtual environments a unique and singular cybermedium.

Chapter 3 The immersive virtual environment: A unique cybermedium

Introduction

The "virtual" seems to submerge viewers even more inside a mental and physical space, powerful and persuasive enough to overcome any resistance to its synthetic character. (Ron Burnett 2004: 77)

This chapter presents the foundations of my arguments defining the immersive virtual environment as a unique cybermedium. In the 20th century we came to accept how technology can extend and enhance our bodily parts and functions through prostheses and devices like pacemakers. I contend that VR technology can extend us in additional ways, most notably in a meaningful experiential sense that engages both our mind and our body. I believe that this particular cybermedium creates a new form of space around a person: mentally, kinaesthetically, and sensorally, and therefore it serves as far more than a technology—it also functions as a medium that can deliver potentially intense human experiences. These two aspects are intertwined and fundamental to the unique possibilities of this cybermedium. The potential, as well as the essential structure, of this medium is enabled by the combination of VR's specialised equipment in concert with our perceptual mechanisms. I discuss these correlations, showing how they support creation of a virtual sensorium that differs from any other cybermedium.

By means of VR equipment, an experient in a virtual immersive environment is not only enclosed within a specially structured (virtual) space, but, at the same time, she is also separated from normal world sensory inputs—experiencing a habitable *pro tempore* space formed by carefully constructed visuals, sounds, smells, and touch. I call this habitation *emplacement*, the body's total comprehension of being in a virtual environment. Each of our senses, in concert with the VR equipment, has its own distinguishing characteristics that contribute to emplacement, from our bodily senses, such as positioning, proprioception, and kinaesthetics, to our vision, hearing, smell and touch.

These virtually delivered sensory components affect our perceptions in ways that closely align with our normal sensory inputs, and I describe the similarities and differences between the two sensory modes. In immersive virtual environments (as in real life) these perceptions are woven together for the whole body—the whole person—to experience an integrated sensory totality.

Throughout this chapter I also explore the role artists have played in extending this unique cybermedium into inspired domains. Informed through both my practice, and in discussion with, and experiencing the work of, other artists, I provide examples that illustrate methods artists have utilised, including those from my own artwork, to take advantage of the unique capabilities of immersive virtual worlds. I remark on the prevalence of female artists working with immersive virtual environments, and propose some reasons why women may be ideally suited to be authors of this form of creation.

For creators, this cybermedium requires the acknowledgment and understanding that, as no experience is ever finished without the experient inhabiting and interacting with the sensory environment, a complete and finished work of art cannot be fully conceived in advance. Rather, I argue that what the artist creates must be a space for becoming, a stage for the evoked interactions that will, themselves, complete the work. This approach requires a mindfulness of the medium/technology dyad, in concert with a deep understanding of the mind/body dyad.

The unique characteristics of immersive virtual environments, in my mind, confer a ceremonial quality on the experiences they can provide, rendering them more closely aligned with experiences of a ritual nature. I explore concepts of ritual from ideas gained from my study of the work of modern ritual scholars Arnold van Gennep, Victor Turner, Ronald Grimes, and Catherine Bell, among others. Referencing their concepts, I delineate my argument for why I believe a correspondence between ritual and immersive VEs exists, and what it means for the potential purposes of emplacement in these environments. Of special interest to my practice are recent neuro-

phenomenological theories combining anthropology, psychology, and neuroscience in the study of ritual and extraordinary human states of mind. I give a brief introduction to this broad area of knowledge, in the context of how VEs are potentially able to generate similar states.

Finally, recent studies in the field of neuroscience are beginning to indicate that these virtual constructions have the power to affect the mind and body in ways that are analogous to real life experience. In *The real effects of the virtual* section, I conclude the chapter with some examples of this pioneering research. Such knowledge is helping to shed new light on why a virtual experience can be extraordinary, and how it is able to evoke real responses by means of digital signals and bits.

3.1 Medium and technology entwined

Eric Davis, in his book *Techgnosis*, says: "The moment we invent a new device for communication—talking drums, papyrus scrolls, printed books, crystal sets, computers, pagers—we partially reconstruct the self and its world, creating new opportunities (and new traps) for thought, perception, and social experience." (Davis 1998: 4) If this is true then virtual reality has (already) recreated us, and the world, irrevocably.

This is what Marshal McLuhan (1964) so presciently declared: each medium brings with it its own message. Yet, immersive virtual reality is often considered more a technology, and much less a medium. If, however, a technology contributes to the information, the connection, or the flow of meaning, then it must also be considered a medium—a substance (ethereal or not) through which two entities mediate. The medium, in this case, is not only the message (in McLuhan's sense), but serves to both initiate and add meaning to the message. Thus, in VR's case, the medium is also partly the *messenger*. Ken Hillis in *Digital Sensations* (1999) argues that virtual technologies constitute an *enactive* medium—one that brings value to the process, instead of being a mere conduit. However, he also says

> The position of technology-as-medium *does* acknowledge that humans invent technologies because they intend them to achieve certain outcomes. Yet humanists and social constructionists, at loggerheads on a variety of social issues, are often as one at dismissing considerations of technology that would assign to it any agency or affect, treating such considerations either as 1) myopic technological determinism blind to the social relations responsible for technologies existence, or as 2) forgetting about what they often claim to be the most important point about theorizing technology—that it gets used in many ways and often for different purposes than intended. (Hillis 1999: 35)

I argue that artists' subversion of virtual reality's original purposes is indeed in that latter category. Through their explorations and creations, artists have begun to form this technology into a medium that expands its original intent, entering into neoteric expressive and aesthetic realms. Yet it adds its own contribution to the meaning being delivered. Original uses for virtual reality, described in the first chapter, were mainly pragmatic. The military wanted to achieve improved training (improvement relating directly to a lessening of cost, and training for potentially lethal situations without actual loss of life). The commercial world wanted to sell products, or amusing experiences; the business world thought it could find value in immersive visualizations that could help determine, for example, where new oil fields could be found. Artists, however, wrangled virtual reality into the territory of magical aesthetics, social commentary, and worlds that have never before been seen. Fred Brooks' quote from *The Mythical Man-Month* is called to mind here: "One types the correct incantation on a keyboard and a display screen comes to life, showing things that never were nor could be." (Brooks 1974: 7-8)

While it is possible to recreate many aspects of the physical world in virtual reality (a frequent goal of VR practitioners), many artists consider this approach to be somewhat disingenuous, as it often adds nothing to the process or the experience. Making a virtual facsimile of a contemporary place, for example, the Washington Monument, provides a proxy for an experience that could be had in real life. Translated to the virtual, recreated most likely only in part, such a

facsimile (reasonably) loses essential aspects of the primary experience. In this regard, it can be considered a *second order* experience. There are, however, occasions where such a recreation makes sense, as when the original place is lost to time or catastrophe. An in-person visit to the original Parthenon, or the Parthenon through the ages, for example, may only be possible in virtual reality. Such virtual time travel adds value because we cannot visit the spot as it existed, and it thus makes the virtual experience a *first order* one. A definition of aesthetic success I learned as a fine art photographer is apropos here: A photograph can be considered *art* if the experience of viewing the photograph is *greater* than the experience of having been in the place from which the photograph was taken at the time it was taken. In the same manner, a virtual experience must somehow be greater than a similar experience in real life (its physical and real world correlate) and not less, if it is to be successful as an expressive work, and not just a second order experience.

Environments created by artists are most commonly directed not to a *re*creation, but rather to a *new* creation designed for a particular artistic purpose. Successful artistic works bring something special to a viewer's apprehension, expanding or enhancing existing ideas, and forcing things to be seen in new ways. In this way they are differentiated from Aristotelian mimetic works, which, as Marie-Laure Ryan reminds us "must be evaluated in terms of (their) accuracy with respect to an external reference world." (Ryan 2001: 92) Artistic immersive environments, by contrast, tend to be *additive*—they contribute more than being in a real place, and serve to elicit additional concepts and understandings as a result of the experience.

Jean Baudrillard's *simulacrum*, which is often referred to as a copy without an original (Baudrillard 1995), is frequently invoked to describe virtual environments. Yet, in the right creative hands, I believe they should more accurately be considered *originals without copies*, as each experience, initiated by the artist via the contributing stage of the created environment, and completed by the actions of each experient, is not only distinctive, but also an event of the first order.

In the last half century, the increasingly ubiquitous range of digital technologies has provided distinctive and untapped realms for creators. All new forms of media tend to recapitulate previously accepted modes in their formative periods, a process Bolter and Grusin (2000) call *remediation*. There comes a point in time, however, where unique techniques begin to emerge, eventually coalescing into a specialised grammar that reflects the distinct nature of the new medium. I believe that we are in the beginning stages of such a grammar being developed for immersive virtual environments. If this is true, then we must look at the intrinsic properties of this new cyber-medium that make it a distinctive new form.

3.2 What makes immersive virtual environments unique?

Virtual environments have much in common with other forms of digital media. They use three-dimensional digital graphics, as do games and computer animation. They include the use of digital sound, and allow for interaction between the participant and the virtual objects, as do many interactive works. Yet, immersive virtual environments possess distinct qualities that set them apart as a unique cyber-medium. The most significant of these qualities include: the capability of the environment to fully enclose the experient while at the same time excluding the sensory inputs of the real world; the embodied experience enabled by position and head tracking equipment; the multiple sensory palette available to the creator; the growing evidence that such virtual experiences affect us on an equal basis to real world ones; and the form of the virtual environment as a stage, or starting point, with the fully realised experience being actualised by contributions from the artist, the experient, and the technology.

I will discuss each of these qualities in turn, looking at how they are enabled by the specialised VR equipment, why they are intrinsically different from similar capabilities of other digital media, and how their uniqueness is being lent credence by recent empirical studies.

3.2.1 Emplacement

The first quality that sets virtual environments apart is what I term *emplacement*, the privileged nature of how one experiences the form and content of the created world through a sense of total immersion. Emplacement represents a twofold aspect of this immersion by unifying the special characteristic of being able to go *within* the created, virtual space, with the coincident *exclusion* of the perceptual inputs of the ordinary world.

In immersive environments, the person who experiences—the *experient*—is fully integrated into the medium, entered *into* the created space of the work. Not only is the experient surrounded by the perceptual envelop of the virtual space, she is isolated, by means of the VR equipment, from any potentially distracting real world stimuli. What this means is that the signals reaching the experient's perceptual mechanisms are provided from, and by means of, the VE technology. Moreover, and just as vital to the integrity of the experience, is that the real world perceptual inputs are held at bay throughout the encounter. Thus, as experients perceive this encompassing environment to the exclusion of other signals, it becomes their immediate, secluded, and primary focal world.

This protected state is critical to the privileged nature of a virtual environment. Michael Heim (1998: 165) writes: "Excluding outside stimuli leads the solitary participant to experience a harmony prepared by the artist." In the early days of VR head mounted displays (HMDs) used to deliver images to the eyes were fitted with a rubber baffle (often using repurposed SCUBA masks) so that extraneous light did not compromise the brightness of the images. A concomitant result of this screening was that it also created a hermetic visual seal. In addition, original helmet displays often had built in earphones that covered the ears, presenting only the scenario-appropriate sounds to the ears, and blocking extraneous sounds. These two factors—going within the virtual world and excluding the real one, had profound, and I suspect unplanned, effects. For all intents and purposes, the real world ceases to exist in the mind of the experient—a magical state.

One is not only in the real world, but also inside another space, not of that world but somehow contained within it, pro tempore. The experient is truly in two places at once, and yet, can be fully focused on the virtual construct over the real. The characteristics of the VR equipment, in large measure, uniquely afford this phenomenological wonder. In the following sections I present the predominant working details of the enabling VR devices—tracking mechanisms, head mounted displays, real time 3D audio generation, olfactory and tactile displays, and discuss their correspondences to our normal sensory inputs and neural mechanisms.

3.2.2 Tracking embodied interactions

Typical interactions with digital media, including virtual environments, consist of selection and navigation. What sets virtual environments apart is the inclusion of the full body of the experient. Non-immersive digital media permit selection and navigation through (most usually) a mouse input device, manipulated by a user's hand. Standard mouse data includes an x and y Cartesian coordinate location that maps grid-like to a two-dimensional screen display. In virtual environments, however, a person's movement is through three-dimensional space, and therefore a device that provides three-dimensional data to the system is essential. Tracking systems (trackers) have been designed to capture and relay such positional information to the program in real time, as a person moves through the environment.

This positional data from the tracker typically includes a location in a three axis (x, y, z) coordinate system as well as rotational information around each of these same axes. (Foxlin 2002: 173-174) Each piece of this data is known as a degree of freedom (DOF), and thus a VR tracking system provides six degrees of freedom. Most HMDs are outfitted with an attached tracking unit on the top, with the resulting data used to determine which direction a person is looking so the system can compute the correct visual scene. Such tracking devices can be attached to any body part (not only the head via the HMD) so the 6 DOF data can specify to the system in real time exactly how that part moves.[21]

Trackers can be used with instrumented gloves or game controllers to permit selection and manipulation of objects within the virtual space. Instrumented gloves, such as the Data Glove mentioned in Chapter 1, can also determine the placement of each finger by using fibre optics along each digit to measure the diminution of light when the fingers are bent. (Sturman and Zeltzer 1994) Other gloves use strain gauges to measure the amount of bending that occurs. (ibid.) Specific bend configurations of the fingers can be mapped to actions the system recognises and responds to in some manner. One such action might be to point an index finger in the direction one wishes to travel (an unusual mapping). Another might be a closed fist near or on an object that signals to the system the object is being picked up (a more natural mapping). In addition to finger sensors, the tracking unit attached to the glove sends positional and rotational information for the hand, permitting a real (gloved) hand to turn a virtual door knob, pat something, or wave within the virtual world.

Having a tracker on a person's head means they can be tracked both looking around and walking in space, at least in theory. Unfortunately, the technology was (and still is in 2007) constrained by required cabling connecting the tracker and the stereo head display head to the system.[22] Another limitation is the range of the tracking receiver, which subtends a radius of approximately six feet or less. (Roland et al. 2001) Because of these current limitations, positional or walking motion is typically non-isomorphically mapped to another navigational device, such as a space ball, glove or joystick.[23] While a bit less intuitive than simply walking, this dualistic scheme still provides the VR system with the exact same information about the person's location and direction within the virtual world.

As trackers can be used in multiples, placed on any significant body parts (e.g. feet, arms, knees), they can provide more complete body information to an immersive environment. Figure 3.1 shows typical mappings and resulting actions for a two tracker VR system.

Tracking information: Tracker 1 (placement on HMD)	**X**	**Y**	**Z**	**X rot (Pitch)**	**Y rot (Roll)**	**Z rot (Yaw)**
Mapped to	Navigation device	Navigation device	Head	Head	Often disabled	Head
Resulting action	Move body forward and back	Move body side to side	Move body up & down (stooping down, stretching up)	Look up and down	Ear to shoulder movement	Look side to side
Tracking information: Tracker 2 (placement on the hand/glove)	**X**	**Y**	**Z**	**X rot (Pitch)**	**Y rot (Roll)**	**Z rot (Yaw)**
Mapped to	Hand position	Hand position	Hand position	Hand rotation	Hand rotation	Hand rotation
Resulting action	Move hand forward and back	Move hand side to side	Move hand up and down (reaching)	Rotate/Point hand up and down	Rotate hand around wrist	Rotate hand from left to right or right to left

Figure 3.1. Two typical VR tracker mappings

The main limitation of having several body parts tracked is the availability (and expense) of the units, as well as the immense amount of data that multiple trackers generate, which could prove challenging to process in real time.[24]

Including a sense of the body

We are embodied creatures. It is this embodiment that is mapped by the VE tracking system and that brings the body so firmly into the virtual world. It is because of the tracking that the VR environment knows where we are, what we are looking at, what we bump into, how we hear directional sounds, and whether or not we are near enough to smell a virtual rose. We may not have all the sensory cues in VR yet that real life affords, yet the fact of this embodiment enhances the perception of the ones that are available, making them all the more compelling. Turning our head in the virtual world and having what is in front of our eyes move as naturally as our accustomed vision is remarkable. Being able to tell where a sound is coming from and being able to follow it, or to hear it diminish as it gets out of range, builds a powerful sense of believability. We are not disconnected from our bodily nature; the VR world accounts for it, believes in it, and thereby provides a sensibility that no other digital media can.

Hillis (1991: 103) affirms (somewhat poetically) "… the space of a VE surrounds…. Envelopes, as a cocoon might. Not only to be perceived is that line of sight, but also the proprioceptive sense of the full world. Of the sights and sounds, and the tree over that little hill, the person waiting inside the door of that far away building."

I contend that many virtual experiences do not give the embodied nature of the experient enough attention and thus miss significant opportunities for a more convincing and solid encounter with the virtual. Even though full embodiment is not yet concurrent with the ultimate vision of Virtual Reality, what is possible in 2007 still provides a substantial foundation for physicality within the virtual space, the forms of which I discuss in the following sections.

3.2.3 Kinaesthetic and vestibular systems

The result of even a single tracker body mapping in virtual environments leads to an interesting phenomenon: a person has the distinct sense that he or she is existing and moving within the virtual space. This is not an abstracted movement provided by mouse pushing and button clicking in front of a 2D screen. It is much more intuitive and visceral. The body being tracked, coupled with the use of 3D visuals, calls several body systems into play, which respond similarly to how they would moving in the space of the normal world. Our kinaesthetic (or proprioceptive) sense keeps us aware of our body parts and the moving or static positions they occupy. (Clark and Horch 1986) Our vestibular sense is most affected by the tracking information, as it keeps us informed about our orientation, posture, acceleration, verticality, and movement. (Howard 1986) This sense seems to be easily fooled, as in the often-experienced illusive sensation that people have that they are moving when sitting in a stationery train watching an adjacent train pull out of the station. Both these senses use a feedback loop from the brain to the body part, with information from the body part going back to the brain. It might be puzzling to understand why these senses work in a virtual system where movement is actually limited. The main reason seems to be that the perceptions received from the receptors that provide the brain with this information are supplemented and reinforced by the visual, auditory and tactile systems. (Knudsen and Brainard 1995) Thus, even though the signals are not perfect, because of this redundancy (reinforcement), the amount of tracking captured in a virtual reality system is powerful enough to convince us we are moving. This technique, then, brings our bodily sensibilities into play more than anything other computer interface.[25] It completes the illusion that we have gone inside a space, and that we have taken our bodily perceptions with us.

As Meredith Bricken, early doyen of virtual reality describes it thusly: "The widest possible bandwidth of participation in cyberspace[26] is enabled when we pass through the barrier of the computer screen to inhabit, fully sense, and interact directly with people and information." (Bricken 1991: 365) Continuing, she offers evidence of the magic of this

going inside: "The personal impact of inclusion within a virtual world has been documented: in questionnaires given to 300 participants in Autodesk's cyberspace, "being inside" the virtual world was rated as the most compelling aspect of the experience." [27]

3.2.4 Sensory components: A gestalt palette

…in the post-war apogee of the 'American Century,' purified and isolated senses were separately addressed by Color (sic) Field abstract painting, hi-fidelity listening, and newly synthesized (sic) and commodified 'flavors and fragrances.' (Caroline Jones 2006: 7)

Another privileged situation for immersive virtual environments is that they can be configured to include more senses than most cyber-media. In combination with the sense of embodiment, this capability presents an exceptionally full experiential perspective for the experient. Multi-sensory cues can tip the balance of believability where individual cues alone could not, due to the reinforcement phenomenon mentioned previously. The immersive environment comprises a distinctive sensory envelope created by the artist, formed by what Bachelard calls a "polyphony of the senses." (Bachelard 1971: 6) This polyphony can be a mix of just visuals and sound, but other senses, such as smell and touch, can amplify the total sensory experience.

Knudsen and Brainard's reinforcement theory—that all senses work in concert to reinforce each other (1995), means that the virtual experience designer should give special consideration to the *combinatorics* of sensory information. The auditory channel, for example, supplements, enhances, and even makes up for failings in other senses, such as vision. (ibid.) Smell is a large part of our sense of taste. (Ackerman 1990:141-142) Vision often enhances our feeling of motion. (Knudsen and Brainard op. cit.) Because of these tendencies, skilfully combining sensory stimuli in VEs can cause the environment to appear richer and more complete than any single piece of VR equipment can support. It becomes, in essence, a gestalt encounter, with multiple sensory systems, that provides a unified, complex whole. I have used these

thoughts as guides in my own practice, to create what I hope are more convincing environments.

In the following sections I look at the senses: sight, sound, smell and touch in turn, discussing how the VR equipment provides similar sensory signals to the embodied inhabitant of the virtual environment, how our brain processes the sensory signals, how the real and the virtual perceptual mechanisms differ, and what this means for the embodied experience.

3.2.4.1 Vision

The ultimate display would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such room would be fatal. With appropriate programming such a display could literally be the Wonderland into which Alice walked. (Sutherland 1965: 507-508)

Sight is the sense with arguably the largest bandwidth, in terms of the neural real estate devoted to its processing (which may subsume half of the brain mass) (Palmer 2002: 23) and it is the one to which the most attention has been paid in developing VR technology. (Kalawsky 1993: 88-135) In early flight simulators, screens displaying visuals wrapped around the participant, showing what might be seen out the windows of an airplane cockpit.[28] This setup worked for any "out the window" situation, such as for aircraft or vehicle simulators, but it was not suitable for close ground-based work, such as a soldier in an urban setting.[29] For this type of setting, research had to focus on bringing a personal level of visuals to the person in the virtual environment. This more body-centric point of view means visual depth cues like stereo and parallax (most apparent at close range) become important, where they were not needed in the distant, wrap around views. The head mounted display was created for this purpose. By placing separate display units—one for each eye—within a head mounted display, two views of the simulated world corresponding to a person's natural binocular vision are sent to a person's ocular system. As these views are

mathematically computed according to optical perspectival rules, they appear very convincing to the participant.[30] The virtual images from the stereo displays enter our eyes just as our normal binocular vision does, following the same paths through our brains for processing by the visual system.

It is now standard knowledge that our visual perceptions start with, and are the result of, moving patterns of light entering our eyes. This movement is not only caused by the actual motion of things in the scene we are viewing, but also by the fact that our eyes scan the scene many times per second and build up a composite picture of what is in front of us. (Cassin and Solomon 1990) This constant eye movement[31] occurs due to the physical makeup of the eye itself. Only the central portion of our retina, the fovea, is capable of seeing in colour and in focus—the rest of the retina receives a monochrome, blurry image. In addition, one portion of our retina receives no image input, being the location of the bundle of nerve fibres that transmit the visual signals to the brain for processing. Because of these eye characteristics, the full resolution of what we see must be built up through rapid eye movements, called saccades and microsaccades. (Palmer 2000: 31-35) In fact, research has discovered an amazing fact: without such movement the scene coming into the eyes rapidly fades away, and we cease to see. (Palmer 2002: 521) Thus, eye motion is critical to our visual process.

As this aggregated light from the scene reaches the photoreceptor cells in the retina (upside down), it traverses the ocular nerve bundle that leads back to the vision centres of the brain, where distinct but connected regions process visual aspects such as contrast, stereo vision, depth, location, and motion, finally allowing us to make sense of what we see.

The point here is that we never see a "direct registration of physical reality." (Palmer 2002:9) All visual perceptions are interpretations; there is a great deal of cognitive processing that happens once the brain becomes involved. The same is true for any visuals, whether provided by a movie, a telescope or an HMD. Our brain does amazing things with any photons that come in through our eyes.

Much of how we interpret a visual scene is based a combination of what we recognise, and for that we rely on our stored memories and the patterns we have developed over the years. (Balota et al. 2000: 396-398) Jeff Hawkins, in his book, *On Intelligence* (2004), discusses how, when we see something, we search our brains to find patterns that match any "invariant representations" we have stored there. These invariant representations are hierarchical, supporting many levels of detail: they can represent someone's face, a series of movements, an address, or a photograph. If no match is found at the topmost levels (the most complex invariant representations), the brain quickly tries to match component parts at successively lower levels, until finding a match or finally reaching the simplest levels. At this phase, we are matching against basic wired (neuronal) elements, such as colour, contrast, edge perception, and movement.

We can basically say that in VR, as in real life, we receive images through our eyes, use the same neural circuits to process them, they are matched to what we know and recognise, and we come up with similar interpretations about their structure and meaning. There are, however, three basic areas where the images presented by HMDs do not exactly match our visual system. First of all, HMDs have a display resolution (measured in pixels) that is not as high as our ordinary perceptions. Several experiments have been done to quantify the effect of the resolution of the displayed images on the quality of the experience; e.g. (Duh et al. 2002) for difficulty ratings, and (Thompson et al. 2004) for distance judgements. What is certain about the resolution's impact on the experience is that if a display has "enough" resolution (and this must depend on the design, content, and context of the VE), resolution ceases to be an issue.

A second mismatch occurs because the image being presented to the eyes is contained on a single plane—the plane of the CRT or display screen. In most HMDs, this is placed about 3-4 inches in front of the eye. This situation causes our eyes to focus only at this plane, rather than our more natural mode of focussing in and out at varying depths. It is hypothesised that this situation can lead to eye fatigue during the

VE encounter, which may limit the practical length of such an experience. (Wann et al. 1995) (Peli 1995)

Finally, the field of view, or the amount of the forward facing world we can see with our head held still, in real life subtends an angle of between 160 and 208 degrees. Each eye has its individual field of view, typically about 140 degrees, with an overlap of between 60 to 120 degrees, allowing binocular vision to form from the positional disparity of objects in the overlapped region. (Kalawsky 1993: 50)

By contrast, the field of view of most 1990s HMDs hovers around 50 to 60 degrees per eye. With the binocular overlap, this amounts to an effective view of approximately 35 degrees, an extremely narrow field of view when compared to our normal vision. While this does work to bring our perceptions into the virtual world, it does result in the VE participant experiencing the environment as if through blinders, without any peripheral vision, as is naturally experienced.[32] The amount of information provided by our peripheral vision is extremely important to our kinaesthetic understanding of our position in space. Absent such peripheral vision, humans navigate through the world in an impoverished way. Several researchers have shown that this limitation has a negative effect on the quality of immersion and ability to perform in the virtual world. (Arthur 2000) (Lin et al. 2002) (Creem-Regehr et al. 2003)

A wider field of view is necessary to more closely align with our normal experiential expectations. In an experiment by Duh et al. (2002), VEs of varying FOVs and resolutions were presented to participants. While the studies showed that subjects had more physical disturbances for posture and balance, the researchers also asserted that people using the high resolution wide FOVs HMDs would report not only more self-motion perception, but also a corresponding larger feeling of presence.[33]

HMDs that transcend this limitation in any sort of affordable way are only recently becoming available. There have been a few previous instances of a wider-angle HMD, but the cost was extravagant: around

$100,000.[34] FakeSpace Research, a company with a long history of creating virtual display devices, is developing a new head mounted display (2005-2007) that has reinvigorated the initial excitement of this technology. I had a chance to experience this in late 2005 at their laboratory in Palo Alto, California, when it was not quite out of its incubator.

I put the HMD on and was in the centre of a virtual space, looking up to a second floor mezzanine that surrounded me. Three-dimensional human figures, like mannequins from computer games, were positioned around the mezzanine. I was able to navigate up to their location and move around them. I found myself continually wanting to lean on the protective railing between my apparent location and the ground floor. Of course, there was nothing solid there, as the railing was only a virtual construct. That had never happened to me in a virtual space before. When the demonstration was over, and I was helped out of the HMD, I turned to walk back to the position I had started from. I was astonished to discover that I had not actually moved, except virtually by way of the joystick. Something had convinced me in a very visceral way that I had indeed moved through space. This was an order of magnitude over any similar experience I had had. The quality and believability of the visuals in this demonstration were not photorealistic, and the content was neither compelling nor artistic. It was readily apparent to me that this phenomenon could only be attributed to the extended peripheral vision of this HMD that more nearly approximated the normal human field of view.

Other types of displays for virtual environments should be mentioned, such as wide angle curved screens that provide some peripheral vision (and sometimes stereo) using three video projectors (Middleton and Milligen 1999: 18-19), the CAVE—a four to six-side box with the 3D environment images rear projected onto the walls (Cruz-Neira et al. 1992) (Bernard et al. 1999), large desktop displays that show passive stereo and facilitate team work on 3D a shared surface (Middleton and Milligen, op. cit.), and even retinal scans that project a laser to the back

of the eye, situating the image internally for subsequent processing by the brain. (Viirre et al. 1998) Some of these are promising technologies for various applications of virtual environments. However, with the exception of the 6-sided CAVE, which is still quite rare, none of these methods serve to shut out the real world, which I consider a critical requirement for full immersion.

The important thing about the visuals is that they serve to surround us with the three-dimensional space of a virtual environment. Our investiture as humans is within lived 3D space, and it is the correspondence to that lived space that gives immersive environments a quality unlike any other cybermedium. Our existence in VEs is the subject of Chapter 4. The implications of virtual environment space will be explored in detail in Chapter 5.

3.2.4.2 Sound

High quality sound contributes substantially to the perceived quality of an immersive environment. Studies have actually shown that better sound can actually cause people to believe that low resolution graphics are much higher. (Storms and Zyda 2000)

Sound for virtual environments can be simple stereo, or it can be quite complex. The most immersive sound, called *spatialised* sound, can be placed anywhere in the full 3D space of the virtual world so that it dimensionally surrounds the hearer. Such sound both enhances the believability of the virtual world, and supports the perception of three-dimensional space. Recall that the images of the virtual world need to be provided by the computer in real time—that is, updating as the participant makes decisions, looks in a different direction, or chooses to move towards something. Sounds also need to respond to those same changes as they happen, appear to emanate from the correct place in space, and change tone according to their distance and orientation to the experient.

Since the mid-1980s sounds have been processed with tools in a studio to appear spatialised, but this process is not typically done in real time. Rather, functions are applied to the individual sound elements,

combined, and the final combined soundtrack is then "rendered," or processed, for the spatialised listening experience. (Gerzon 1985) (Kyriakakis et al. 1999) Rendered sound it is not dynamic sound responsive to the ad hoc choices of the experient moving through the world. To have sound spatialised in real time takes special processes. I discuss two of the major ones I have used in my practice.

Real time spatialised sound has been an ongoing research topic within the virtual reality community since VR's early days.[35] Crystal River Engineering was one of the pioneering companies to provide a viable solution for real time spatialised sound with a device called the Convolvotron that they marketed for use with virtual worlds. (Wenzel et al. 1993) This system required special digital signal processing hardware located in a second computer networked to the primary computer.[36] The main computer ran the graphics and kept track of the experient via the tracking system. It then sent this positional information to the audio server whenever an audio element was encountered in space. This information was combined with the source sound via a mathematical function called a head related transfer function (HRTF) that encodes how our ears hear and process sound signals. (Wightman and Kistler 1993). The HRTF is derived by measuring how sound reaches two parts of our ears: the inner canal, and the external portions of the ear, the pinnae. This is done by placing tiny microphones in each portion that record the precise way sound is received from an array of speakers placed in a hemisphere or sphere around the subject. Time differences from the sound hitting the two microphones are factored into the HTRF for each possible position, and thus the Convolvotron can compute this same difference for any localised sound in the virtual environment.[37] The result is that sounds seem to emanate from any direction, including over the top of one's head, or directly behind one. This spatialised sound reinforces the dimensionality of the virtual space, making it even more convincing.

This form of spatialised sound has one limitation. It cannot be sent to ordinary speakers placed in a room. Instead, it requires the use of

speakers placed at each ear (headphones). Thus Convolvotron sound was typically incorporated into the HMD in this way.

A second approach to creating spatialised sound involves a room-sized array of carefully placed speakers, as is used to play the pre-rendered sound described earlier. Dr. Kris Kyriakakis at the University of Southern California has been pioneering such sounds, and developed, along with Tomlin Holman, a system he terms 10.2 sound. (Kyriakakis 1998) His work couples this processed and rendered sound with films shown on a wide-angle curved screen to produce a very immersive experience. During the making of *DarkCon*, we were able to help expand Dr. Kyriakakis's 10.2 sound to make it function in real time.

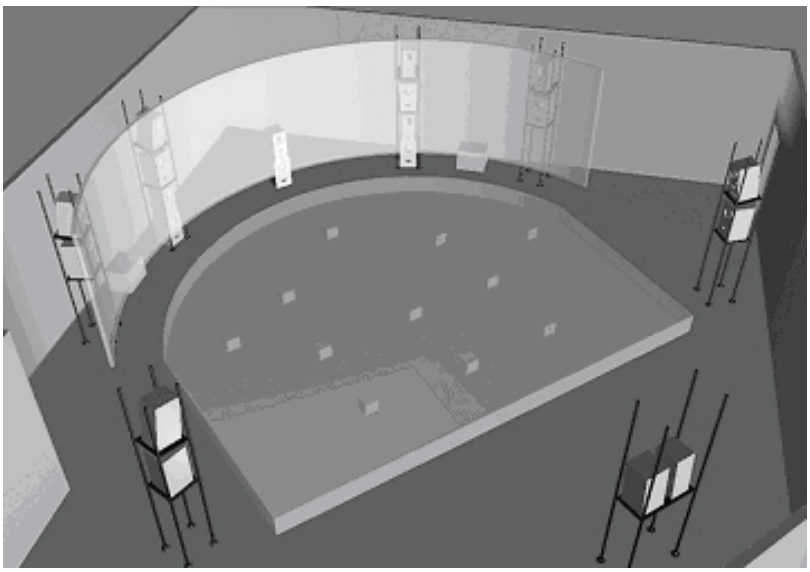


Figure 3.2. The room arrangement of the 10.2 speaker system for DarkCon

The first implementation of the 10.2 real time spatialised sound system for my *DarkCon* environment is described by Sadek and Kyriakakis (2004). It required several machines to run, including a Macintosh with a high-end ProTools system, and two Tascam media playback devices. Sound was also stored and served from the main Linux machine. These devices handled four types of sound for our environments: ambient sounds, general effects, triggered effects, and low frequency sound. Subsequent improvements to the system lessened the amount of equipment required and refined the process.

It should be noted that neither the Convolvotron nor the 10.2 sound system can replicate the actual acoustic properties of the virtual space, as such properties are not part of the information available in the virtual world. Doing this requires a computationally intensive simulation not likely to be possible in real time for the near future. While such acoustic information would lend exceptional believability to VEs, simply having the spatialised sound provides a strong sense of dimensionality, supporting the illusion of space.

Spatialised sound is a key feature of immersive VR worlds, but it is also critical to understand how the form of the sound can affect us. Tones, melodic progressions, and rhythms all have the power to affect us strongly and emotionally. Techniques such as entrainment, where our bodily rhythms synch up to an external beat, [38] and the use of ambient sounds to create an emotional timbre, can be used to create emotionally evocative and convincing environments. In the *Embryonic Chamber* experience of *The Memory Stairs*, I use the sound of a heartbeat that starts out at normal speed, increases to a rapid beat during the arguments, and slows down again when the lullaby is heard.

I deal with the design of the sound in more detail in Chapter 6, but I will introduce here one aspect of sound that has been part of my research into generating emotional correspondences in immersive environments.

Humans can hear sounds that are in the frequency range of 20 hertz to 20000 hertz, though some of the perception of the highest frequencies tends to diminish with age. (Moore 2001: 52) While we do not hear the frequencies below the hearing threshold in the 4 to 20 hertz range, called infrasound, we still perceive them through other body senses, primarily through our vibrational and tactile sensors. (Møller and Pedersen 2004) Popular misconceptions about infrasound include the belief that is it harmful or causes loss or damage to bodily functions, but several primary studies concluded definitively that there is no basis to any of these assumptions. (Slarve and Johnson 1975) (Westin 1975) (Harris and Johnson 1978) (Harris et al. 1976) In fact, extremely deep sounds produced through instruments that generate resonant

low frequencies have been used in rituals world wide to assist in producing a higher state of consciousness. (Gaynor 1999:75) Some instruments, like the Tibetan Ting-Sha, when rung, set up resonances that emanate an Extremely Low Frequency (ELF) hum, which it is hypothesised, readies the brain for meditation. (ibid.: 74) Such low frequencies have even been implicated in parapsychology as the source of the "ghost" phenomenon (Holt 2006).

In my practice I have developed a delivery system for low frequencies that consist of ten subsonic transducers in an approximately sixteen by twelve foot floor. Each of the infrasonic speakers can be sent signals by the VR sound systems, and are used as what I call an "emotional score." (See Figure 3.3.) Sending a slight signal to the floor, especially during tense moments of an experience, will serve to make the experient more tense. A stronger signal can heighten the feeling even more, while an absence of any low frequencies tends to remove this arousal state. While definitive studies of direct correlations between specific frequencies and emotional or arousal states have not been done, in the *DarkCon* scenario, where infrasound was liberally employed, we were able to see a stronger arousal response where it was designed via the emotional score. (Morie et al. 2005)

Localised sound and infrasound—and as we will see next, smell—all reinforce the sense of embodiment in the virtual world by supporting, and being supported by, our vision.

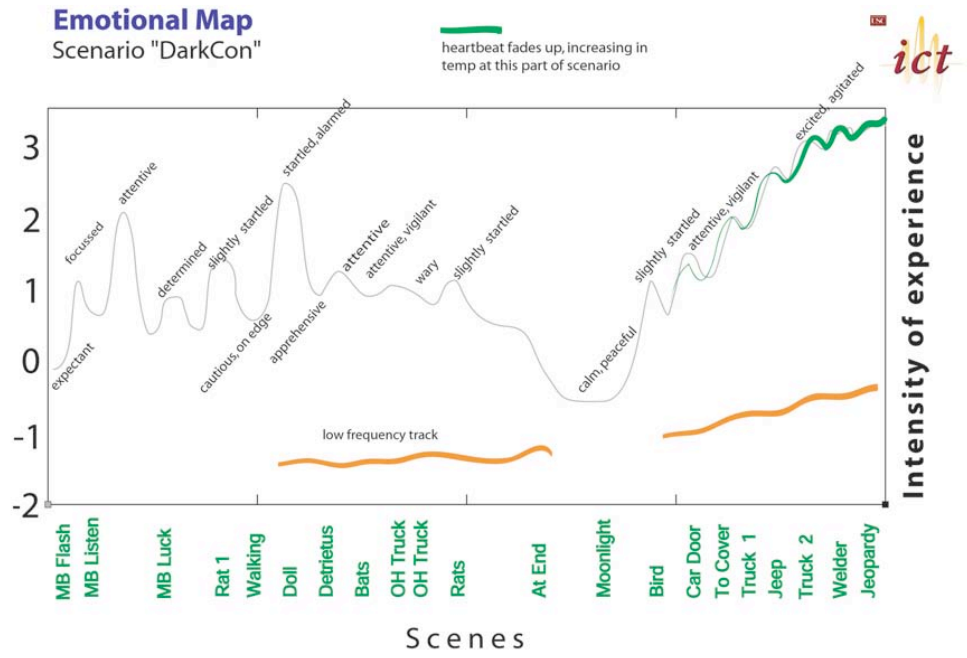


Figure 3.3. The low frequency emotional score for the virtual environment DarkCon

3.2.4.3 Smell

Historically, the smell-sense is the most ancient of all. Only the olfactory nerves are directly connected to the hemispheres of the brain. Hence it is inferred that the brain itself arose in connection with the sense of smell. The original brain is a smelling-organ. (Millen 1960/2001: 6)

Smell is widely regarded to be the most evocative stimulant of any of our senses (Herz 2004), conjuring up ineffable scenes from our past at the merest whiff of a familiar odour. Trygg Engen, a noted scent researcher, believes that an experience gets coupled to a smell along with a "hedonistic" valence, which stays with us throughout life. (Engen 1991:16) Because of this, the ability of odours to affect us is powerful.

All odours are formed from odorant molecules, simple or complex. The ability of the human to recognise 10,000 odours with our approximately 1000 smell genes seems remarkable, but does not even begin to match the olfactory prowess of animals such as dogs. (Buck and Axel 1991) Humans require a surprisingly small amount of odorant molecules to smell something, fewer than a dozen for strong smell compounds. (Engen 1982: 4) These few molecules are wafted or

breathed into our noses where they activate smell receptors located in the olfactory epithelium. (Matlin and Foley 1992: 403-405) The signals from these receptors are relayed to the olfactory bulb and then take two paths to get to our brain. The first path is extremely fast, as it is, according to Engen (1991:110) "only one synapse away from the olfactory bulb." This path triggers near instantaneous responses from our most primitive brains regions, those involved in survival mechanisms. It is also this old brain, sometimes called the smell brain, part of the limbic system where emotions are triggered. The other path smells take is through the thalamus to the olfactory cortex and finally to our brain's frontal lobe where we can recognise it and decide on a cognitive response. Engen notes that the reason so many smells are indescribable is because in the shorter, faster path, we are experiencing a sensation and response before there is any connection to our brain's language centres. (ibid.: 110-111). Smell is also strongly linked to emotion and emotional response, as the limbic section of the brain is also responsible for this aspect of our human nature. (Trygg 1991: 64) This makes smells capable of generating strong affective reactions.

To date, scent has been minimally used in virtual environments. Several reasons may account for this. Equipment that delivers scent to virtual environments has traditionally been limited to large devices that fill a space with odours that are subsequently difficult to clear away. People also have a wide range of reactions to odours. What is pleasant to one person may be perceived as obnoxious to another. Familiarity also plays a role. Because odours travel to the emotional centres of the brain, the first reaction is usually a strong like or dislike, before we even consciously identify the smell. If we know the smell, it will most often seem pleasant; if not, we will immediately tend to brand it as unpleasant. (Engen 1991: 13-16) Therefore, it is difficult to predict the effect that a specific smell will have on any given experient. VE creators who wish to incorporate smell have to realise that the same odour may affect different people in very different ways, holding positive associations for some, and negative feelings for others.

There is also no simple way to fabricate or mix the 10,000 scents we can recognise. Where light has primitives of red, green, and blue, with which all other colours can be mixed, there is no such simple formative mapping for olfactory signals. (Dulac 2006) (Mori et al. 2006) Scents used in virtual environments must therefore, be individually chosen, or mixed from elemental odours in advance of the experience.

In spite of these issues, it is clear from olfactory research that scents can add a strong emotional power to virtual environments. (Herz op. cit) Because of this, I incorporated a scent component into my virtual environments *DarkCon* and *The Memory Stairs*. To deliver scents to the experient, I designed a custom scent collar, as introduced in Chapter 1. Worn around the neck, this collar holds and delivers a number of unique scents. (The prototype can hold four, one in each cartridge in the collar.) The scents (I use primarily oils, or mixtures of oils) are placed in the bottom reservoir of a cartridge. Via a wireless signal, the collar releases a desired scent directed towards the user's nose.[39] The designer can program or set the desired flow rate, interval and duration for each scent individually, appropriate to the intended effect. In this way a variety of scents, from powerful to evanescent, can be delivered to the experient at appropriate places in the experience. Because in the virtual environment smells are produced by actual molecules, and not a digital representation, they are processed as any other scent would be in the physical world. One limitation in adding a wide range of smells to a virtual environment is in the number of unique scents the delivery device can support. Finding a broad range of scents for VR use is also difficult, especially for scents that do not have a commercial purpose.[40] Scents often need to be mixed from available odorants to be able to achieve desired aromas suited to the environments, and this is a skill that must be developed over time. Perfumers, for example, study years to be able to combine scent molecules to produce well-integrated complex mixtures. Finally scent suppliers prefer to sell large quantities (on the order of 25 gallons), far beyond what a virtual environment could use.

These challenges aside, I have found in my practice that the quality of the experience is profoundly enhanced by the use of smells. One visitor to *The Memory Stairs* anecdotally remarked about his experience: "I cannot clue in on the vocabulary to describe, but the world filled my heart."

3.2.4.4 Haptics

Haptic interfaces are concerned with the technical means needed to make use of the extensive and exquisite capabilities of human touch. (Hayward et al. 2004: 18)

Haptics interfaces can contribute enormously to the perceived realism of virtual environments, lending a strong sense of physicality to the VE's weightless, ephemeral elements. Our skin, the outer body covering which receives most of our tactile inputs, is our largest organ. (Arnould-Taylor 1998: 86-87) Ashley Montagu, who devoted his life to the study of touch, says (based on medical evidence) that all other senses are derived from our skin; our sense organs are, in fact, specialised skin segments. (Montagu 1986: 3-5) Virtual environments without this sense can be convincing, but VEs will lack the full human experience (and fulfilment of its original promise) until detailed touch is integrated.[41]

Researchers have been pursuing many paths to achieving a viable "haptics display," and, while these efforts have not reached the type of consensus that head mounted displays, dimensional audio, or even smell have, there is progress being made. Instrumented gloves provided the first early examples of tactile feedback. Mechanisms that push against the fingers or parts of the hand are embedded in the glove and receive signals from the VR engine that regulate the amount of force felt. Another type of device uses external linkages arranged outside the glove, like an exoskeleton, that produce resistance the user equates to touching or feeling an object. (Marcus and Sturman 1991) A very small number of full body tactile suits have also been designed and built using tactile transducers (tactors), but manufacturing cost

and difficulty of use preclude their widespread adoption.[42] (Lindeman 2004) (Bloomfield and Badler 2003)

Still, even simple forms of haptics can create a powerful sensory effect. The sensors deliver a sensation to the skin and the skin reacts in a responsive way, sending information back through the haptic device. According to Hayward et al. (2004: 18) this bidirectionality of haptic devices is its most desired feature, and the one with which haptic devices generate a "strong sense of immediacy." (ibid.) Hayward distinguishes these directions as the "read" and "write" capabilities of haptic devices, noting that most other VR sensory input devices do not have this two-way conversation with the body. Not all devices need to both read and write. For example, a force feedback steering wheel coupled to a driving simulator gives a strong haptic sense, but does not react to the hands that are holding it, so it does not know if the user is gripping it tightly or casually holding on. In laparoscopic surgery trainers, the cutting instrument held by the doctor delivers a resistance based on the calculated density of tissue it is encountering, and so does exhibit the desired bidirectionality. Haptic devices have been or are being developed for several real world purposes, such applications in the health sciences (McLaughlin 2006) including stroke rehabilitation (Rizzo et al. 2005).

Though this bidirectionality is the ultimate goal of haptic researchers, few haptic devices in 2007 have this feature within immersive virtual environments. When it is achieved and in use, experients will be able to pick up a virtual egg and crack it if they squeeze too hard, or feel the firm handshake of another person in the world.

There are tremendous challenges to creating a high resolution functional haptic system. Today's devices have extremely localised feedback as compared to the sensitivity of full skin organ that encompasses us. Neither are our tactile responses uniform across our bodies, a situation that complicates the development of such devices for virtual environments. For example, our skin has a two-point discrimination, which is different for each person, and varies across different body parts. It can be illustrated by two toothpicks touched to the skin. If far

enough apart, one will be able to distinguish the two tips, but moving them closer and closer together will eventually result in a perception of only one point touching the skin. (Villis 2006: 7-7) The differing resolutions of body parts for touch is known as somatotopic organisation or mapping. Our tongues, face and fingertips have the most resolution, and other areas, such as knees, feet, and the back have the least. A full body haptics system would therefore need a variable sensor density system to be as convincing as reality.

Until that time, there are other means at the VE designer's disposal to create some indication of haptics. Being able to pick things up, even without haptic feedback, can still convey a sense of touch. Pinch gloves and single or two-handed data gloves provide this level of interaction. (Sturman and Zeltzer 1994) (Mapes and Moshell 1995) Simply having the location and configuration of the hand in proprioceptive space coupled with the visuals and other supporting techniques, may be sufficient to cause a participant to believe, at some level, that he or she is picking up that object. These techniques include sounds that indicate when a virtual object has been grasped, or short loud sounds that occur when a collision with some object takes place, this last containing perhaps a strong base component that has a visceral impact on the experient. The characteristic of deep bass, or subwoofer, sounds to create a physicality is used often in films and even music.

Further exploiting this concept, infrasonic sounds (that are below the threshold of hearing as previously described in the discussion on sound) can produce significant vibrational signals that can be used for effects such as heavy trucks passing by, thumping engines, or the rumble of an earthquake. This is a very visceral form of sound, which I refer to as "passive haptics" as it is essentially part of the environment and not caused by direct contact with the experient. Being able to include a tactile component to the immersive world, even in their current nascent forms, is another unique aspect that sets immersive worlds apart from more ordinary representational schemes.

3.2.5 Form of the VE work

The designers of Disneyland, the builders of cathedrals, and even the humblest gardeners of Kyoto Zen gardens understand the power of the environment to influence our inner world. (Pimentel and Teixeira 1993: 237)

The VE creator combines varying proportions of the elements discussed thus far to form the sensory and environmental envelope that aligns with his or her intent in building the work. Yet this envelop is far from complete. The embodied experient possesses free will during the encounter with the virtual, and can make individual choices. He can travel right or left, interact with this object or not, stay in one place for minutes, run through the entire environment as fast as possible, and even miss some triggers or entire sections. The final experience can never be fully mapped out ahead of time, and therefore the ultimate form of the work will be different for each person who experiences it. The artist, the creator, will never know exactly what decisions might be made. This unique characteristic of immersive virtual environments—their emergent nature—compels a distinct design approach.

3.2.5.1 Design for emergence

Designing for emergence removes the artist from the role of an authoritarian author of a finished text. Instead, the environment becomes a place where events *can*, but do not *have to*, happen. By bringing their own being, thoughts, needs, desires, and experiences into the space and interactive possibilities of the virtual environment, participants make significant contributions to the final form of the experience. In addition, the system itself can be an active player, subject to emergent behaviour, even if it is not explicitly programmed into the code. Such "accidents" or "glitches" can even provide a new direction, feeling, or motivation for the experient. Thus, the ultimate experience comprises a triadic relationship amongst machine, artist, and experient.

Various methods have been incorporated by artists to elicit control over their works. In *The Thing Growing* (1997), an immersive CAVE experience, artists Josephine Anstey and Dave Pape imposed a three-

act play structure on the experience. (Anstey et al. 2000) After certain events have happened, the next act begins; the experient has little control over the progression, which is determined by the creator. This is the case in many narrative-focused VEs, yet some descry its use. As Steve Dixon quotes Brenda Laurel and team "A hard-driving plot is… a great way to control how long an experience takes… but classic VR is inimical to this type of authoritarian control." (Dixon 2005: 393) In Laurel and Strickland's *Placeholder* (1992), the role of director played by Laurel herself bypasses a prescribed narrative structure for a more improvisational means of control, one that nonetheless ensures that the experients progress through a more impromptu form of drama (a need which may be more crucial for multiplayer agency). (Laurel et al. 1994) In my own practice I have developed techniques to unobtrusively "steer" the experient towards my desired paths, which I collectively call "coercive design." The experient is not consciously aware that there is any coercion going on. This technique is discussed in detail in Chapter 6, and is another mechanism to avoid use of a "hard driving plot," which, while it has some validity, does not take full advantage of the nature of the immersive environment.

3.2.5.2 Female creativity

The topic of gender in immersive virtual environments is evident not only from VR's history, but also in the preponderance of artistic VEs that have been designed and created by women. My survey of nearly one hundred artistic VEs shows that approximately 62% of them have been designed and/or created by women. (See details in Appendix B.). Male designers of virtual environments have tended to approach the medium as a rationally built world; an architectural and (typically) dispassionate space, designed for a "serious" purpose. It is obvious that there is a different aesthetic at work in female-designed immersive environments, which are typically made to be art. While art is a serious purpose (in some, but not all minds) it is rarely rational or dispassionate. In fact, in my experience I have noted a strong emotional component to VR work created by women. A few examples illustrate my conjecture.

Nicole Stenger's early VE work *Angels*, introduced in Chapter 1, was the first major work by a female in this male-biased technological domain. That it was not widely experienced did not detract from its ethereal and poetic utilization of the medium. (Popper 1993: 102-3) The angels were separate entities whose ultimate fate was to merge, like lovers, into a single being. At The Banff Centre in the early 1990s, the works of Toni Dove, Diane Gromela, Brenda Laurel, and Rachel Strickland all stand out as being more emotionally and aesthetically oriented, whereas the work of the all male teams at Banff tended to focus on more technical themes, such as, for example, mathematical shapes. (Mosher and MacLeod 1996)

Rebecca Allen probes the freedom of the spirit in her work, *The Bush Soul* (1998), experienced visually via an expansive setup of three large screens, with joystick navigation. She questions the location of our spirit within the immersive environment: Can part of it lodge within our avatars? All things, creatures, and objects in her worlds are alive, generating interactions and energy, communicating with the experient's avatar, a non-photorealistic dervish of colour, sound and movement.

Tamiko Thiel, whose virtual environments are shown in a secluded darkened room with a large screen at one end, and a bespoke jewelled joystick for navigation, brings a poetic sense to political injustice in her work *Beyond Manzanar* where she emplaces the experient in a deserted virtual recreation of the infamous World War II Japanese-American internment camp in California. The virtual Manzanar is still inhabited by the sights and sounds of those times, and poems are trapped along the barbed wire fences. Remnants of contemporary injustice also inhabit the virtual grounds, reminding us how far we have come and still have to go. (Thiel 2001)

Maureen Thomas presents the nature of the female aspects of ancient Norse mythologies in her screen-based virtual artwork *RuneCast*. The space is open and endless; the narration is provided by the voice of a female shaman, Vala. Prominently figured is the Norse tree of life, the

centre of the world, which is nourished by three women, from their "well of becoming." (Thomas 2007)

Margaret H. Watson's *Liquid Meditation* (1999) provides CAVE-based immersion into an environment where "water pulses and flows infinitely in a world where moments can continue for an eternity." She hopes her work will serve to re-instil a bond linking humans and nature. (Watson 1997)

These women and others discussed within this thesis have all helped expand the possibilities of what can be done. It is not that there are no men working in the field, but I argue that the truly unique works appear to emerge from a feminine approach. This approach seems well suited to immersive environments as it incorporates aspects of inclusion, wholeness, and a blending of the body and the spirit.

Female attention to holistic concerns fits the gestalt approach needed to create in a fully functional yet open-ended virtual world. It focuses not so much on producing a finished object (like a text or a sculpture) but rather on creating a possibility for becoming, like bringing a child into the world. Immersive VEs are not objective works of art to be hung on a wall and critiqued. They are vehicles for experience, vessels to live within for a piece of time.

These tendencies may be accounted for, in part, by recent studies by Larry Cahill and colleagues, of differences in male and female brains. Under resting conditions it appears that, in females, the left side of the amygdala (the primitive emotional centre of our brain) show strong functional connectivity to the rest of the brain, while in males it is the right side that is strongly connected. Men's right amygdalas connect to brain areas concerned with sensory, motor and attention functions, while women's left side is connected to areas attuned to "attending, to and controlling aspects of the *internal* milieu." (Kilpatrick et al. 2006: 454) (emphasis mine). This outward/inward orientation, they hypothesise, may explain why females get digestive ills when they have an emotional occurrence, and men may have the urge to go somewhere. Neuroscience research continues to explore several

sexually based brain differences, anatomically, functionally, and neurochemically. While much more corroborative experiments still must be done before sex differences can be positively ascertained, the evidence appears to be mounting. Cahill and colleagues have reported several studies that continue to support the differential lateralization of brain functions, especially involving the amygdala, which is implicated in the formation of emotions and of long term memories. (Cahill et al. 2001) (Canli et al. 2002) (Cahill et al. 2004) Decision-making too, seems to have sex-related differences. (Tranel et al. 2005)[43] Shelly Taylor (2000) has recently proposed gender differences in the "flight or fight" reaction so often described. Citing that studies about this response were done primarily with males, she postulated that females have a different response. Due to their nurturing and parenting roles, she says the more appropriate description of their response is to "tend and befriend." She supports this with evidence of the different neuro-chemicals released in males (vasopressin) and females (oxytocin) during intensely stressful situations.[44]

Such differences, which are only beginning to be revealed by modern neuroscience, may serve to reveal fundamental biological differences in male and female creative modalities. It may not be too much to assume that females create VEs from a unique neurological and thinking perspective, a decidedly feminine perspective.

3.2.5.3 Feminist crucible

Hélène Cixous and other feminist theorists study how gender is created and/or destabilised within the structure of a medium, with a particular focus on writing. In their view, the quintessential male gendered implement of creation is the pen, both for its output of logical writing as well as its phallic symbolism. (Cixous 1990) While VR technology was created in a predominantly male-gendered milieu, I argue that many VE experiences have transcended these origins. In my view the immersive environment (so similar to the exclusively female domain of the embryonic chamber) is the perfect vehicle for feminist aesthetics, becoming in some sense, Cixous' perfect "l'écriture feminine." (ibid.)

Cixous' thought coincides with my ideas surrounding the creation of immersive virtual environments. I believe, building on the theories of these feminists, that if a text is inherently male, then a virtual environment is inherently female. It is a "writing through the body" in Cixous' primary sense.

Though Julie Kristeva argues against a primarily feminine voice, she discusses the maternal body as a unique process lying at the boundary of the pre-verbal (her *semiotic*) and the symbolic, connecting nature and culture. (Kristeva 1984: 26-27) In this passage by Kelly Oliver describing Kristeva's views, the sensibility can be seen as similar to that of Cixous' concept of "writing through the body."

> By insisting that the maternal body operates between nature and culture, Kristeva tries to counter-act stereotypes that reduce maternity to nature. Even if the mother is not the subject or agent of her pregnancy and birth, she never ceases to be primarily a speaking subject. In fact, Kristeva uses the maternal body with its two-in-one, or other within, as a model for all subjective relations. Like the maternal body, each one of us is what she calls a subject-in-process… (Oliver 1998: 2)

For Kristeva, the maternal body that protects and nurtures the process of becoming, makes the feminine aspect sacred. (Clément and Kristeva 2001: 69-70) While not all feminists agree with Kristeva's concepts of the maternal body (see, for example Judith Butler 1990), the concepts of the "two-in-one" and a "subject-in-process" (or what Kristeva has termed the *semiotic chora* (Kristeva 1984: 26)) resonate with my own views of the VE experient. I will explore these concepts further in Chapter 4, in the context of the nature of "being" in virtual environment.

Charlotte Perkins Gilman, many decades earlier in her book *The Man Made World*, (1911: 46) stated this about the difference between men and women and their innate urges: "The basic feminine impulse is to gather, to put together, to construct; the basic masculine impulse is to scatter, to disseminate, to destroy." She felt that as women bear and raise children, while men have an affinity towards machines, and

mechanistic pursuits, these gendered tendencies set up a dialectic between the male and female, the organic and the material that takes place at the boundary where they come together.

As Donna Haraway states in her foundational *Cyborg Manifesto*: "the relation between organism and machine has been a border war." She puts both the enjoyment of these borders and the "*responsibility"* for their "construction" (emphasis hers) on us. (Haraway 1985: 66) This seems to confirm our role as creators and our potential to steer the shape of those borders, their permeability, their meaning and their gendered nature.

> From one perspective, a cyborg world is about the final imposition of a grid of control on the planet, about the final abstraction embodied in a Star Wars apocalypse waged in the name of defense, about the final appropriation of women's bodies in a masculinist orgy of war. From another perspective, a cyborg world might be about lived social and bodily realities in which people are not afraid of their joint kinship with animals and machines, not afraid of permanently partial identities and contradictory standpoints. (ibid.: 71)

The immersive virtual environment, as a feminist crucible, may be the anodyne to this cyborg world, a creative space wherein the shape of those borders can be steered, and where people live in joint kinship with and within immersive virtual environments.

3.2.5.4 Co-creation

I do not know which of us has written this page.
--Jorge Luis Borges in Borges and I (Borges 1964: 200)

The relationship between artist and experient in interactive virtual worlds is highly entwined. Each actively contributes to the form of the final work, making co-authorship an integral principle of immersive worlds. Artists have, in some ways, always been accustomed to this—what they intend in a painting or sculpture is not always what the viewer takes away from it. This is also true of writing. In *S/Z*, Roland Barthes concludes that ideal text is open to a variety of meanings and interpretations. He calls this a *writerly* text, the goal of which is to "make the reader no longer a consumer, but a producer of the text."

(Barthes 1974: 4) Eco too, maintains that the role of the reader is an active, not passive one. "Hence every reception of a work of art is both an *interpretation* and a *performance* of it, because in every reception the work takes on a fresh perspective for itself." (Eco 1984: 49) If this is so for texts and art, it is even more so for the medium of virtual environments, which, because of its embodied and ontological nature, amplifies this co-creative process.

As previously discussed, the artist creates a space of possibilities to enable an experience, the exact form of which is not explicit, but which supports the direction the work is trying to travel. Pierre Lévy describes this as a form of collective intelligence, where

> …the artist now attempts to construct an environment, a system of *communication* and production, a collective event that implies its recipients, (and) transforms interpreters into actors… (Lévy 1997: 129) (emphasis mine)

The experient brings his or her contributions to the work and must actively determine what they get out of the experience. This is the challenge and the blessing of creating immersive environments: the user can experience the environment in ways that the creator never imagined.

I also note that there is a third partner in the conversation of a virtual encounter. The equipment and technology that facilitates the experience both enables the conversation and adds its own contribution. This can be subtle or obvious. A special piece of code that recognizes certain actions and presents random responses to them, for example, can contribute to the shape of the experience. In Davis' *Osmose (1995)*, the text of the code, green on black, becomes one of the ethereal visions, floating past the *immersant's* (her term) space as if she were seeing through the machine's eyes.

3.2.5.5 Ritual connection

Rituals are things that people do. They are not meanings buried in words. They are meanings expressed through actions. (Robert St. Clair 1999b: 1)

Rituals are prescribed sets of activities engendered by a culture (or a person) by which relational skills, both social and intrapersonal, are inculcated. These activities are often performative, meaningful, and transformative. They typically involve ceremonies and a space outside of everyday life where the ritual actions are supported. Jonathan Z. Smith, Professor of Religious history at the University of Chicago, calls ritual a "focussing lens" that assists humankind in seeing what is most significant in life's journey. It also serves to bridge the gap between the real and the ideal. (Smith 1982: 64-65)

The contemporary study of rituals grew out of the work of 20th Century anthropologists and sociologists such as Max Gluckman and Victor Turner. It has absorbed inspiration and ideas from many other disciplines and scholars, such as mythology (Sir James Frazier, Joseph Campbell), psychoanalysis (Rudolf Otto, Carl Jung, and Sigmund Freud), psychology (Jean Piaget, Erik Erikson), and anthropological neuroscience (Eugene d'Aquili, Charles Laughlin, Barbara Lex).

Rituals have existed in human society for millennia, and there is ample evidence that shows even animals express ritualistic behaviour. (d'Aquili et al. 1979: 28-29) The difference for humans is that we add a cognitive component to the ritual process; we assign to it a meaning. It is conjectured that much ritualistic behaviour, in humans and in animals, may be aimed at "overcoming social distance between individuals" to enable stronger bonds that increase the chance of the group's survival. (Guthrie 2000: 1)

Ritual Stages

Arnold van Gennep delineated three phases of the ritual process: a preliminary phase, the liminal phase, and finally the post liminal portion. (van Gennep 1960) Victor Turner focussed on the liminal stage and expanded it to cover modern forms of non-sacred activities, especially those permitted by the rise of leisure time among the middle class in the 19th and 20th centuries. To distinguish secular from sacred, or *liminal*, activities, he gave them a similar name, *liminoid*. (Turner 1982: 33-34) Such activities include sports, games, and other manner of leisure play and even escapism.

According to Turner, the liminal, as well as the liminoid, are both threshold conditions that take one outside of the everyday for a period of time. They serve to refresh, renew, relax, or perpetuate significant change. However, he distinguishes the two concepts even further. Ritual activities that support the tribe, that are pluralistic, social and shared, such as those of pre-industrial tribes, are the foundation of liminal activities. Liminoid actions are also on the edge, but tend to be at odds with social establishments (unlike the liminal, which is an integral part of the social fabric). Liminoid activities, according to Turner, typically comprise "idiosyncratic framing, individual reflectivity, subjective flow, and see social as problem, not datum." (Turner 1979: 494) Artists creating work and people experiencing such creation often share characteristics with the liminoid as described by Turner.

Private Ritual

While ritual scholars such as Roy Rappaport have called ritual the most basic social act (Rappaport 1999: 137) ritual does not belong exclusively to the group; many rituals are individual and private. Mediation is one such meaningful, more personal, ritual, with a space set aside that is singular and usually private. Anthropologists such as Emil Durkheim (1912) explain rituals as a means of behaving in the presence of the sacred, and, according to Catherine Bell, such codified conduct can serve to structure communal experiences that not only provide a reintroduction to the private self, but also reaffirmation of the larger society of which it is a part. Moreover, Bell maintains, it does this in an emotional way. (Bell 1997: 24) Others (Bell cites Radin, Malinowski and Lowie, for example) situate rituals with more "personal feelings, such as reverential awe, exhilaration, or fearful anxiety." (Bell 1997: 25)

So it is clear that while the process of ritual has strong social components, it also, especially in our day and age, includes singular and individual qualities of the liminoid, as does the immersive virtual environment, by instantiating a strong personal liminoid space.

Immersive virtual environment artists, for the most part, eschew outwardly motivated ritualistic enactments, in favour of inwardly directed and private ones, ones that call or re-call to mind tender insights, wrenching shocks, or possibly forgotten memories that bring meaning to the fabric of our individual lives—that tap us into what Grimes calls "inescapable rhythms, …or deep processes." (Grimes 2006: 71) The VE works of Char Davies (*Osmose* 1995 and *Ephémère* 1998) fit well in this category. They provide a space for private exploration into ethereal realms and bring one in touch with a solitary internal milieu, in part by use of one's rhythmic breath as the navigational device—breathing in to rise and out to descend. (Davies 2003: 329) The *Ashes to Ashes* (2004) six-sided CAVE environment by Anne Dean Berman, Carolina Cruz-Neira, Steve Berman, and Larry Tuch, is a ritual re-enactment of emotional responses to the 9/11 disaster, as experienced by the people who were present. It is not a dry written description—mere words on paper—but a true ritualizing. (This work will be further discussed in Chapter 5) Ritualizing is action, living, transpiring; the moving of one's consciousness through some experience without knowing a fully formed (and static) structure. Grimes explains, it is "how we actively await formative pulsations. The goal of ritualizing activities is not to be original—this is a modern aesthetic concern—but to locate and attend to originative impulses." (Grimes 2006: 74) In *Ashes to Ashes* the experient is moved through what it felt like to be at the centre of an intense emotional upheaval, allowing one to resonate with the core experience.

Ritual Space

Immersion in a special space is also a characteristic of ritual. Jonathan Z. Smith, in his book *To Take Place: Towards Theory in Ritual* (1992) emphasises the role of constructed place in the ritual form. Such a space is a ritual wrapper that enables and supports the ritual act. More than a simple setting aside, a space is essential to the shaping of the ceremony, the form, and the thought of the ritual itself. Immersive environments are similar in that they set aside a private and special place for the experience to happen, and contribute unique qualities to the form, in much the same manner as ritual.

Ritual and the Senses

The sensory manifestations that surround the ritual act are also important. Smells like incense, sounds, chanting or droning, visuals like mandalas, all support the action and purpose. Grimes says (2006: 70) that a ritual enactment "is action thick with sensory meaning." A multisensory virtual environment, where the artist imbues the sensory envelope with meaning and intent, has this in common with ritual.

Ritual as a Return to Direct Experience-Ritual as Resonance

Robert St. Claire maintains that ritual, unlike our more symbolic means of communication (words, pictures) sets up a resonance by its enacted nature. He maintains as a "way of knowing and understanding" ritual was, in the past, able to convey messages without words, through rhythms, chants, movement and contact. This recalls Julia Kristeva's *semiotic chora*, introduced earlier in this chapter, which refers to the "kinetic functional stage …" that "precedes the establishment of the sign" (Kristeva 1984: 27). Today, St. Clair argues, we have replaced such knowing with language as a system of signs, but one that is no longer direct, being instead a representation of the original enactment. "The printed word becomes one of the new codes of representation about the experiences of life." (St. Clair 1999: 72-73) Foucault, in his *Archaeology of Knowledge* (1969), called this situation an "epistem-ological rupture" as, according to St. Clair, "the event itself was no longer important in the new cultural framework. It was replaced by the new importance attributed to representation. The retelling of a story became more important than the …actual live experiences themselves." (ibid.: 72) All this, St. Clair says, resulted in a "richness of meaning" collapsed "into a poverty of forms." (St. Clair 1999b: 2) He goes so far as to call the dictionary and the grammar of a language "books of the dead" because of their far remove from direct action. He especially notes that so many experiences cannot be put into words, and that the purpose of poets and artists is to bring these ineffable experiences to light. (ibid.: 3) The role of the virtual environment artist is to create such experiential worlds consecrated to one's inner response mechanism.

Ritual also serves to keep a balance between the internal and the external, but we live in a time where the modern world has usurped older ritual patterns. Julian Huxley, as well as others, has noted that the elimination of what was previously ingrained in our ritual patterns creates an imbalance that negatively affects everything from communication and social bonding, to aggressive tendencies. (Bell 1997: 31) Such a situation is tolerable only if other experiences are pressed into service to fulfil the lost functions, and Bell believes these are possible:

> In modern life, it is suggested, we may be removed from the more overt and primitive forms of these patterns and rhythms, but any such form of "estrangement" also testifies to the power of a potential return to meaning. This is the heart of the perennial philosophy of universal myth and ritual patterns that continues to speak to the imagination of new generations. (ibid.: 22)

What can replace them? Turner's liminoid seemed to point to a solution, but entertainment may not correspond in equal measure to more meaningful events. Hillis speaks of the commoditisation of experience that is ubiquitous in amusement parks, our themed malls and cosy coffee shops, and even our sporting events. (Hillis 1999: 28) Is it possible that we could move towards transcendence over commoditisation with our VEs? I believe this is the case.

Ronald Grimes says "Ritualists dance ... to discover new ways of inhabiting space. This is the noetic, or divinatory function of ritual; ritual helps people figure out, divine, even construct, a cosmos." This new dance with technology, offered by the mechanism of virtual environments, may help us construct a new meaningful cosmos.

Affective Ritual; Ritual and Brain States

Ritual affects us not only psychologically, but also physiologically and neurologically, through mechanisms that are just beginning to be explored. One group of ritual researchers, the biogenetic structuralists (sometimes also known as the neurophenomenologists), believe that ritual is not merely a cultural phenomenon, rather it is hard wired within our neurological brain structures. Even before birth, each child is genetically programmed towards ritualistic behaviour, in a process

they call *neurognosis*. We therefore engage in such behaviour whether we do so in a proscribed cultural sense or not. As Ronald Grimes says, "These impulses are essential to being human; they permeate human actions ..." (Grimes 2003: 36) The neurophenomenologists also propose that ritual serves to set up resonances within our neurophysiology that cause physiological changes in our brain structures, and indeed, that such resonance, formed by ritual or by other means, is a formative element in consciousness. A full discussion of the mechanisms by which they argue this happens is beyond the scope of this thesis, but the basic concept involves what Barbara Lex describes as a simultaneous stimulation of ergotropic (heightened activity, arousal, augmented sympathetic responses) and trophotopic (relaxing, calming, increased parasympathetic responses) physiological systems. This sets up the aforementioned resonance, combining the two aspects into a holistic, interconnected brain state. (Lex 1979: 134-136) Furthermore, Lex states "… evidence that ritual trance involves shifts in hemisphere dominance and trophotopic-ergotropic balance is extrapolated from neurobiological analysis of Yogic and Zen meditation and ecstasy…" (ibid.: 138). Victor Turner, greatly influenced by the biogenetic structuralists, was working with similar ideas of the brain and ritual when he died. (Turner 1983)

More recently, neuroscience has begun to look more closely at the inner workings of meditative states, and is starting to achieve consistent outcomes, according to Rael Cahn and John Polich (2006). Their recent survey of experiments studying functional brain changes in meditative states covers methods from EEG and ERP (evoked sensory potential, cognitive event related potential) to PET and fMRI scans. A picture is beginning to emerge that indicates strong evidence for specialised states in human experience that bring meaning, understanding, and a feeling of wholeness to our lives. We gather this ineffable knowledge in specific neurophenomenological ways, and we are changed by it.

I believe we can gather/accumulate this same sort of knowledge and achieve similar states in virtual environments by their unique nature.

It is feasible that they could serve as places for personal ritual, sacred spots, or ethereal places of transcendence. Though there is a great deal of work to do before virtual environments such as these become widespread, I posit that they are beginning, through the efforts of arts and creative teams who see more than a substitute for reality in their immersive digital creations.

It is too soon to tell if the uses of virtual environments as a transcendent means of ritual endeavours will truly be able to suffuse experience with power of a transformative character, but I believe they have this potential.

3.2.6 The real effects of the virtual

While there have not yet been studies that measure the physiological and neurological effects of being in a ritualistic or meaningful virtual environment, there have been some notable studies that show VEs produce very real effects in experients. I will use a few as examples, though more are being done every year. The first shows how a significant number of human subjects respond to a virtual version of a known stimulus in the same way they do to a real one, and the second uses animal subjects to show the correspondences between the perceptions of virtual and real space.

In the early 1960s, psychologist Eleanor Gibson described her now famous visual cliff experiment. (Gibson and Walk 1960) For this experiment, she created an experimental environment with surfaces of two different heights: one at surface level contiguous and one positioned a few feet below the surface. A black and white chequered cloth was then draped over the surfaces. Next a large sheet of heavy clear plastic was placed to cover the entire setup, creating the perception that the floor drops sharply, even though the plastic makes the surface level physically continuous. A baby is placed on a board set at the junction of the two sides. Babies who have learned to crawl (typically from six months on) will show emotional stress when called by their mothers from the far side to cross the deep space, even though there is no physical threat. They even hesitate when they can feel the plastic surface with their hands. They show no such hesitation while

on the shallow side, only when they reach the 'drop.' The act of crawling has presumably given them enough visual knowledge of how physical space works that they will not crawl over the illusive drop.

Fred Brooks and colleagues at the University of North Carolina replicated a similar setup within a virtual environment. With 3D modelling tools they constructed a sunken room surrounded by a ledge that was experienced with a stereo head mounted display. The stereo view reinforced the illusion that the sunken room was located about 10 feet below the participant's position. The visitor was instructed to drop a ball onto a target within the pit room and to do this he or she had to walk to and lean over the edge of the ledge. There was a small section of moulding on the floor that the feet touched that served to provide physical corroboration that there was a real ledge in the virtual space. Even seasoned VR veterans had difficulty overcoming the feeling that the pit was real. When I experienced this space, I got a visceral gut reaction to being on the edge and looking down. Physiological signals collected from the participants during the experiments showed that the virtual cliff provoked the same physiological responses as the traditional visual cliff or a corresponding real space. (Meehan et al. 2000)

So convincing is the spatiality of VEs that even animals, whose understanding of such an environment would be direct (rather than overlaid with the metaconscious as would be the case for humans), are fooled. Recent scientific experiments have confirmed this. Rats, outfitted with a specially constructed HMD that recreates rat-centric vision, are able to traverse a virtual maze with no difficulties. (Holscher, Schnee et al. 2005) What fooled the rats into the spatial traversals they accomplished in a space that did not "exist," unless the experience correlated with the same cognitive neural mechanisms that process reality?

Finally, the increasing use of virtual reality in clinical therapy to treat serious conditions such as Post Traumatic Stress Disorder experienced by returning war fighters is yet another testimony to the real effects achievable with immersive virtual environments. (Rizzo 2006)

3.3 Conclusion

In this chapter I have presented my arguments for why I believe immersive virtual environments are a unique cybermedium, unlike any other digital media. I have discussed how the enabling equipment of virtual reality facilitates the emplacement of an experient within a separate and private space, and concomitantly seals out real world sensory inputs. Thus sequestered, pro tempore, the experient perceives the sensory inputs in virtual immersive environments in much the same way as normal sensory signals, though there are a few differences, mostly predicated on the incomplete development of the technology in 2007. I have shown the importance of our bodies to the immersive experience, and how embodied senses are stimulated by the VE experience.

I also explained the dialectic of VR/VE as technology *and* medium, and its contribution to the meaning of the message. Artists have expanded the possibilities of the medium beyond its more ordinary implementations, going beyond re-creation, forging original experiences that have meaning, and often transformative affects, upon the experients. To create such experiences, a new gestalt approach is needed, and I introduce methods and ideas from my own practice that can inform the creation of virtual environments. The task of the artist in creating an experience to which an experient also contributes is essentially to set a stage that invites interaction, or a place that allows an unfolding of the experient. Describing some examples of meaningful virtual artworks, I noted the preponderance of female artists in this medium and proposed some reasons why creating virtual environments may be especially suited to a female sensibility, looking to recent discoveries from neuroscience as well as the writings of feminist theorists. I also express my beliefs that immersive environments serve a personal and private purpose, similar to rituals. Finally I cited recent experiments that have empirically shown the capability for virtual environments to affect us in much the same ways as real events.

Within this chapter, I have introduced or defined the terms experient, emplacement, embodied tracking, dynamic spatialised sound, head-

related transfer functions, haptics (touch), passive haptics by means of infrasound, the combinatorics of sensory inputs, and entrainment. In the next chapter, I apply these new terms and concepts to the subject of what it means ontologically to exist within a virtual immersive environment.

Chapter 4 Being and immersive environments: Interaction, embodiment, and experience

Introduction

Whereas this thesis as a whole argues that traditional virtual reality is orthogonally positioned to other forms of cybermedia such as computer games, online worlds, social community software, and interactive artworks, this chapter sets out terms of reference for the sense of 'Being' that distinguishes virtual environments from those forms. Because immersive environments are a unique medium (as I have argued in Chapter 3) the way we exist within them entails special ontological qualities.

I begin this chapter by discussing three levels of associating with media. The first involves the recipient's passive acceptance of the media. In this mode I position temporally linear media such as films and texts that primarily engage our eyes and ears. The second mode includes computer-based games and other interactive artworks, such as computer-based installations. Here interaction involves a volitional process where the participant is an interactor. The final mode comprises immersive media, and experiences that involve an inhabiting. The fullest expression of this last mode is the immersive virtual experience.

After describing the three levels of experience, I will explicate the ontological nature of immersive virtual environments—what it means *to be* in such a construct. I start with the concepts of presence and involvement, and discuss the phenomenological implications of Being within virtual environments.

Finally, I look at embodiment and representations of the self, including the nature of emplacement of the body within the virtual space. I introduce my concept of *the bifurcated body* inhabited during the immersive virtual experience. I follow this with a discussion of possible actions within the virtual constructs and the qualia of such agency. Agency leads me to avatars and role playing, from whence the question of narrative must be addressed. I examine the connections

between narrative and experience, where the former is a form of codified signification via story content set in advance of the telling, however that telling is delivered, whilst I believe experience constitutes the elemental mode of Being within immersive environments prior to any signification.

I conclude the chapter with some thoughts on the ritual potentials of immersive experiences.

4.1 Forms of media and their interactions

Media such as film and literature have been the objects of extreme scrutiny by theorists from many disciplines. They have been examined for their intrinsic nature, their quality of involvement, and both semantic and semiotic layers of meaning. Literary metaphors have, in fact, been adapted to many other media. For example, we use the term *text* to refer to any authored work, and *reader* to denote the person who experiences that work. Newer forms of media, especially those collected under the heading of cybermedia, have expanded the playing field through several levels of user interaction, from passive media to fully immersive virtual environments. This range insists that we call into question the role of the body in such media.

4.1.1 Passive media

Books are engaging in a way that captures our imagination. We interact on many cognitive levels when reading a text, including using our imaginations as essential mechanisms in the visualization of the book's content. Yet film is widely acknowledged to be the quintessential medium of the twentieth century. It is a medium based on time, with frames ticking by like sub-seconds of a clock, 24 per second. It is an illusive medium; there is no motion without the passage of time and frames. As time passes, the images are passively received by our perceptual systems and merged into motion through our persistence of vision. This passive interaction with film requires us to invest attention to witness, comprehend, and make sense of the images but we do not act on the images as the things they represent, but rather for their own sake. This is the time-image of Deleuze. (1989)

Deleuze was poetic in his description of film as a time-image, time moving the viewer along like a non-linear river that doubles back on itself, with whirls and eddies. It is not causal, sequential time, as in the movement-image. Deleuze's distinctions point out that film-time is under the ultimate control of the director and the editor of the film. One can only look and follow what is presented with mental attention—a receptive, yet passive, stance. In spite of this passivity, it is evident that film has a powerful effect on our minds and our emotions. It provides a form of mental immersion that can be intense. Yet there are only images beamed into our eyes as photons, sounds vibrating our eardrums, and little active bodily interaction.

In *The Skin of the Film*, Laura Marks, restating the theories of Deleuze, says the time-image

> ... which evokes the stranded eyeball, powerless to draw on resources of common sense—questions everything about how this particular image got to be constructed from a given perception. It thus compels the viewer to start the act of perceiving all over again, choosing which part of the available image is relevant. (Marks 2000: 42)

Engagement with film involves the perception of the eyes and ears coupled with the cognitive interpretation of the mind, making film primarily a cerebral medium. Torben Grodal, however, believes that film elicits in film viewers a "sensory holism," affecting both cognitive and emotional responses, which must include the body, because, as he states: "Our minds have no direct contact with the world." (Grodal 1997: 279) The content of the film, as experienced through the body does encourage the viewer to mentally investigate the images for relevance and meaning. It can, as Marks states, draw out other memories from the viewer, "memories encoded in senses other than the auditory and the visual." (ibid: 26) Yet, I assert that film evokes these memories from what we have experienced in our fully embodied lives. It does not imprint new personal experiences from the content of the movie; the body's experience is merely that of watching the film. Thus, in the end, cinema is a shadow of the living real. As Hélène Cixous argues (comparing theatre to film), "the cinema screens us from reality by

foisting mere images upon us." (Cixous 1984: 548) The view of the film camera takes the place of one's gaze, usurps it, and presumes control for the time of the film. We can question, but not change, that view.

4.1.2 Interaction

Cybermedia can also be passive, as films are, but one of their primary potentials is that they allow for interaction. Interactive forms of cybermedia include screen-based media, such as computer games, online worlds (metaverses), social software applications like Flickr™, MySpace®, and YouTube™, and a plethora of interactive works made possible by the added functionality of the current generation of Internet tools dubbed Web 2.0. Interactive forms of cybermedia also include many interactive artworks where a visitor must click and pick through a screen-based interface, as well as innovative forms that use interactivity in ways difficult to categorise. These forms share characteristics with immersive virtual environments, as they are often built upon the same basic technology of computer graphics.

Interaction is perhaps *the* hallmark of modern cybermedia. Via this characteristic we are given the means to have some sort of effect on the basic form and function of the medium's content, if only to select from predetermined choices, determine where to go, or how often to pull the trigger. Video games are described as interactive to distinguish them from passive media, and they do provide players interactive capabilities such as shooting, attacking or collecting things, typically to accumulate points. For most of these games, there is only total failure, total success, or abdication: you stop playing the game. A few more challenging games, e. g. simulation games like *Civilization* (Microprose 1991) and *SimCity* (Maxis 1989) permit the player to go beyond what I call the "hunter/ gatherer stage" of games. In these simulations, the player's success or failure is a direct result of his or her actions. The decisions made have positive, negative or even neutral effects on the outcome of the game. With these games it is possible to partially succeed, and to make nonfatal mistakes and learn from them.

All the interactive media mentioned above have one thing in common: they are viewed by means of a screen that gives a two-dimensional view of the content. It is a looking *towards*—akin to the Renaissance style called *vendutta*—painting a view through a window, and not an engagement *in* the content. Films, games, and Internet applications share this characteristic. Both passive and interactive screen-based media root participants to a flat screen, within their immediate field of view of the real world, even including parts of the real through active peripheral vision, but limiting the frame of the content. Even if the view is into a three-dimensional world, such as in a computer games, the viewer is still outside, looking in through Alberti's window,[45] as it were.

4.1.3 Immersion

Immersive virtual environments, in contrast to screen-based media, place participants *inside* the virtual space via perceptual mechanisms that correlate to real world experience. A virtual environment has no predetermined "front" to face except where the experient chooses to turn and look. This situation makes virtual environments, at their core, a medium of spatiality. In such immersive spaces, there are distances to traverse, walls to bump into,[46] and objects that appear slightly different to each eye so that they stand out in depth against the virtual backdrop. While the virtual space is most definitely an illusion, it is one that, as discussed in Chapter 3, fools our entire perceptive being. Virtual reality can comprise the same sort of interactions as simulation-type games, but is qualitatively different in that one steps *through* the screen into the virtual space. It is possible to move around and through that space by various means, as I mentioned previously, e.g. by navigating with a joystick or a mouse or treadmill. Other innovative forms of navigation—hang gliding, riding mythical beasts, or walking within a human gerbil ball—are also being employed to permit 3D locomotion within virtual worlds. Most often a joystick or game control device is used, as these are low cost and familiar to those who play video games.

Virtual environments also offer interaction with objects and characters, ways to manipulate things, and even to change them as desired, assuming their creator has enabled these capabilities. An experient can pick up objects, stretch or shrink them, build and decorate with them, put new windows in a room, lock a door, turn a light on or off, dig a hole in the ground, or use things up and throw them away. This constitutes a fully enactive world: one where visitors can leave their mark; one they can change in some manner. In fact, the nature of immersive digital worlds makes it possible to say we actually live in, or inhabit, them for periods of time.[47] The immersive world is rich and expansive, and unlike film, point of view is not *a priori* determined by a director or cinematographer. The experient chooses her point of view at each moment throughout the experience. She does not see through a flat screen, but rather stands in an encompassing space that can be explored. No stranded eyeballs here, rather a full body immersed in a fluid medium.

Immersion is natural in our everyday waking world; so natural that we take it for granted. We have few other modes of experiencing our existence, dreams and out-of-body experiences excepted. Three-dimensional computer environments are, for the most part, based on our ordinary modes of perception; if the designer has done a good job, there will be a natural correspondence. Replacing our normal sensory inputs such as eyes and ears with computer-generated substitutes means we feel the same type (if not degree) of immersion. The degree of immersion we experience depends on several factors. It can be enhanced by the addition of senses such as touch and smell; the consistency of the graphic imagery, how well the sensory input is integrated with the content, and the synergy of all elements working together to portray a virtual world. The degree of immersion is also heightened by strong emotional engagement. (I will discuss how such engagement might be evoked in Chapter 6, which covers my methodology for making virtual environments.)

In linear media such as films and text we have at best the ghost of fabricated experience.[48] It is what *was*. In interactive media we have

what *was* and *is*. The past is what the artist made and the present is how we interact with it. In virtual environments there is an unfolding, a what *is* and *will be*. The work comes to life, comes into being, only through the real time communication between the experient and the possibility space of the virtual environment. It is these relational circumstances that make virtual environments a unique experience for each visitor. Such a work is, in effect, a living dialogue.

4.1.4 Involvement

None of the methods mentioned above, separately or together, are an ultimate qualifier of the degree of immersion experienced in a virtual environment. The degree of immersion is determined, and exceptionally mediated by, our willing suspension of disbelief—how much we "buy into it." The amazing thing about virtual environments is just how much we are *willing* to buy into it. Part of this is due to our physiological nature; how we process the information we receive from our perceptual world.

Merleau-Ponty says:

> In so far as we believe in the world's past, in the physical world, in "stimuli," in the organism as our books depict it, it is first of all because we have present at this moment to us a perceptual field, a surface in contrast with the world, a permanent rootedness in it, and because the world ceaselessly assails and beleaguers subjectivity as waves wash round a wreck on the shore. (2002: 241)

Familiar media such as books, movies, plays and television do, I argue, provide us with a degree of involvement. We frequent these types of activities precisely because of that involvement—they have the capacity to lift us out of our everyday mode of being and into another for a while. While they are considered passive forms of entertainment, we can be totally engaged by a good play or a great book. Engagement is not the same as immersion. Douglas and Hargadon (2004: 203) describe the two as ends of a continuum of involvement that can overlap, with the engagement dimension requiring schemas and back stories to bring about involvement, whereas immersion is more direct and of the moment. Engagement, therefore, can allow involvement

without interactivity, and without full 3D immersion in some virtual space.

A high degree of involvement mediates our perception, engages our mind, and sparks our imagination. It is what completes the building of alternate worlds in our brains, whether they derive from a novel or a full 3D computer environment. This quality of involvement—the indefinable something that makes it all come alive for us—is inherent in virtual worlds. Much of what produces this quality of involvement in, say a movie, is executional (coalescing the aesthetic dimensions of all of its parts). The greater the aesthetic execution, the more we may believe in the experience. The very best of these transcend the media and its inherent limitations, and what we remember is the experience, the story and characters, or the way we felt. We may look at a certain painting and be transported to another time and place. It is the aesthetic dimension that allows this to happen. Aesthetic qualities help make connections to meaningful interpretation.

I argue that artistic virtual environments have this dimension. Yet, to have meaningful involvement in immersive virtual environments, entirely new vocabularies of form and content must be created, ones that may not require schemas and back stories or verisimilitude (while not precluding them). Only as this grammar is developed and matures can virtual environments take on status as a new medium and begin to achieve its potential. Developing the aesthetic dimensions of virtual environments will serve to increase the degree and quality of our involvement with our virtual worlds. (Morie 1994)

4.1.5 Presence

A prevailing contemporary topic of Virtual Reality research germane to the concept of experiential involvement is that of *presence*. Presence is the term used by the VR community to describe the degree to which one feels to be in a virtual environment to the exclusion of the real world. My definition of presence is when the actual world does not intrude upon the virtual one and therefore time spent in that world is equivalent to time spent in the real world. The terms *presence, involvement, immersion*, and *engagement* are often used interchangeably within

VR literature, with the distinctions between them under intense debate. Presence researchers hope to find optimal combinations of factors that induce a strong feeling of presence in VR.[49] What conditions cause the feeling of Presence to emerge from a collection of digital signals?

There have been extensive discussions, especially since the mid 1990s, on how one both defines and creates the feeling of presence within virtual environments.[50] Kwan Min Lee calls presence "the psychological state in which the virtuality of experience is unnoticed." (Lee 2004: 32) While presence is one way to describe a virtual world as being indistinguishable from the real world, virtual reality is not the real world, but a new medium that enables its own experiences—potentially different from, but perhaps as valid as, those that can be had in the real world.

Yet I agree with Peter Vorderer, who says: "Whether the experience of Presence arises during the exposure to a media setting therefore depends on the external stimulation provided by the system and the internal condition of the user." (Vorderer et al. 2003: 7) Presence requires not only a stage set for the experience (Vorderer's media stimulus), but also, most importantly, those aspects brought to it by the participant him- or her- self. Vorderer lists these as motivation, mental state, memories, intellectual capability and perceptual-motor skills.

Presence seems to be a qualitative, subjective phenomenon. There is no absolute threshold beyond which one can be said to be experiencing presence. It is different for each person, for each experience. Just as one symphony may cause one person to close her eyes and be transported to a musical world, another, sitting by her side, might close her eyes and fall asleep from boredom.

At a recent conference on Presence, during a "shoot-out" discussion among top researchers, a participant stated, "Presence is a function of a fully attentive mind focused on the experience." (Morie, personal notes 2003) This is true, yet the phenomenon of Presence is also intimately bound to our physical being. It arises not only from the

stage of possibilities but also from the actions enabled by those possibilities in conjunction with an engaged participant. In these aspects it is most similar to ritualistic phenomena.

However, there is a lingering question as to whether we can ever experience the mediated world to the exclusion of the real one given our ability to process inputs on multiple levels of consciousness. We will always, at some level, be aware that we are having a "mediated experience." For the purposes of this thesis, the notion of presence will be used in its simplest form, excluding any metaphysical overtones, ignoring the extensive debates surrounding the term.

I personally do not believe the concept of Presence can be measured or quantified. Its essence (like the internal effects of ritual) is not scientifically observable. What can be measured is twofold: The mechanisms by which an immersive experience is delivered, such as the resolution of the images, the aberrations of the optics, the speed of the frame rate, the data being gathered by the tracker. We can also measure the external phenomena of presence: how long a person remained in the experience, whether they became sim sick,[51] if their pulse rate changed, if they had certain brain areas active. The nature of presence will remain elusive, because it is ineluctable, ineffable. It is, indeed, phenomenological.

4.2 Phenomenology and the virtual

Phenomenology involves seeing in the fullest sense, beyond the direct appearance, into the essence of what is perceived—what Merleau-Ponty calls "before it is objectified." Perception is influenced by all manner of predispositions. We see and comprehend through the lens of what we already know or think we know. Senior Professor of Philosophy at Rutgers, Bruce Wilshire, notes: "Our seeing is limited by prejudices so habitual we have no awareness of them." (Wilshire 1982: 12) He also says: "Phenomenology is a discipline of the imagination. For example, to determine what we mean when we call something a table we fictively vary in our imagination the characteristics of any possible table until we reach those limits beyond which it cannot be

varied and remain a table." (ibid.) In so doing, we know the table as an essence whose phenomenon says table and only table to us. Likewise we know the self as it is constructed through the phenomenon of lived experience.

My research in immersive environments is informed by phenomenological ideas of embodiment and the lived experience as espoused by philosophers Husserl and Merleau-Ponty, and more recently Lakoff and Johnson, Hillis, and Massumi. Merleau-Ponty sees the body as both the generating and enduring aspect of experience. Reversing the mind-body dualism of Descartes, he declares that our world, based on our perceptions, must be grounded in the lived experience, which is, in turn, grounded in the body.

Lived experience, according to Merleau-Ponty, emerges from a pre-reflective, pre-linguistic, primordial source within and without the body. Experience is direct as it happens; it is only later we consider what has happened, when we reflect, through conscious thought, about the encounter. Once it is reflected on, it becomes something else indeed. It becomes a mirror or a memory, but not the essence of the lived experience. (Merleau-Ponty 1962: 22-23)

Husserl agrees with Merleau-Ponty's immediacy of the lived experience, and yet he conceives of the real world as a concrete entity:

> I am aware of a world, spread out in space endlessly, and in time becoming and become, without end. I am aware of it, that means, first of all, I discover it immediately, intuitively, I experience it. Through sight, touch, hearing, etc., in the different ways of sensory perception, corporeal things somehow spatially distributed are for me simply there, in verbal or figurative sense "present," whether or not I pay them special attention by busying myself with them, considering, thinking, feeling, willing. (Husserl 1990: 91)

Husserl did not envision a world *within* the world of everyday reality, a "world, spread out in space endlessly," that exists only as experienced and that does have an end: a finite world within another world. Stanton B. Garner, Jr., states in *Bodied Spaces* (1994: 230) "As the

Husserlian tradition relinquishes its hold on the stable subject, bound in ideal self-giveness, it opens its domain to experience as we are learning to see it, in its dislocations and ambiguities, its variable modes of embodiment, its traces." Let us see how this intersects with and perhaps changes phenomenological conceptualizations within virtual environments, and how this impacts cybermedia.

Immersive virtual environments raise new issues *vis-à-vis* phenomenological thinking. Not only does the world exist within another (physical or "real") world, virtual environments have introduced an entirely new mode of Being. This mode is embodied, to be sure, but it also splits the body into distinct aspects: the self/body goes into a simulated world, taking much of its physicality, sensory equipment, and kinaesthetic senses with it. Yet, in a very real way, the physical body remains in the solid space of the outside world, even as it also inhabits the veridical and aesthetic space within the simulation.

In spite of this split, there is no ambiguity at the conscious level. I can be comfortable in this bifurcated self, and choose to favour one over the other, or allow them to coexist equally. If my physical body accoutred in the VR gear feels cold, or is encumbered by the weight of the HMD, then this aspect of my embodied self will come to the fore of my awareness. If I am engaged with the content of the virtual environment and centre my attention on that, it does not mean I have abandoned the other aspect of my embodied self. I am able, somehow, to keep the two in their appropriate experiential places. I live in both simultaneously. This dualistic experience forms a change in the very structure of consciousness, as evidenced in Merleau-Ponty's view of colour perception (2002: 35): "The first perception of colours, properly speaking then, is a change in the structure of consciousness, the establishment of a new dimension of experience, the setting forth of an a priori." The first experience of the virtual has a similar effect on our consciousness.

Ken Hillis (1999: 127) says, "VEs are about mixing it up, by intense immersion in mediation, the old binaries of self and other, and of nature and technology as a cultural representation of nature.

Promoters of the technology operating within the hard sciences seem to have as much difficulty acknowledging this as do critics of VE's effects writing from a humanistic perspective on the academic left." This thesis hopes to bridge these disciplinary approaches.

Hillis (ibid.: 164) states: "In VEs, a quasi merger of embodied perception and externally transmitted conception happens at the level of *sensation*." (my emphasis) When we sense the virtual world (e.g. once we are inside), the virtual environment provides the sensations that comprise the lived world, even while our physical body exists within its own lived world, which includes not only the real, but the virtual world as well.

Brian Masumi's position, and his post-Bergsonist explanations, are directly influential on my argument. He says: "Positionality is an emergent quality of movement." (Massumi 2002: 8) and continues, "'Passing into' is not a binarism. 'Emerging' is not a binarism. They are dynamic unities." He also posits: "It is not enough for process concepts of this kind to be considered ontological. They must be *ontogenic*: they must be equal to emergence."

Merleau-Ponty believes that the real world is not just a variant of the possible world. He maintains that the possible, things and worlds of our imagination, are variations of the actual world. In *Visible and Invisible*, he states, "On the contrary, it is the possible worlds and possible things that are variants and doubles of the actual world and of actual beings." (1968: 112) Yet, virtual environments are not purely imaginal; we experience them through our bodily senses, and in this way they are also real in the sense of the lived world.

Erik Davis asks what it is about virtual reality that generates the wondrous views of what it might do. He answers himself thusly: "The concept is absolute simulation: a medium so powerful that it transcends mediation, building worlds that can stand on their own two feet." (Davis 1998: 247) It allows us to firmly situate ourselves in the virtual space, or as Don Idhe notes, "We are bodies in technology." (Idhe 2002: 138) What that technology is and what its purpose for us as

embodied humans might be are the phenomenological questions of virtual reality. Benedikt concludes his thought: "Phenomenology, after all, entails nothing less than *taking appearances seriously*, and, containing no material objects, no energics, no physical dynamics, cyberspace is just such a realm of appearances to be taken seriously." (Benedikt 1991: 126)

4.3 Embodiment

No matter how virtual the subject may become, there is always a body attached. It may be off somewhere else—and that "somewhere else" may be a privileged point of view—but consciousness remains firmly rooted in the physical. (Allucquére Rosanne Stone 1991: 111)

4.3.1 Rethinking the body in the digital age

The body is the zero point of the world. There. Where paths and spaces come to meet, the body is nowhere. (Michel Foucault, Utopian Body, 2006: 233)

A number of late twentieth century theorists, as well as practitioners of digital art, have reconsidered the significance of the body in the digital age. For some, the "meat shell"—or physical aspect—of the body is no longer relevant. Australian performance artist Stellarc, who accoutres his meat shell with numerous physical and digital devices, has proclaimed his desire to replace all the internal parts of his body with mechanical or electronic substitutes. (Personal communication, November 1992) Hans Moravec, a prominent roboticist at Carnegie Mellon, promotes the concept of downloading the essence of the human mind into a computer, so one may live forever. (Moravec 1998)

Erik Davis says these ideas could be seen as "symptoms of an arrogant and deadly rift with nature" (1998: 128). Technology is not infallible. Beyond the fact that most computers have life spans that do not even reach that of a half-grown child, what of long-term maintenance? Will there be an army of servant bodies left behind to tend to the machine-encapsulated brains? Or worse yet, human slaves? Or, will the machines simply be programmed to tend to themselves until the

inevitable post-apocalyptic power failure? Then wither the no longer electrically sustained silicon-embedded minds?

Body as meat can be contrasted with the concept of body as container for information, promoted by Katherine Hayles in *How We Became Posthuman*. She also asserts, as many feminist critics do, that body concepts reflect gender differences at their core. Hayles maintains that the body is a female concept, disembodiment a male one. Direct sensory input is messy, the 'wetware' limited and confining (which according to Hayles parallels the state of women in society), whereas the realms of thought and silicon are clean and noble. Yet, Hayles says that today's situation moves us beyond this dichotomy, fusing these ideas. She describes this as the age when we became *posthuman*, which she defines thusly:

> …posthuman represents the construction of the body as part of an integrated information/material circuit that includes human and nonhuman components, silicon chips as well as organic tissue, bits of information as well as bits of flesh and bone. The ***virtual body*** partakes both of the ephemerality of information and the solidity of physicality or, depending on one's viewpoint, the solidity of information and the ephemerality of flesh. (Hayles 1996: 12)

Neither has modern cognitive science lent much credence to the futuristic dreams of Stellarc, Moravec and their similarly minded colleagues. Instead science, especially neuroscience, has supported and justified a mind/body union, finding an extreme interdependence between our brain's development and our embodied human state. In pointed terms, there would be no mind as we know it without the body that engenders, contains, and nurtures it.

Lakoff and Johnson discuss these concepts in their foundational work *The Philosophy of Mind*.

> "There is no such thing as a computational person, whose mind is like computer software, able to work on any suitable computer or neurological hardware… Real people have embodied minds whose conceptual systems arise from, are shaped

> by, and are given meaning through living human bodies. (1999: 6)

Their arguments deflate the concepts of such notable philosophers as Kant ("no autonomous person"), Frege (detached thought not based on mind or body) and Chomsky (language as pure form) and such movements as post-structuralism (no decentred monolithic self, whose meaning is only relevant to a particular milieu).

Phenomenologists, from Husserl to Merleau-Ponty, have also brought the body back into the picture, and their concepts of embodiment have had tremendous influence on diverse areas of thought, from cognitive science to the arts. But only recently, with the bridge of cognitive science adopting empirically derived knowledge about the inner workings of our brains from neuroscience, has there been any means of vetting the philosophical theories.

Lakoff and Johnson (1999) maintain that all prior philosophical schools of thought have been based on *a priori* assumptions, and not empirical data. Cognitive science, a continuum of related disciplines ranging from the more empirical computer and neuro-sciences on one end and psychology and philosophy on the other, brings that empiricism into philosophical discourse. It has itself gone through an evolution paralleling, in some sense, that of philosophical constructs that have to do with the mind. According to Lakoff and Johnson, the first generation of cognitive science was based on symbolic computational systems, such as computers. It is logical that this phase developed in the 1950s and 60s. They argue that such concepts were in synch with the "Anglo-American philosophy" of the time, and were informed by the domains of "early artificial intelligence, information-processing psychology, formal logic, generative linguistics, and early cognitive anthropology." (ibid.: 75) Moravec was a first generation cognitive scientist. Succeeding generations of cognitive scientists subscribe less and less to the mind-body duality.

When findings from neuroscience about the mind-body connection began to be published, it became evident that many assumptions on which early cognitive science was built could no longer be justified.

Chief among those findings was the understanding that our brain and its functioning, structure, and ability to reason is based on the actions of the body, and that absent such a body there can be no mind as we know it. Damasio and others have shown how far from the mark the prophets of disembodiment are. (Damasio 1994: 87-89) (Edelman 1992: 34-36) (LeDoux 1996: 39-40) The body and what it does, how it experiences the world, is responsible for the complicated interweaving of neuronal connections in our brain, out of which our mind—and perhaps consciousness itself—is constructed. Twenty-first century science has only confirmed that corporeal intelligence translates directly into our mental intelligence.

Lakoff and Johnson also argue that our mental concepts are built upon metaphors that are so deeply integrated into our embodied self that they are taken for granted. Phrases such as: life is a *journey* (ibid.: 193-194), these two names are *close* (ibid.: 205), *face* your problems(ibid.: 204), *grasping* the concept (ibid.: 125), I *see* what you mean (ibid.: 126), or *weighed down* by grief (ibid.: 204), all originate in a lived body experience.

These same mental concepts apply to the mindset we bring with us into the realm of the virtual. We cannot leave such deeply ingrained ideas behind; as our mind enters into the virtual environment, our body is also there, both mentally and phenomenally.

4.3.2 The body emplaced within the virtual

The phenomenological discussion and its focus on the lived experience leads directly into one of the quintessential qualities of virtual environments. As discussed in Chapter 3, they are a medium of embodiment. VEs engage the body as kinaesthetic input via the specialised interface devices that both permit and *require* bodily actions to be performed sensorially, kinaesthetically, proprioceptively—within a full 3D spatial construct.

That this perception is mediated by the VR equipment has caused many to reconsider what does and does not constitute a mediated environment. VR expert and psychologist Jack Loomis states:

> The perceptual world created by our senses and the nervous system is so functional a representation of the physical world that most people live out their lives without ever suspecting that contact with the physical world is mediated… (Loomis 1992: 113)

Frank Biocca says experience within virtual environments have further confused concepts of what is mediated. "The experience of compelling virtual environments has disturbed this common complacency." (Biocca 1997: 16)

The relationship between the body and experience is direct and immediate, even entwined. Our body becomes the vehicle for sensory experience—that body which has itself been formed *of* experience.[52] The body shapes who we become by compelling our neurons to form their intricate and scintillating patterns of connectivity. Experience affects how we think, feel, and understand our place in the external world, and it does this by forming the mind by which we make sense of it.

Merleau-Ponty describes it thusly:

> Experience discloses beneath objective space, in which the body eventually finds its place, a primitive spatiality of which experience is merely the outer covering and which merges with the body's very being. To be a body, is to be tied to a certain world. Our body is not primarily *in* space: it is of it." (2002: 148)

Katherine Hayles argues that the interpretive balance of body to information, real to virtual in virtual environments "is struggling to establish itself in a field dominated by militaristic values and male high-tech culture." (op. cit.: 15) She then goes on to describe the *Placeholder* project, by Brenda Laurel and Rachel Strickland, arguably one of the most embodied virtual experiences ever to be created.

Placeholder directly recalls Haraway's notion of our relationship to other gendered creatures. (Haraway 1985) In *Placeholder* you are embodied, but not as a human being. You take on the persona and characteristics of one of four totemic animals: spider, crow, snake or

fish. The human body is, as Hayles says, "resurfaced and reconfigured by its interface with the technology." (ibid.: 17)

This reconfiguration is necessitated by one's emplacement within the virtual environment, in both the embodied and cognitive sense.

4.3.3 The isochronic structure of emplacement

In immersive environments we are embodied, this is one of their hallmarks. Yet, we know little about the body that is experiencing a virtual environment. Any investigation into this dualistic phenomenon will surely raise more questions than it can answer. Where do we position the body that the experient leaves behind in the room? It is the living body, as it exists, breathes, and continues working where it is situated, but it is not the lived body, which is experiencing the world within the virtual environment. The VE experient possesses knowledge of two simultaneous bodies. This is true whether there is a virtual body image or not, whether there is direct or interpreted mappings of navigation and movement.

The act of emplacing one's body within the immersive environment signifies a shift to a dualistic existence in two simultaneous bodies. VR pioneer Marcos Novak calls the body the "threshold between two worlds." (in Palumbo 2000: 65)

Hillis and others (op. cit.: 65) have discussed how participants enter into the world of the virtual "while leaving their bodies 'behind'." Experients do not actually leave their bodies behind, though to a bystander or spectator the physical body may seem to be a form of shed detritus in the room. The body of the experient is synchronously subsumed into the virtual self that enters into the world within the screen, which is created in the mind from what the body experiences. Entering into a territory that is not quite imaginal, and yet not fully based in solid physicality, the self becomes subsumed, bodily, consciously, and subconsciously—dancing with the created space-for-becoming.

Ontologically, simultaneous Being within the real and the virtual worlds is a situation humans rarely experience, even if one considers

the phenomenal states shamans enter into in performance of their ritual duties. Much of the intrinsic nature of Being in an immersive virtual environment underscores this profound phenomenological shift. In a virtual environment, our self exists within a space that in itself does not exist, but that our senses readily believe is there. In our lifetimes, no greater change of Being has taken place than this duality of existence at our command.

The lived body has bifurcated and become two. I call this bifurcation an *isochronic embodiment*, since both lived bodies co-exist in time. What does this imply for the lived body? Does it inhabit both spaces equally? Do the isochronal embodiments affect our conscious Being equally? An actor 'bodies forth' (in performance terms) the character he or she is playing in a play or film. Does Davies' immersant 'body in' to the virtual construction? Are we semi-embodied in a virtual environment, or dually so, ontologically speaking? Are these dia-critical states of embodiment, or complementary?

We are inside the virtual yet we are also aware that we are still in the physical world. I believe this is the quandary that makes the concept of Presence so elusive. At some level we are aware of our dual per-ceptions, and because of this it takes an extraordinary amount of connection to the virtual experience to overcome, or momentarily forget, this dualistic state of Being. It is more than a simple "willing suspension of disbelief." (Coleridge 1817) Such a feeling can happen in Csikszentmihalyi's state of flow (Csikszentmihalyi 1997), but the conditions that can bring us to it are far from predictable. I believe that while this sense of presence is the ultimate goal of many virtual environments, the experient may also have meaningful experiences whilst still aware of the bifurcated nature of this self-ness.

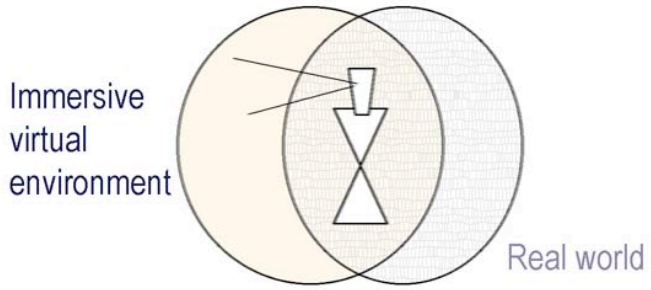


Figure 4.1. The bifurcated self–existing isochronically in both the real and the virtual worlds

Merleau-Ponty argues that the physical body is, in fact, not the full incorporation of the phenomenal body. He says "We actualise separately from the physical body, the body of the anatomists or even the organism of the physiologist, all of which are abstractions, *snap-shots taken from the functional body*." (Merleau-Ponty 1962: 205) Experiencing the immersive virtual environment, our functional body is within, yet the physical body is not simply playing the role of a snapshot; it is the context for our functioning.

Kathleen Rogers, a UK-based artist whose immersive VE works include the series *Sleepless Dreaming*, describes this bodily displacement phenomenon within her work:

> Sleepless Dreaming is composed of computer model houses and interiors that a participant could navigate through to experience the gravitational paradox and the heart of VR. In this work a participant was in effect in two spaces simultaneously. In the real world of the gallery, and moving along a recurrent corridor of rooms, navigating through doorways, along walls and into a void. (Rogers 2006)

In Rogers' immersive HMD-based work, the action of the experient happens inside, within the virtual space, while the external space of the gallery retains a stable inaction that frames and situates the phenomenal duality.

Maria Palumbo, says this about the body as surface for the dual experience:

> In this way the body becomes an inter-media surface, the field for a dual experience between real space and virtual space which thereby acquires a new single dimension. And this dislocation of the corporeal experience can open the way to a new interrogation of the world and ourselves and, consequently, the possibility of imagining other possible kinds of space, other possible ways of being a body-that-becomes-space. (op. cit.: 65)

Space has its own phenomenologically unique properties in the virtual incarnation, which I cover in the next chapter.

4.3.4 Representation: The imaged forms of embodiment

Once we are in the virtual environment, what form do we take? In immersive VR the physical body itself is shielded from the view by the very apparatus that presents the simulated world to our eyes. Early VR made do with the simple representation of a disembodied hand, correlated to a physical hand encased in an instrumented glove. Within the virtual space, one saw this representational hand floating out in front of the computed "eye position." Moving one's real finger caused a similar motion to occur with the virtual hand. Later the image was expanded to a full body image correlated to the physical body via an instrumented suit. This was, unfortunately, a leap beyond the ability of technology to handle then (or even now in 2007). Yet, even minimally mapped, virtual bodies can be represented in virtual environments.

Early VR technology permitted crude graphical representation of bodies. These representations, called *avatars* (a name borrowed from Hindu mythology, where it denotes the incarnation of a spiritual being into bodied form), are more graphically sophisticated today, though not yet to the level of photorealism. The question these visuals raise is not how real they look, but whether they are helpful or distracting to the experient in a VR world. VR practitioners agree there is no single answer to this question.

Merleau-Ponty viewed the body as "the common texture of which objects are woven" (1964: 273), yet his philosophy did not grapple

with new forms of immaterial bodies beyond the phenomenal, nor with questions about how we might weave a new type of common texture from them. How we relate the immaterial bodies of VR to our own perceived body image adds new threads to those common textures we might weave.

In his foundational article, *The Cyborg's Dilemma* (1997: 2), Frank Biocca discusses salient aspects of the concept of avatars and the way we perceive ourselves in a virtual environment. He contends that we have been moving towards ever-more digital representations of our "self"—a "progressive embodiment" of which virtual reality is the most advanced and sophisticated example.

Michael Heim (1991: 59) asks what form the cyber body should take. He questions the range of representation, from a detached hand to a full body, to no image at all: "should users feel themselves to be headless fields of awareness, similar to phenomenological experience?"

> How are users best immersed in virtual environments? I mean this from a technical-ontological point of view. Should users feel totally immersed? That is, should they forget themselves as they see, hear, and touch the world in much the same way as we deal with the primary phenomenological world? (We cannot see our own heads—just part of our noses—in the phenomenological world.) Or should users be allowed and encouraged to see themselves as cyberbodies? Should they be able to see themselves over their own shoulders? Should they be aware of the primary bodies as separate entities outside the graphic environment? Should they be able to see other primary bodies interacting with virtual entities? Or should they suspend physical experience? Should we see the primary bodies of others in virtual worlds, or does telepresence mean that we will never be certain of the society we keep, how much of it is illusory or artificial? Should we make up the avatars that represent us or be given various identity options by the software designers? (Heim 1998: 98-99)

Biocca calls the choice-of-body representations a "psychologically profound issue." (op cit.: 12) The selection of a body image within virtual environments is not simply an aesthetic choice; it incurs distinct

effects on the structure of one's perceptions within the experience, and therefore on the overall qualities of the encounter. Within most immersive environments, as they exist today, this choice is still made by the VE designer, though the myriad representational possibilities inherent in games may exert a strong influence on future decisions about representational form in virtual environments.

Neuroscientist Antonio Damasio reminds us how acutely our thought processes are informed by our bodies:

> … the body as represented in the brain, may constitute the indispensable frame of reference for the neural processes that we experience as the mind; that our very organism rather than some absolute experiential reality is used as the ground reference for the constructions we make of the world around us and for the construction of the ever-present sense of subjectivity that is part and parcel of our experiences; that our most refined thoughts and best actions, our greatest joys and deepest sorrows, use the body as a yardstick. (Damasio 1994: xvii)

Damasio (1994) and other neuroscientists (as noted before, Edelman, 1992 and 2000, and LeDoux 1996) view the body as the primary shaper of neuronal connections constituting our brains, which, in some as yet-to-be-determined way, create our minds, and even our human essence. It also contains the grammar of experiencing, rule bound by its sensory apparatus and neural underpinnings, networks and connections. Wilshire says "… [the] lived-body is the locus through time of multi-tudinous acts of experiencing by this real self–by I-myself." (Wilshire 1982: 159) How will alternate forms of experiential representations in the virtual domain influence and perhaps change this mental development? This, of course is a question future researchers will study. For now we can only take a preliminary look at the forms of representations and how they are experienced.

The primary modes of embodied expressions in contemporary VEs, delineated by Heim (above) and others, include no avatar, a mirrored self, a partial or full graphical personification, and an observer's view of a graphical avatar that represents the self. I will discuss aspects of

these as they relate to our ontological nature as emplaced in the immersive environment.

No avatar: The simplest means of representation is no representation at all. This is the first person point of view. The environment appears as though seen through our own eyes. The views in the virtual world are computed with the camera lenses situated at the approximate location of each eye (as there is a wide range in the actual physical parameters of each experient). This corresponds to the mental model we have of the self that inhabits the physical world, but in a virtual form within virtual space.

"For example, in perception it is only because the body is perceptually engaged with the perceivable world that the world is perceived at all, yet it is only because the body gives way to this world beyond it (*it is not focally perceived itself*) that perception of the world can occur." (Wilshire 1982: 155) (emphasis mine) While we are perceptually aware of our physical bodies (seeing the nose in our field of view as Heim mentioned, or even looking down and seeing our laps), not having a representational body in VR is not usually disconcerting. The exception is when we consciously look to see ourselves and don't, for example, when we look down to ensure correct placement of our feet upon a stair, and we see no corresponding virtual foot to place.

Many immersive environments use this mode of (non)representation. Char Davies' worlds are specifically designed to take one outside of the ordinary body, even while using aspects of the physical body (i.e. breathing) to navigate the environment. She says of her work:

> The methods are intended to reaffirm the role of the living physical body in immersive virtual space as subjective experiential ground. They are also intended to act as channels of communion rather than root of control, encouraging the immersant to effectively "let go." As in meditation, the practice of following one's breath and being centered in balance opens up a profound way of relating to the world. (Davies 1995: 68)

According to Mark Hansen, Davies "seeks to catalyze a more primitive, undifferentiated form of self movement as the activity that confers reality as such." (Hansen 2006: 136) This is the underlying premise for my own virtual environments, from *Virtopia* to *The Memory Stairs*, which all also use this first-person point of view.

Some VR critics have a very different view of the non-representational form of Being in virtual environments. Writing in the early days of VR, Nell Tenhaaf, who calls the human in concert with the VR experience a "bioapparatus," argues:

> But there appears to be a complete absence of representation in the immersive cyberspace experience, because it is perceptually so immediate as to seem unmediated … Rather than returning more knowledge to the self, hypersignification in cyberspace overthrows representation and projects it into a machine consciousness with a new order of transcendence attached to it. (Tenhaaf 1996: 58)

Yet I believe that it is not so much the machine consciousness that is envoked by the "bioapparatus" but rather a newly expanded embodied consciousness that does indeed return knowledge to the self.

The mirrored self: This form presents the participant with a view of himself as captured (typically) by video cameras or other devices that keep track of the body movements of an individual. Few VEs have yet to fully employ the mirrored self, with one prominent exception. Myron Krueger, pioneer of immersivity,[53] believes the human body to be the ultimate interface between the mind and the machine. He insists the body of the experient be unencumbered, and has worked for many years to build interactive media based on this philosophy. In Krueger's installations, the movement and actions of the body alone cause the desired results to occur, by integrating mirrored representations of participants. The body image presented in Krueger's work is typically a single colour, flat field video silhouette of the participant, seen by him (and others) on a screen at the same time as he moves his own body. (Krueger 1983) The mirrored image is intuitive, in that we have become accustomed to such representations of self since we first

learned to recognise ourselves in a mirror.[54] It is nevertheless a dualistic form, though, separating the representation from the physical body spatially, but not temporally. Such representation, while isochronic with the physical body, is not used much within VEs, Krueger's work excepted.

Graphical personification (partial, whole): When a body image is used, it raises a more ontological question concerning the nature of that image and its correspondence to the experient's own body. Unlike Krueger's video image that was a spatial translation of the "own body" some VR creators elect to use a spatially coincident graphical avatar for the body representation. In other words, the avatar appears to be in the space occupied by the person's mental construct of where they are in the VE.

VE designers are not yet able to create a specialized image for each individual without a great deal of advance planning, and therefore use a generic 3D model. The design of this model is up to the creator of the work. For example, it could be humanoid or not, or it could be quite disconcerting. For example, one could unexpectedly find their female self housed in a male-modelled body.[55]

Third person/observed avatar: In this form of embodied image, the participant takes on an image of herself at an experiential locus that is outside the perceptual self. An avatar appears at some distance out in front of the experient's physical and imaginal locus. It is obviously related and connected to the experient, in that its motions and actions may be controlled by the participant's actions and corresponding decisions. This is what Freud might call the "observer" or third person view as opposed to the "field" or self view.

This form of body image is most common in games, where players control an avatar to move through the objectives of the game world. It is less common in immersive virtual environments. Rebecca Allen uses this form of representation in her *Bush Soul* series, allowing the experient to inhabit the body of an intelligent virtual agent. The graphical depiction of this agent is not a human form, but a set of swirling geometric shapes that twirl and spin as the experient directs it, via a

force-feedback joystick, across the colourful virtual bush landscape. In fact, however, Allen's design allows the avatar some autonomy. While the experient provides suggestions to the character, ultimately it may not fully follow those directions. The avatar/agent has its own intrinsic behaviour set that can take precedence during the experience. (Allen 2000) This situation sets up a phenomenal dichotomy: am I controlling myself, or another? In fact, one of Allen's stated research goals for this series was to investigate the relationship between the avatar and the human.

Shared environments: In shared virtual realities, there is also the question of the representation of others in the environment with the experient. A representation of some form seems mandatory, for absent it, the worlds will appear empty. This poses a larger question: how are forms of self and other determined? Are there guidelines that might govern how we see representations of self and others in shared spaces?

Benedikt maintains that participants should have a body representation. His *Principle of Personal Visibility* (1991: 177-9) actually addresses two rules of visibility: that you must project an image within the digital realm, and you must have the right to decide which others in the environment you want to see. (This strikes an odd note in the name of privacy. If I must be visible to everyone, but I can turn off representations of others, then others can turn off my representation. This seems to defeat the purpose of having a representation at all, and in any case it works only for realms of the virtual that are truly shared spaces.) Part of his rationale for this is to foster accountability in cyberspace and to nullify voyeurism, but curiously, he suggests a "small blue sphere" as a minimal presence marker for cyberspace denizens. In spite of a shared space, he argues for a way to be alone, by turning off the representations of others. What if that is done, but others can still see you? What sort of snobbery might they conclude is behind being ignored by that out-of-touch blue ball?

Private, meaningful, immersive worlds are my primary interest here, so I will conclude with a few more thoughts on the subject of self-

representation within them. A form and metaphor of my body icon that I cannot control may compete with my own inner representation of self in inhabiting this environment. In such cases, it may be better to have nothing at all. As Davies' work shows, the virtual environment becomes a sacrosanct *enceinte*; a sacred, encompassing space, where mind transcends body even as it references the body, felt organism even in visual absence. This body, as felt phenomenon, is how we know the world, true as much within the virtual as in the real. To have no body icon might even be perceived as an antidote to the commodification of the body in our consumerist, product-saturated world.

4.4 Bodily actions in virtual environments

4.4.1 Movement and navigation

As I discussed in Chapter 3, the data produced by the combination of tracker and joystick causes the illusion of movement by correctly computing the change in sensory components of the virtual world as if one were actually moving. I also noted the implications of non-isomorphic tracker-joystick mappings for our perception of movement. Beyond this, however, the way movement is portrayed in virtual environments has predominantly been simplistic, and often out of keeping with their content. Flying, a long used default method of travel in VEs, is not necessarily a given, though its early ubiquitousness was likely due to limitations of the technology.

Ken Hillis notes that much of what passes for movement in virtual environments consists of an extremely reductionist form, "akin to a dolly on wheels." (op. cit.: 129) This is unfortunately the type of experience people had moving through early forms of VR, and in much of current VR as well. This type of movement is the easiest to program and thus becomes a default. This reduction of movement to the traversal of vectors does a great disservice to Being in virtual environments. Now, in the first decade of the twenty-first century, it is more likely that this type of movement is a limitation of the imagination, as the technology is capable of much more imaginative solutions than it was in the early days.

There are examples where this modality has been transcended. In my own practice, I strive to make movements map more directly to the content of the virtual world. In *DarkCon*, for example, when the experient is walking, the viewpoint moves slightly up and down along with his motion. Footsteps are heard too, that correlate to the tempo of his steps, and to the type of material that is being walked on. These few techniques helped convince participants that they were actually walking, rather than being moved via a dolly. Quite simply, this technique made the virtual experience closer to their perceptual experience in the real world.

Brenda Laurel and Rachel Strickland's 1994 work, *PlaceHolder*, took experients' actions and interactions to new levels:

> If you stand outside the virtual world of *PlaceHolde*r, you can watch helmeted people flap their arm like wings, caw with their voices like crows, and bend over to dive like birds from the sky. You see the human body fully engaged in a virtual world. They belong to a world that has the functional equivalent of animal flight, animal sight, animal movement. These bodies are not just going through the motions; they are responding to events in their perceptual fields. (Heim 1998: 73)

These experients did not have a virtual body image, with the exception of two points of light for each hand that represented a special gripping device used in lieu of a data glove. (Laurel 1994: 6) Laurel and her colleagues embodied experients via other means, such as allowing them to physically walk about the space (within a "magic circle" the size of the tracker's ultimate range) (Strickland 1994: 5), and by altering the sound of their voices to match the creature they had chosen to inhabit during their experience. (Laurel op cit.: 8) The team also planned to have unique visuals for each creature, such as snake. Snakes can use the infrared part of the spectrum to see in the dark. This vision (the only one time permitted them to implement) was represented by adding a red overlay to the worldview. (Laurel 1994: 16)

These examples go far beyond the VR navigation concept of the "flying finger" where the experient pointed her data-gloved index finger in the direction she wanted to travel in the virtual space. While not every builder of virtual worlds has the space for a full "magic circle" option, techniques do exist that are fairly effective in convincing the sensorium fairly effectively that the body is walking. The addition of slight but perceptible up and down movement of the field of vision in reaction to the body's walking, as in *DarkCon*, is one such technique. There are few "right" ways to navigate within the virtual. Though it may be embodied, it is NOT navigation in the quotidian sense, for better or worse (this latter in the sense of requiring an external device like a joystick). Yet, wondrous forms of movement are possible: flying, floating, walking, swimming, and teleporting.[56] This last seems so logical to the VE space, and so natural to our mediated experiences, like a jump cut in film, that one wonders why it raises questions. In his theory *Principle of Transit*, Michael Benedikt, for one, argues that:

> If *instant* (my emphasis) access to people and information were to become endemic to cyberspace, gone would be the process of progressive revelation inherent in closing the distance between self and object, and gone would be a major armature in the structuring of human narratives: the narrative of travel. Destinations would all be certain, like conclusions foregone. (op. cit.: 170)

Film, however, has prepared us for this, as, one might argue, have experiences such as some from the earliest days of childhood where, as infants, our waking moments were often discontinuous. Falling asleep in one place and awaking in another, not ever knowing how we made the transition is taken for granted by infants. At that age we do not expect continuity; that perspective comes only with experience and growth.

Benedikt's book was written in 1991, when the dreams of today's technologies were distant. He surely did not envision the speed with which we would expect answers, information, and access to people, instantaneously. Chat windows save us from even dialling the phone; hyperlinks vitiate distance. I believe Benedikt's *Principle of Transit* does

not hold for today's virtual environments, unless travelling through space is thought to be an essential aspect of the experience by the creator.

4.4.2 Agency

Agency refers to the types of actions and interactions that can take place in the virtual environment. It is closely related to what perceptual scientist J. J. Gibson's calls perceptual affordances.[57] (Gibson 1979) Gibson outlines how any perceived object presents a specific range of options for interaction. A doorknob provides a means of opening a door, for example. A single object can have multiple possibilities for interaction, depending on context. A glass of water affords a thirsty person a means to quench that thirst; the same glass of water to a person facing a small fire affords a way to put it out. Clive Fencott terms such affordances in virtual reality *perceptual opportunities*, and relates them to intention and consequences associated with the experient's actions. (Fencott 2001) In his theory of perceptual modelling, Fencott breaks the opportunities down into three distinct categories: *sureties*, *surprises* and *shocks*. Sureties provide consistency in a virtual world. Surprises correspondent to agency, and include attractors, connectors and rewards. Shocks are occurrences that break one's belief in the virtual world.[58] (ibid.: 93-94)

Range of agency is often curtailed in virtual environments, typically due to technological limitations. Artists have, however, found amazing ways to counteract these limitations. Several examples attest to this.

Placeholder implemented several innovative interactions. Most unusual for virtual environments of the time was a method of leaving marks in the world using *Voiceholders*. These were representations of rocks, with faces, that contained *Voicemarks*—utterances left by an experient for others to replay. (Laurel 1994: 9)

Placeholder also used spirals as portals to nearby places within the virtual environment. Sounds coming from the spiral were indicative of the auditory flavour of the world on the other side of this transport

mechanism. Portals were a new technique at the time of *Placeholder*, but have become part of the emerging grammar of VEs.[59] Experients also had the option to speak and be heard (and sometimes be seen) as a specific embodied creature. *Placeholder* also provided grippers, allowing a fine-grained ability to pick up objects in the environment. (Laurel 1994: 123)

I have previously discussed the agency of breathing as navigation in Char Davies' worlds, another example of agency. Other artists have designed unique and intuitive formulations to provide agency. Maurice Benayoun, for example, provides a camera for the interface to his *World Skin*. For a tourist to the horrific realms of war, the camera offers a protective form of distancing, allowing a participant to look, seemingly protected from harm. Yet this safety to the viewer causes further damage to the war-torn scene, ripping the very textures from the world. (Grau 2003: 237-240)

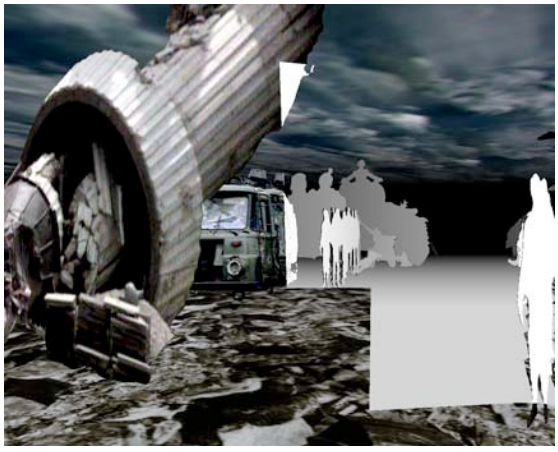


Figure 4.2. World Skin image showing the texture removed by participant interaction

Simon Penny and colleagues, taking a critical stance on disembodiment, make the entirety of the participant's body the unencumbered centricity of the work *Traces*. Volumetric images (*voxels*) and spatial acoustical elements generated via body motions projected on a large screen take on a life of their own; at first decaying, and at the last, becoming "autonomous entities … which have complex behaviours of their own." (Penny et al. 2001: 4) Finally, Agnes Hegedüs' *Handsight* uses a fishbowl (eye shaped) into which a participant thrusts her hand,

which holds a small spherical camera that looks like an eye. Moving the camera around the fishbowl reveals another world, as if the hand/camera has peeled away the layers of nothingness behind which it was hiding. This world is shown as a circular projection in front of the participant. (Hegedüs 1993)

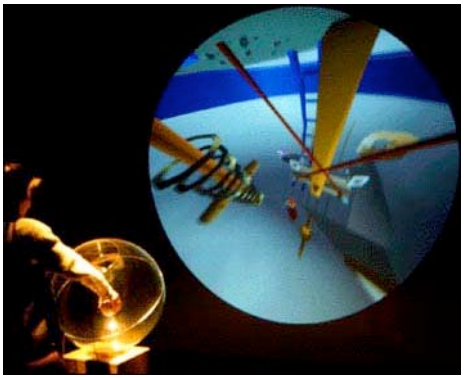


Figure 4.3. Participant experiencing Hegedüs' Handsight

Because of the use of the hand in this work, there is a direct physical embodied agency. As Hegedüs says, the hand becomes a metaphor for the body, a "mediator between thought and action … a pragmatic and symbolic point of contact between our bodies and what is incorporeal." (Hegedüs 2003: 265) It is the means for active agency.

Agency is not only a result of the actions afforded by a virtual space, but also, as author Celia Pearce explains, is provided by the projection of the experient as a player within the space. (Pearce 2004: 147) She elucidates this agency as a distinct contrast to "the classic Aristotelian techniques of mimesis and empathy" (ibid.) as it requires the person to make choices about the role to be played within the environment.

4.4.3 Role playing

Role-playing is direct. It engages both the physical and cognitive elements of our psyche. Anyone entering into a virtual world is, by default, playing a role. At the most basic level, he is playing the role of one willing, or unafraid, to enter into a technically mediated environment.

More importantly, the user is also playing the role that the virtual environment imposes on him. In *Placeholder*, experients take on an

animal persona such as a snake, bird, spider, or fish. To fully enter into the role, they must act like the creature whose form they inhabit. Josephine Anstey's 'Thing' (from *The Thing Growing*), compels you to play a starring role opposite this strange and fickle creature you have freed from its prison.

In any virtual environment that asks the experient to be other than his natural self, he must play along with the role to get the most out of the experience. What happens, however, if the person is at odds with that role? In *DarkCon* the military nature of the mission briefing gave some participants an aversion to the role. Anecdotally, we found people wanted to be able to choose—even in an ersatz scouting mission—to play different parts. One experient wanted to be able to see the world through the eyes of a refugee; others thought it would be more helpful to be inside the mind of one of the suspected rebels.

Role-playing in virtual environments ties neatly into Brenda Laurel's concept of computers as theatre (Laurel 1991) and relates directly to other performative aspects of virtual environments, which I discuss next.

4.4.4 Performance

The very word performance conjures images of the theatre. The word theatre comes from the Greek word *theatrum*, a place for seeing, not simply in the sense of watching, but also as the deeper meaning to see —to behold, grasp or understand. (theatre 1989) Post-humanist theorists maintain that interaction with our technologies allows us to gain new understandings of our self. Allucquére Rosanne Stone relates the multiplicity of selves made possible by modern virtual technologies.

> The technosocial space of virtual systems, with its irruptive ludic quality and its potential for experimentation and emergence, is a domain of nontraumatic multiplicity. (Stone 1995: 61)

Immersive virtual environments, therefore, can proffer exceptional insights, through expanded concepts of body and identity and understanding of essence, agency, and meaning in life. Yet it is theatre

in a different sense, not adhering to a pre-determined script, but unfolding, beholding and grasping throughout the experience. Steve Dixon describes immersive virtual environments as being "highly individual and improvisational, and require sufficient time for users to orient themselves and explore." (Dixon 2007: 393) This time allows for determining who and how we will be within the experience.

In real life we put on different personas to perform specific social roles. Erving Goffman refers to these personas as masks (Goffman 1959). Within private, immersive virtual environments, we most often (though not always) play ourselves. Viewed thus, virtual environments become not so much a mask waiting to be put on (though some have equated the HMD with a physical mask), as an enabling methodology, allowing us to cast aside the social masks that everyday conduct requires. I view the performance within the virtual environment more as a metaphorical door that leads to an understanding of a private and personal self.

4.4.4.1 Public and personal performance

The view available to the observer of a person wearing VR gear is that of the physical body as a text, the body as performer of the virtual experience for the enjoyment of others. This is a very different kind of performance from the performance of the VR experient within the virtual environment. Most participants in virtual experiences are not aware they are performing in a dual mode. However, there are few instances where an experient is alone while in the environment; most often others are watching, listening and may themselves be involved with either facilitating or observing. At some level, the experient knows this to be the case. Such knowledge can engender actions intended to be seen. Yet, if the experience creates deep involvement on cognitive and emotional levels, then the experient may become much less aware of their body's physical performance.

If an experience is convincing and meaningful, the experient primarily performs the text of the experience, and not the reflexive meta-text of herself experiencing the VE. This private performance requires no

audience save the performer, observing the inwardly focused experience.

In many forms of new media, the performance aspects have a functional role. Grounding virtual environments in embodied performances gives rise to particular phenomenological issues, some of which may share philosophical territory with other forms of embodied performance, such as ritual, performance art, theatrical or social roles. Steve Dixon notes that, despite its high tech leanings, performances in virtual environments often place experients in spaces that are primitive or that deal with a more primeval side of nature. (Dixon 2006: 23)

Perhaps the most salient example of a private, performative experience in primeval nature is Char Davies' *Osmose* (1995). Davies says "*Osmose* swallows the experients—suitably swathed in electronic gear—into a sensuous, luminous, and deeply enveloping dreamworld of cloud forests, dark pools and verdant canopies." (quoted in Erik Davis 1998: 56) Yet *Osmose* is unique in that it promotes both public and private forms of performance. Not only is the experience itself so engaging that it "swallows" the experient, Davies also allows an external audience to observe the *Osmose* participant behind a screen, as a silhouette engaged in her personal performance. Davies shrewdly imbricates both performative aspects in exhibiting her work, and resolves any speculative conflicts thusly:

> … *Osmose* is a powerful example of how technological environments can simulate something like the old animist immersion in the World Soul, organic dreamings that depend, in power and effect, upon the ethereal fire. Besides pointing to a healing use of virtual technologies, *Osmose* also reminds us how intimate we are with electronics, in sight and sound, in body and psyche. (ibid.)

In the silhouette, the audience sees the merged human/machine dyad, which assumes, as Donna Haraway has asserted, "people are not afraid of their joint kinship with … machines." (Haraway 1985: 71) It also confirms Katherine Hayles' contention (as quoted in Wertheim 1999: 230) that one must still have a body to experience cyberspace.

4.4.4.2 Rites de passage

Victor Turner cites experimental theatre evangelist Jerzy Grotowski's concept of the theatre as a stage for performance as a modern rite of passage, where the stage is done away with, and the spectator becomes a participant in a liminal activity. (Turner 1979: 495) According to Turner, Grotowski's concept goes so far as to imply the participants in his theatre will discover their essential selves through these ritualistic performances without standard theatrical boundaries.

Unlike Grotowski, noted performance researcher Richard Schechner does not disallow the separate audience within theatre's ritualistic functions. In *Ritual, Play and Performance* Schechner (1976: 218), explains the "efficacy/ritual–entertainment/theater" as a general form of performance that embraces

> the impulse to be serious and to entertain; to collect meanings and to pass the time; to display symbolic behaviour that actualises 'there and then' and to exist only 'here and now'; to be oneself and to play at being others; to be in a trance and to be conscious; to get results and to fool around; to focus the action on and for a select group sharing a hermetic language, and to broadcast to the largest possible audiences of strangers who buy a ticket."

Virtual environments have much in common with Schechner's form of theatre, but those that are meaningful and private are closer to Grotowski's concept. For now these ritualistic forms of virtual environments are not common (Char Davies' *Osmose* and *Ephémère* excepted), but nonetheless important in what human needs they address. My own work, *The Memory Stairs*, borders on the private form of ritualistic concerns through a poetic structure of memories.

4.4.4.3 Post-ritual possibilities

Religious behavior may take new forms within the context of highly developed Western technological societies. But whether in a new form or old, it is much too important to the psychological well-being of society to lapse into oblivion. (Eugene d'Aquili 1979: 179)

Recall from the discussion of ritual in Chapter 3 that, according to Victor Turner, the liminal experience is part of societal norms, an

aspect of social or religious ritual charged with obligations and meaningful consequences that must be met to be able to return to the group. The liminoid experience also breaks from society, but is a form of play that rarely upsets the status quo with meaningful consequences. Turner states that liminal experiences are rare and diminished in industrial societies, and have been mostly replaced by liminoid experiences. If we conceive of a continuum from the sacred liminal to the secular liminoid, where should we place immersive virtual environments? I would say it depends significantly on the content of each environment and the intent of the creator. Certainly a virtual environment can be pure entertainment, as in the early VR game *Dactyl Nightmare* where four networked players could shoot each other while avoiding being snatched by a prehistoric flying bird. (Aukstakalnis and Blatner 1992: 204) It can also offer a sublime experience, as in Char Davies work, or my *Release* experience in *The Memory Stairs*. A virtual environment has the potential to be either ritual or entertainment, liminal or liminoid experiences, along a continuum, as illustrated in Figure 4.4.

Liminoid		.....*Liminal*
Pure entertainment		Pure ritual
Dactyl Nightmare	*Osmose*	*????*

Figure 4.4. Continuum from liminoid to liminal, entertainment to ritual

I see meaningful immersive virtual environments as being positioned towards a more liminal state on a continuum from liminoid entertainment to liminal ritual, as shown in the diagram. Immersive VEs separate us from everyday society, and by their situational positioning on the margins of acceptance are doubly so. Most technology is about communication and social connection, and while virtual environments can be made for these purposes, those discussed here are more often about personal discovery.

In *The Cyborg's Dilemma*, Frank Biocca calls virtual reality "part of an ancient desire to use media for transportation." (Biocca 1997: 13) By this, he is referring to "physical transcendence;" being able to experience that which we cannot in ordinary life, and using virtual environments to "move beyond the limits of body and sensory channels" (ibid.) Another view is that of David Tomas who equates this existential condition to that felt in rites of passage, and argues that such cyberspaces "hold considerable promise as a testing ground for postritual theories and practices, in particular as conceptualised by critical postindustrial, postorganic anthropology." (Tomas 1991: 33) Rather than obviate the need for the organic body, however, I believe that such rites of passage require it; the body is essential to the interaction with technology, especially if technology is to exert a positive, meaningful and direct influence on the human being.

Turner, in *From Ritual to Theater,* says that, while entertainment in industrial societies often subverts normative patterns (carnival, burlesque), it also shares much with original sacred forms of ritual:

> The word "entertain," incidentally, is derived from O. E. entretenir, to "hold apart," that is, to create a liminal or liminoid space in which performances may take place. Some of these entertainment genres, such as the "legitimate" or "classical" theatre, are historically continuous with ritual, as in the case of Greek tragedy or Japanese Noh theatre, and possess something of the sacred seriousness, even the rites de passage structure of their antecedents. (Turner 1982: 41)

Virtual environments too, can be considered a nascent "entertainment" but also a form that can be many things, from mundane to sacred, an empty structure whose content creators define the scope of what will therein take place. As creators, we provide opportunities for new experiences, perhaps even of a sacramental nature. We contribute to the architecture of living. The ritualia of the virtual is twofold. Those elements that bring us to the table and those that constitute what is on the table when we get there. Because we live in a culture permeated with technology, it seems only fitting that the technology itself

becomes a means of deep and personal understanding of how we fit into that culture.

Turner says " 'Meaning' in culture tends to be generated at the interfaces between established cultural subsystems, though meanings are then institutionalised and consolidated at the centers of such systems." (ibid.: 41) Don Idhe also notes that every microperception of an individual is situated in the macroperception of that individual's time and culture. (Idhe 1990: 42) Marshall McLuhan described the emerging electronic society as "a resonating world akin to the old tribal echo chamber where magic will live again." (McLuhan and Fiore 1968: 72)

Virtual environments are significant in that they are not individuated media; they speak to our total sensorium, as did rituals of the past. Imagine the redolence of incense within a Gothic cathedral, the sounds of Gregorian chant reflecting within the building's vast vault, the colours streaming into the space through the stained glass, the silky touch of wooden pews, and the coldness of stone contrasted with hundreds of votive candles flaming before statues of the saints.

> This is an important point—rituals, dramas, and other performative genres are often orchestrations of media, not expressions in a single medium. Levi Strauss and others have used the term "sensory codes" for the enlistment of each of the senses to develop a vocabulary and grammar founded on it to produce "messages" …Thus certain sensory codes are associated with each medium. The "master-of-ceremonies, priest, producer, or director" creates art from the ensemble of media and codes, just as a conductor in the single genre of classical music blends and opposes the sounds of the different instruments to produce an often unrepeatable effect. (Turner 1988: 23)

Heim speaks of virtual worlds fit for human habitation… in these cloistered, phenomenal spaces, perhaps visitations are more in order. Like rich meals, or sacramental wine, we may want to imbibe selectively. (Heim 1998: 75) For me, it is this possibility of the numinous that sets meaningful virtual environments apart from other

cybermedia, and what keeps me returning to the altar of their creation again and again.

Phenomenology and semiotics are two ways of looking at a thing. (See for example Merleau-Ponty 1962, and Eco 1976) The first embraces the corporeal body; the latter makes of it a sign, even within its lived state. The symbol and the experience cannot co-exist temporally. In living we are unaware of our meaning. It is only when we put on the distancing goggles with their semiotic lenses that we can observe the signs. The views are complementary, but not congruent. Stanton B. Garner argues that signification is

> … the other pole in the object's oscillations between the experiential and referential, the 'always already' of external constitution. But this movement into dialogue is also an assertion of place: as phenomenology acknowledges its position in this theoretical dialectic, it can propose experiential accounts as the inescapable other face of signification, as the fields (subjective, perceptual, and corporeal) that condition, and infiltrate, the sign. (Garner 1994: 18)

Yet ritual action provides a means of signification while at the same time, as St. Clair says, it predates and precludes any linguistic retelling of it. (St. Clair 1998: 72) Taking this further, the post-ritual post dates and precludes the visual hegemony, as well as the linguistic. Instead we have a multisensory enclosure, a space apart that serves as a respite from the layers and simulacra (in Baudrillard's sense) that confound our day-to-day existence. Immersive virtual environments, imbued with meaning, can be opportunities for post ritual formulations, created by the shamanistic efforts of the modern, technologically savvy artist.

Our intimacy with technology—its pervasiveness—appropriates everything, from social activities to those that press deeply into our private selves. Where is there escape? What respite do we have? Paradoxically, immersive virtual environments may serve as an antidote to this constant flux of technology in our lives. It is hard to be alone in this day and age, and yet, within Char Davis's work, in a

museum full of people, and with spectators looking on, I could be alone with, and find myself at last. (Morie 2001)

4.5 Narrative, meaning and experience

You weren't born knowing, but tasting. What you were tasting turns out to be a universal principle. Of course the moment we state the principle we are admittedly back in the world of abstraction. It is only while receiving the myth as a story that you experience the principle correctly. --Discussion of Orpheus and Euripides in The Inklings (Carpenter 1979: 143)

Performance and especially performance of roles, often tells us some form of story is in play. Ever since computers have become a medium, there has been a focus on how traditional narrative structures such as theatre, film, and written texts can be mapped to the interactive realm. (See for example, Laurel 1991, Murray 1997, Klastrup 2002, and Ryan 1997, 2001 and 2002) This transfer has proven to be inherently difficult to implement without compromising either the narrative or the extent of interactivity.

Narrative itself is a form of codified signification. How the story is delivered (orally, in book form, via film, or a play) may change, but the story content is set before the telling. Stories also encourage a natural correspondence between what we (already) know and what we are listening to or watching. We draw comparisons and parallels to make the story meaningful to ourselves. We understand story structure because it is familiar; it has been part of how we convey knowledge and lessons since the development of language. The mapping of any particular form of narrative to another form, especially one less familiar, is not always direct. This is especially true when transferring story to the interactive realm, as the stable story is not conducive to accepting outside influence while still retaining its original meaning.

The relationship of narrative to our real life depends on the content of the story and how applicable it is to some one's personal situation. Christopher Tilley, in *A Phenomenology of Landscape* explains the relationship thusly:

> Narrative is a means of understanding and describing the world in relation to agency. It is a means of linking locales, landscapes, actions, events and experiences together providing a synthesis of heterogeneous phenomena. (Tilley 1997: 32)

The appeal of narrative comes from the human need to interpret experience. We take the events we experience and try to explain them in a way that makes sense. This sense making naturally takes the form of a story. We weave a beginning (set up) middle (what happens and why) and end (what sense we make of our experience). It is important to keep in mind that the story comes *after* the original experiences.

4.5.1 The primacy of experience

Experience, it can be argued—and here I would include virtual immersive experience as well as 'lived experience'—is not yet a story during the living of it, in that it does not necessarily have a beginning, middle, and end. Experience is created via active participation; traditional forms of narrative are not. Narrative theorist Espen Aarseth states "a reader, however strongly engaged in the unfolding of a narrative, is powerless… he is not a player." (Aarseth 1997: 4)

Story may be part of an experience, yet an experience may only be a part of a story. In fact, it is my view that experience is itself the raw material, the warp and weft, from which the fabric of any story is woven. This lived experience is primary; it exists *a priori*, before, as Merleau-Ponty says, "reflection begins"—"a direct and primitive contact with the world." (Merleau-Ponty 2003: vii) It is only later is it 'told' or 'retold' to form a part of our personal life story.

I assert that the experience of the immersive virtual environment, being a primary experience, is that "direct and primitive contact." It can be enough to simply live the experience and reflect on it afterwards, to bring its meaning into our situation. Neither life stories nor experiential art have to be seen as stable text to be understood or contextualised, as we recreate our own living story with every layer of experience. The immersive experience can be thought of as a form of living text that is both written and read at the same time. The

openness within the experiential framework of the VE allows the experient choices that constitute a chain of events, which Aarseth terms *ergodic* actions, "produced by the non-trivial efforts of one or more individuals or mechanisms." (Aarseth 1997: 94)

Virtual environments are arenas where a process of Being is played out (Aarseth's ergodic actions), prior to a formalised freezing of the event into signification or any form of coding (such as a formed narrative). (See Massumi 2002: 7.) Narratives are instantiated from this active process. Even in a narratively oriented virtual environment, the experience, the *process-thing*, is paramount. That concreteness comes after the fact, when the experience—the process-thing—has been processed. The narrative is the *post-process-thing*, the encoding of the experience into a concrete form.[60]

In fact, within the work itself, the lived experience can transcend any need for any narrative. In such a case, no story is required to guide the experience, and the immediate perceptions become, in and of themselves, all the justification needed. This *pre-narrative* state is derived out of the raw material of sensory experience. By pre-narrative, I mean that the story is latent in the virtual environment, but does not exist until it is experienced and assimilated. How this assimilation occurs will determine the form of the actual story. This is the basis for the design of my environments of *The Memory Stairs*.

For example, the perceptual material may trigger stored memories and other personal ephemera of the experient's life that were never intended to be a part of the content provided by the environment's designer. Barry Atkins maintains that the experient and the experience (in his example it was computer games) are constantly renegotiating "in an extended series of moments in which we exercise our willingness to be deceived." (Atkins 2003: 146) In this renegotiating, a larger narrative structure arises as a participant weaves the moments into their personal story, both during and after the fact. This squares well with Damasio's (1999) concept of the continually reconstructed self, which emerges from a person's interactions with objects, people, and

events. The assimilation of these interactions with their experient's mental structure forms the basis of the life narrative.[61]

Experience, story, and memory are related. David Carr, an expert in designing memorable museum experiences, discusses the nature of memory in his book, *A Place Not A Place*. He calls memory both "our self-encountered self" and "our self-experienced self." (Carr 2006: 117) He describes memory as an ever changing construction based not only upon what we have experienced as the core of the memory, but also everything experienced before and since, up to and including the moments of recounting of the memory. He calls this a "construction of the instant." As such, it is our ongoing constructed narrative, comprising experiences, changes, feelings, and failures. Carr maintains that memory is a spontaneous and ongoing construction, and as such is essentially an innate performance.

> Every life contains a constant performance of memory—and it is always an improvised performance, summoned to the table with the arrival of some foul or fair breeze through an open window. (ibid.: 121)

Performance is not only how we recall memories, it is how we create them in the first place. The experience of virtual environments provides a unique stage for not only for both types of performance, but moreover for the memorable experience that becomes part of our cumulative life story.

At the core of the kinds of VR works addressed by this thesis is the desire to make a technological work that provides a participant with a significant experience, whether that experience is looking at new artistic worlds, or embarking on some personal journey within the confines of the digital domain. It also has immense potential for experiences of a more personal nature—"moments of being" as Frances Downing calls them. (Downing 2000: 35) Such moments speak to our human nature and provide opportunities for growth or change. The ultimate manifestation of virtual reality is, in my opinion, to make meaningful, and even unforgettable, experiences.

4.5.2 Meaningful experiences

Perhaps most simply put, an unforgettable experience is one that has some personal significance for the person that lasts beyond the time of the experience itself. It is one whose meaning becomes directly interwoven with our personal narrative. It may be only a momentary or short-term experience of story, or it may become a more enduring narrative that stays with us for life. It might initiate the formation of strong memories of the experience itself, ignite ties to past memories, and produce lasting change within the experient. I believe that meaningful immersive environments have the potential to become transcendent experiences. Merleau-Ponty describes this transcendental nature of experience:

> The fact is that if we want to describe it, we must say that my experience breaks forth into things and transcends itself in them, because it always comes into being within the framework of a certain setting in relation to the world which is the definition of my body … Any perception of a thing, a shape or size as real, any perceptual constancy refers back to the positing of a world and of a system of experience in which my body is inescapably linked with phenomena. But the system of experience is not arrayed before me as if I were God, it is lived by me from a certain point of view. (Merleau-Ponty 1962: 303-4)

Beyond interactive stories or entertainment possibilities, because of the very nature of emplacement into the space of the virtual, the opportunity exists for these environments to touch and bring meaning to our lives, to provoke a sense of the numinous, to evoke ritual concepts and structure. As we will see in the next chapter, the nature of that space is also vital to forming such transcendent moments of being.

4.6 Conclusion

In this chapter I have argued that meaningful immersive virtual environments create a unique ontological status and I have explicated modes of Being within them.

I have defined the terms: bifurcated body, presence, and isochronal embodiments. I have discussed forms of embodied representation,

including avatars, and the mirrored self. I have noted the primacy of experience that must precede personal self-narrative, and I have considered the correspondence of virtual environments to rites of passage and post ritual possibilities of the liminal and the liminoid.

In the next chapter, I apply these new terms and concepts to the subject of immersive space, exploring distinctions between different forms of 'space and place' whilst continuing the study of Being and audience or participant experience in and of those spaces, both virtual and 'real'.

Most importantly, this chapter sets out a core argument of the thesis: e.g. there will always be a need for our bodies, to develop our brains, and by the mysterious means of consciousness, our minds. The disembodiment of much of our day to day living may push us further into any means of bodily involvement. The "segmented self" engendered by the "polyvocal polyvalency" (Hillis op. cit.: xxxiii) of our increasingly fractured lives may desire a place of unity, where the only self there is the one that is core to one's consciousness. This argument takes forward my study of immersive experience whilst also contextualising the concepts of self (and particularly embodied 'selves') in relation to virtual environments.

Chapter 5 The nature of immersive virtual space

Is space indeed a medium? A milieu? An intermediary? It is doubtless all of these. But its role is less and less neutral, more and more active, both as instrument and as goal, as means and as end. (Henri Lefebvre 1974: 411)

Introduction

Just as Being in an immersive environment has unique qualities, so too does the space of such environments. While computationally based on a Cartesian grid, the virtual space encompasses a range of spatial considerations that extend far beyond a structural coordinate system. Creating a work for emergent interaction between experient and environment demands an understanding of the potential spatial ramifications of immersive territories.

Throughout history, the concept of space has been fluid—often perceived as an extension of the reality of the time and culture. We have lived with the mathematically described space of Euclid and Descartes for so long that it seems natural to us, but historically it is only one spatial construct among many. Early spatial thinking tended to emphasise relationships, and such concepts were mirrored in the art of the time. In Medieval paintings, for example, important objects or people were often portrayed as larger to emphasise their importance in the scene, revealing, as it were, the actual essence and not merely the physical form. (Wertheim 1999: 85) (Eco 1986: 113)

To illustrate the changing concepts of space, I briefly discuss some historical notions of space, and describe the radical change from medieval to modern times concerning how space is viewed. I also describe space as it is understood in today's post-modern sensibility in various domains: mathematics, cyberspace, architecture, and games.

I argue that virtual space is the newest shift in spatial understanding. We can experience the space of virtual environments from many dimensions. Rather than being the one in which we primarily and naturally exist, the space of virtual environments requires both a physical and a mental compliance to enter into it—to become

emplaced. Emplacement in a virtual environment demands this agreement at the start, and therefore virtual space is never neutral space. It is a unique space apart, and because of this, it can function in many ways that real space cannot. Nonetheless, immersive environments have commonalities with many types of physical space, both in their characteristics, the agency afforded by them, and in how the spatial constructs affect us. I close this chapter with descriptions of the philosophical nature of space in the virtual world.

5.1 Spatial constructs

Space is best understood as an extension of a particular time and culture. Our ideas about space reflect prevailing attitudes and philosophical approaches to societal needs. Spatial concepts are also reflected in both the art and communication mechanisms of the time.

From medieval times to this century, the nature of space has undergone radical changes. How we order it, measure it, inhabit it, and conceptualise it influences much of our day-to-day existence, from determining land ownership to plotting flight paths across an ocean. Digital technologies have exacerbated the rate of change and in this day of the Internet, space has become nearly irrelevant, at least for communication purposes. Yet space is important for our embodied existence, our physical needs, and our sense of belonging. Beyond physical space, there are other intangible forms of space, from psychological to social to phenomenological. I present these types of spaces and give examples of how they have been incorporated in immersive virtual environments to show the broad range of spaces the medium can address.

5.1.1 Medieval space

The normative space within the art of Western medieval times (here defined as roughly from the beginning of the 12th through the end of the 14th centuries) depicted symbolic space associated with the spiritual realm, as religion permeated and ordered the society. The space of the church or cathedral—the central shared architecture of the time—was replete with symbolism. According to Umberto Eco, it "actualized a

synthetic vision of man, of his history, of his relationship to the universe," in its very structure, its directional orientation, its decoration and carvings. (Eco 1986: 61-62) In paintings of the time, God and Christ were typically shown most prominently in a scene because of their symbolic importance. Angels were portrayed a bit smaller than the deities. Man, as the lowest of God's created entities, was usually placed in a diminutive position. (Wertheim 1999: 85) In terms of the space in which characters and objects were placed, the medieval mind was still firmly ensconced in Aristotelian ideas of a space that contained no empty parts, as in the famous statement attributed to him, "Nature abhors a vacuum." Aristotle believed that contiguous with the surfaces of an object was the material of what existed next to them, such as air. It was a full universe; there was always something, never nothing. (Aristotle 350 B.C.E.)

It would not be until the 17th century that experiments would finally disprove Aristotle's idea of space, but by the 13th century artists had begun to develop the amazingly realistic technique of perspective. Margaret Wertheim in the *Pearly Gates of Cyberspace* (1999: 82) calls Roger Bacon and Giotto, who were advocating this manner of painting, the first promoters of virtual reality. Perspective was a radical departure from the more idealistic use of space of the medieval artists who depicted religious relationships. Yet, since Giotto painted the visible surfaces, and not a full perspectival continuity of the space in which they resided, Wertheim concludes that his comprehension of space was transitional between the old and the post-medieval understanding of space to come. (ibid: 97) Gradually, as scientific thinking developed, it began to compete with religious interpretations of our world. Scientists came to believe in the possibility, in fact the inevitability of empty space, and more importantly, of a continuous and unified space in which things themselves were able to be placed and exist.

5.1.2 Cartesian space

With the rise of enlightenment, space became a thing to be measured and described in precise terms. Scientific and mathematical thinking was unleashed upon the domain of space, and the worldview was

fundamentally changed. Lefebvre describes it as a clarification of previously indeterminate concepts.

> According to most historians of Western thought, Descartes had brought to an end the Aristotelian tradition which held that space and time were among those *categories* which facilitated the naming and classing of the evidence of the senses. The status of such categories had hitherto remained unclear, for they could be looked upon either as simple empirical tools for ordering sense data or, alternatively, as generalities in some way superior to the evidence supplied by the body's sensory organs. With the advent of Cartesian logic, however, space had entered the realms of the absolute. As Object opposed to Subject, as *res extensa* opposed to, and present to, *res cogitans*, space came to dominate, by containing them, all senses and all bodies. (Lefebvre 1974: 1)

The space of virtual environments was founded on Cartesian space, based on geometric mathematical descriptions encoded in the computer programs. (Kalawsky 1993: 13) Thus it appears to emulate what we have believed about real space since the invention of perspective. However, perspective may have tied virtual space down to too solid a framework, a view confined to Alberti's window that is "out there" and not a liveable space. The space of a virtual environment need not be limited; the concept of space in an invented environment can be as fluid as the dream of the creator. The lived space of an immersive virtual environment is formed not by the virtual construct, but by a coalescing of the created space with interior spaces and thoughts in the experients' mind, including the memories of all their previous experiences. What is ultimately experienced, therefore, is a never-before extant space—a space that is never the same for any two people, even if the authored work is stable.

Additionally, Cartesian space, as it exists in so-called realistic paintings, is a locked-in singular viewpoint. The mathematical formula is deterministic in such paintings,[62] computed and unvarying.[63] No such point-of-view lockdown exists in virtual environments. Our eyes move, and our bodies. We are never locked in, and cannot be because we are living, moving beings who experience the world by our actions within it over time. That movement—space and time woven

together—is not accounted for in the Cartesian coordinate world. Cartesian space does not reveal relationships as space in a Chinese painting or a pre-renaissance triptych does, where multiple times and spaces are merged together via multiple views within the same work. The rigid mathematical perspective of the Renaissance denies this. A computable definition of space, Cartesian space does not represent lived space.

For Descartes, Euclid, and their contemporaries however, such space seemed more real because it could be mapped onto the geography of the real world, as noted by Hillis. (1999: 74) Space was both objective and quantifiable—important qualities at the heart of the Age of Enlightenment. This approach to space is culminated in the western concept of space as something to be conquered, explored, and claimed. To do these things required a way to divide that land, the landscape of both the physical world and its mental correlates. This approach to land, to space, was often at odds with that of non-Western indigenous peoples. Spatial regulation limits how we consider space. Yet Ken Hillis, in relating ideas from VR pioneer Steve Ellis, says Ellis seems to suggest that virtual environments incorporate a return to a medieval sensibility "—one in which symbolic importance was not yet subordinated to spatial regulation." (ibid.: 99) Virtual space opens up other, more expansive ways of conceptualizing space and gives the artist space as an aesthetic tool, rather than a tool of regulation.

5.1.3 Beyond measurable space

The last century has seen vast new concepts of space take hold, such as those of Einstein's breakthrough concept of the space-time continuum, and contemporary quantum theories. (Ashtekar 2006) These are not spaces correlated to physical space, at least not at human scale. They are not measurable in a traditional sense.

In the 20th century, mathematician Benoit Mandelbrot circumvented the absolute nature of Cartesian space (Mandelbrot 1982). Even in the real world, he said, space is made up of a continuum of dimensions, leading to fractional relationships between our more familiar two or three dimensions. Because of this, he maintains that it is not possible

to measure, to any degree of certainty, the length of a coastline for example. The measured length essentially depends on the measuring instrument's scale, be it yardstick or a jeweller's calliper. Carrying this into the virtual realm, what standards for measurement exist? Could it be that the more meaningful measurement is the human being and the human experience within the virtual space?

5.1.4 Cyberspace

Space in the 20th and 21st centuries is not anywhere near absolute. Distance is conquerable; communication methods have discarded those limitations numerous times, from the telegraph and the telephone, to instant messaging and beyond. By contrast with Cartesian space, the cyberspace of the Internet is a space of no-space. Traversing real space takes time that is correlated to distance in a very physical sense. The time of button-click and page-load does not. Like travelling on the London tube, with its famed iconic map, one focuses only on the time to destination, travelling within a symbolic representation of the actual space of the city above. (Garland 1994) The space of the London tube is measured more by the body moving through time, not the body moving through space. Cyberspace, as exemplified by the Internet, is a further exaggeration of time conquering space, and, unlike Virtual Environments as a form of *cybermedia*, it is most decidedly not embodied.

Wertheim argues, however, that cyberspace—that non-dimensioned area of communication, commerce and dreams—brings the dualistic nature of space back to encompass both a physical form we inhabit with our bodies and a mental form we inhabit with our minds (Wertheim 2000: 229). Others, such as Katherine Hayles, also maintain that one must still have a body to experience cyberspace (eyes to see the screen, ears to hear the sounds, etc.) (ibid: 230) Yet, even if our bodies are needed as the input/output interface to cyberspace, they are not situated within it. Wertheim is informative in this passage:

> In some profound way, cyberspace is *another* place. Unleashed into the Internet my "location" can no longer be fixed purely in physical space. Just "where" I am when I enter cyberspace is a question yet to be

> answered, but clearly my position cannot be pinned down to a mathematical location in Euclidian or relativistic space—not with any number of hyperspace extensions! As with the medievals, we in the technologically charged West on the eve of the twenty-first century increasingly contend with a *two-phase reality*. (emphasis mine) (ibid.: 230)

This reality separates the mind and the body that houses it. Cyber-space is data space, social space, play space, communication space, and role-playing space. Yet is does not need our full embodiment, just the subset that permits us to take in the sights and sounds that comprise our screen-based interface to that realm. Wertheim confirms the emphasis on the mind:

> …this new digital domain functions as a space for complex mental experiences and games. In this sense, we may see cyberspace as a kind of electronic res cogitans, a new space for the playing out of some of those *immaterial* aspects of humanity that have been denied a home in the purely physicalist world picture. In short, there is a sense in which cyberspace has become a new realm, for the mind. In particular it has become a new realm for the imagination; and even, as many cyber-enthusiasts now claim, a new home for the "self." (emphasis mine) (ibid: 232)

Wertheim's two-phase reality calls to mind my concept of the bifurcated self, though the self I address is firmly embodied, while hers is not. The space of immersive virtual environments is and must be bodied space; cyberspace need not be. Perhaps the forms of selves we create in each type of space—real, cyber, and virtual—will connect, and enhanced by their relationships with one another, form a new 21st century gestalt of self.

5.1.5 Other forms of space

5.1.5.1 Architectural space

Architectural space is the space of human use. (architecture 1989) It is the domain of architects who shape it for specific embodied purposes —from the massive frames of public buildings to the intimate nature of a single family home. It serves practical human needs as shelter, comfort, and social connection. The forms of buildings and designed spaces (such as gardens) constitute and support our most basic and

noble human functions. Architecture provides "the environmental whole that allows life to take place." (Norberg-Schultz 2000: 27-28)

As a lived space, architecture shares many similarities with virtual environments, and architectural walkthroughs of planned, existing and vanished buildings have been a subject of virtual environments since their inception. Yet it is less the objectiveness of architecture and more the design sensibilities with which it approaches conceptualizing space that is most applicable to virtual spaces. The role of the space—whether it is to comfort, provide privacy, fulfil an aesthetic—imaginary, familiar, playful or strange—must be conceived, as architecture insists, with the human in mind. Designed space, as architect and designer Philip Thiel asserts, "can only be evaluated with the participants in mind." (Thiel 1997: 7)

5.1.5.2 Fantasy spaces

Fantasy spaces exist to take us to places outside the ordinary, which imbues them with a liminoid quality. While they have a physical presence they are also, in some sense, virtual constructs. They are designed to affect our interaction with them. Being liminoid, they evoke a taste of the unknown, the imaginary, and the wondrous. One very familiar modern fantasy space is that of Walt Disney's wildly successful theme park, Disneyland. The places within Disneyland share many characteristics with virtual environments. Participants are involved as full players in the space, becoming part of the themed areas, which were, of course, designed to pull visitors into these magical worlds.

Erika Doss in her essay in the book *Designing Disney's Theme Parks* explains one of the ways that the design of the space elicits active participation:

> … the rides in Fantasyland were designed to let the children "step into" and become part of their favorite animated films. Central figures in several rides were downplayed in order to allow their riders to "become" Snow White or Peter Pan. As Disney put it, "What youngster hasn't dreamed of flying with Peter Pan over moonlit London?" (Doss 1997: 181)

Doss also quotes Miles Orvell, who affirms: "Fantasyland occupies a special realm, a kind of unconscious or basement level for the mythos of the human realm, for it features the stories of fear, struggle, transformation, and conquest transposed to the level of the unconscious, of fantasy, of the fairy tale." (ibid.)

In contrast to architectural spaces that serve practical human needs, fantasy spaces serve deep-seated psychological ones.

5.1.5.3 Game space

Games also present us with a space outside the ordinary, whether in the form of classic board games, Dungeons and Dragons style role-playing, or computer-based games.[64] Game space has its own unique constructs, characteristics and dimensions. Game space is designed to keep the player moving through the game either to facilitate the mechanics of play or for the sake of the story. Especially in computer games, this typically results in fast forward movement that disallows the luxury of any leisure to experience one's surroundings. Racing forward requires keeping the action focused forward. Movement is more about achieving goals than traversing a place. While game scholars such as Espen Aarseth maintain that games are a medium of space (Aarseth 2001), I assert games as a medium are fundamentally based on time, and not space.

Certainly first person shooter games, with their relentless action and pursuits, are a prime example of this time-based space. Yet even more sensuous games have this quality. One example of such a game is *Myst* (Cyan Worlds 1993). Locations in the *Myst* world exist only to serve up the next clue to continue the journey. They are beautiful, but do not encourage a player to linger. Each location has been designed to contain affordances that move the game along its arc. Game spaces are predominantly dense with actions that propel one towards the goal of the game. The space is important only in how well it supports this function.

5.1.6 Immersive virtual space

Virtual environments, by contrast, encode space better than time. Yet, what is space within a virtual environment? Is it somehow continuous with the space we inhabit every day? How do we reconsider space from the point of view of the virtual? What is it about such space that fools our consciousness into believing that there is a there there?

The space of the virtual is an inter-space—one that exists within our normal space and yet also outside of it. It is a space that requires a transition, one that causes one to encounter and be aware of the mechanisms that allow entry. The setting where most people experience a virtual environment today is in a room in a computer lab or an art gallery, where the technology is set up. In this way, the space of the virtual is essentially a space within our normal space. The virtual space is what is *therein*, but not truly there, not a part of that world. It is its own world, and becomes perceptually and sensorially known only through dialogue with the technology.

In the post-Aristotelian world we consider real space to be empty, containing the material things that exist within it. Virtual space has no need of matter, but it is not formless. While the form and content of the virtual space can mimic the real world, it can also be fluid and evolving, abstract and shifting, full of incandescent contents, formed of light. It is a space of luminosity and illusion, yet one that nonetheless is capable of satisfying our sensory systems in a visceral way.

Precisely because virtual space is perceivable, it implicitly becomes space not only of the mind, but also of the body. As I discussed in Chapter 3, virtual space can be quite convincing to the body. Recall the experiments of Fred Brooks and colleagues with the virtual cliff experiment (Meehan et al. 2002), and the rats who could traverse virtual space as they would a real one (Holscher et al. 2005). Empirical studies about virtual space have produced conflicting results, especially where they relate to the transfer of knowledge[65] from experience in a virtual environment to the physical world. (See for example, Witmer et al. 1996, Lampton et al. 1994, Attree et al. 1996). Some, however, have found a significant transfer of knowledge from

virtual environments to real world tasks, including wayfinding and spatial object memory (Wilson 1997: 198-203). These experiments, using a range of environments, and even equipment, tend to confirm the bodied nature of virtual space.

Confounding issues in these experiments may be low resolution HMDs that do not provide a full sense of space. According to artist Char Davies, a low resolution HMD might actually create a different sense of space. (Hansen 2006: 110) The same may be true of HMDs with a narrow field of view. We are used to our peripheral vision and the lack of such perceptual clues may negatively (or differently) affect certain types of spatially oriented experiments. The Wide5 HMD by FakeSpace Research, described in Chapter 3, was designed to include peripheral vision and provides a more perceptually realistic experience. While no formal experiments have been done utilizing the Wide5 HMD, anecdotal comments from those I have personally watched experience it tend to confirm its more compelling sense of space.

Ultimately, whatever its relevance to real world tasking, the virtual is a space with few physical limitations. It can replicate normal space or it can expand it. My early *Virtopia* work (1994) had an experience called *The Endless Forest*, where the boundaries of the woods could never be reached, and where haunting wraiths sang doleful songs and ran from your approach. The purpose of the endless space in this scene was to evoke a sense of longing and regret. To the extent that most people said that was what they felt during the experience, it was successful. The work of Norwegian artist Marianne Selsjord also incorporates endless virtual space without walls or other barriers. Selsjord's *The Garden of Earthly Delights and Beyond*, (loosely based on the Hieronymus Bosch painting) immerses the experient in multitudes of gardens, from a Water Garden to an Inferno, a Nervous Garden and even one made of virtual snow. (Selsjord 2007)

Virtual space exists not only as a space within the space of the real world. Having few limitations means that it may even be recursively nested—spaces within a space with spaces continuing further within.

In the fantasy fiction work, *Little Big* by John Crowley, the realm of Faerie is such a world. This description of Faerie from the text could be about the possible space of immersive virtual environments. As described by the theosophist Reverend Theodore Bramble who spent his life trying to understand that mysterious realm:

> It is another world entirely, and it is enclosed within this one; it is in a sense a universal retreating mirror image of this one, with a peculiar geography I can only describe as *infundibular*... I mean by this that the other world is composed of a series of concentric rings, which as one penetrates deeper into the other world, grow larger. The further in you go, the bigger it gets. (Crowley 1981: 50)

VE portals can take one further and further into the worlds of the virtual. This is the essence of space within the realm of the virtual as I see it—not contained by normal space/time, with no limitations; a space of worlds within worlds, where anything one can imagine can be realised.

5.2 Space and place

I have described just a few of the myriad forms of space. Space can be thought of as a container for all that happens in it. In a phenomenological sense, however, space itself is an open a mental construct. Place, by contrast, manifests a personal reality, as it encompasses the how, where and why of a person's investment in that construct. Space only becomes place when someone assigns personal meaning or importance to some section of it; only then does it attain the aura of place. As architect Norberg-Schulz states, "the role of place is to 'admit' and to 'incarnate' the role of life." (Norberg-Schulz 2000: 223)

Christopher Tilley, professor of Anthropology and Archaeology at University College London states: "A mathematical 'space' of measurement contains no spaces, places or locations, for it is not humanised." (Tilley 1994:13) This is especially true of the nascent space of the virtual environment, which arises from the forge of numerical description.

5.2.1 Creating place from space

Places are formed by the mix of the ethereal nature of space and embodied experiences, like water and dust forming clouds. Space is possibility; place is what we make of that possibility, physically or metaphysically. David Carr, an expert in designing museum spaces that encourage interaction, states in his book *A Place Not a Place* (2006) that place makes immanent experience tenable. The VE artist, as initial author, sets up a space in which some sort of place can be constructed, embodied, enacted. The space encourages action and involvement on the part of the participant to make it tenable.

Carr speaks of this encouragement as a means to fulfilment:

> When you enter it a place can communicate and fulfil its own purpose, a quality of occasion that is irresistible and distinct. It is a form of energy; we immediately want to live up to it. The place allows us to experience more the possibilities of *being* there: it also allows us to experience the possibilities of *becoming* there. It evokes energy from us; we have no choice, except to fulfil ourselves, and the place, as we can. (ibid.: 126)

Canadian anthropologist Margaret Rodman says, "Places come into being through praxis, not just through narratives." (1992: 642) I believe this is also true for the inception of virtual places formed from the space of the immersive environment. Both the artist and the experient play a role in this praxis: the artist in creating the *energy* and the opportunities for action, and the experient by finding the means to *live up to it* and make it his or her own by the act of *becoming*. Lars Qvortrup, director of the University of Southern Denmark's Interactive Media Knowledge Lab, has written extensively about virtual environments, including discussions about artistic worlds. In discussing Maurice Benayoun's immersive artworks, he says, "Benayoun has created the conditions for a universe and not the universe itself." (Qvortrup 2002: 224) It takes at least two to make the virtual universe come into being. The experience of the participant is key to forming a place that will have a unique feeling associated with it.

Tilley agrees that places are associated with experiences, which can be different for each person, but can be repeated to form traditions associated with particular places. Such places are accessed through a transitional zone, and, he says the transition from space into place is as important as the place and its functions. (Tilley 1994:17-19) This thinking supports my design methodology that separates the VE from the ordinary world via a threshold that helps provide that transition.

For Lefebvre, space embodies an "active-operational or instrumental role," being "knowledge and action." (Lefebvre 1991: 11) It is powerful and produces significant relationships. Qvortrup agrees, "Thus space is not only about Euclidean positions and dimension, but also, and more importantly, about functional and experiential relations." (Qvortrup 2002: xvi) Lefebvre argues that space, even as it produces these things, must, itself, be produced in turn. The production of the virtual space of a VE sets up this "active-operational role" by providing the stage on which relationships emerge. The active space and the emergent relationships are what form the opportunity for meaningful transformation in VEs, which I see as the essential outcome of that production.

Ken Hillis adds to this the role of imagination in the formation of place:

> Our sense of place is memory qualified and deepened through imagination. Memory and imagination depend on experience and take place in our bodies, which act as sensory mediators of, and witnesses to, this experience. (Hillis 1999: 83)

Following this line of thought, interaction with the space of our selves and our minds—specifically our imagination—is necessary to fully create place from either real or virtual space.

Space dedicated to ritual, according to Ron Grimes (2006: 78), is a "founded space." It must be hallowed in some sense, "given shape and life" and, without such space, rituals cannot occur. The founded space is the baseline for the event, accrues a power during the enactment, and is charged and changed by embodied action. These sacred qualities, thus invoked and made tangible in the space, can

form either a permanent state or one that lasts only as long as the ritual itself. In like manner, the space of an immersive environment requires a founding and an embodied involvement to become a transpiring medium.

5.2.2 Entering virtual space

Emplacement, as the means for a praxis that can create meaning from the environment, starts with the manner in which a person enters into the virtual space. To enter within is its own singular experience. How this entrance is accomplished serves to shape the perceptions by which the rest of the experience is understood. Beyond putting on esoteric equipment, beyond the keystroke that brings the virtual environment to life in the display, the form of the entrance entails the time from the moment the visitor arrives in the setting until they are safely within the immersive world. My approach to forming entry thresholds (which will be described in more detail in Chapter 6) serves to set one apart from the spaces and places of reality. The entry opens one door only by closing another. Once one is over that threshold, the virtual space is revealed, ready to be experienced and formed into place. I contend that this liminal stage is very important, yet often neglected in presentations of virtual environments.

5.2.3 Experiencing virtual space

We experience the space of a virtual environment both physically through our embodied nature of being within it, and mentally via the connections the engagement activates in our minds. Physical ways of experiencing space include those aspects based on our body: egocentric, allocentric (or exocentric) (Campbell 1994: 8), and kinaesthetic, as well as those based on our sensory apparatus (visual, sonic, and olfactory).

5.2.3.1 The body-centric space: The space of the self

Egocentric space and allocentric space are important epistemological modes of engaging in the phenomenological experience of space. Egocentric space is based on the body's vertical midline; allocentric on spatial encoding beyond the reach of the body, formed by engagement with the space. Ecological psychologists Nigel Foreman and Raphael

Gillett state, "Egocentric space is important, because it includes the region of central space to which our sensory processes (e. g. vision) are most sensitively directed. " (Foreman and Gillett 1997: 8)

Allocentric space is the understanding, coded into our cognitive maps, of the spatial constructs beyond our own body. According to Foreman and others, these two perceptions of space are connected. Egocentric space is multiplexed as it is experienced, to form our perception of the allocentric. "The co-existence of these types of representation is assumed within most versions of an important model of spatial behaviour, cognitive spatial mapping theory." (ibid. 1997: 10)

Egocentric space is the type of space most often experienced in virtual environments, though the role of the environmental allocentric space must also be recognised. The first is implicated in the agency of the lived-experience, the other in the supporting matrix of that experience. Egocentric space, as it references the body, is part of the envelope that surrounds and influences the person making cognitive choices. We have an internal referent that puts our body at the origin of the space we inhabit. As discussed in Chapter 4, even our metaphors, as Lakoff and Johnson argue, are based on these bodily referents. Up-down, on-off, and over-under are all understood in relationship to the position of the body in physical space, with specific gravity and orientations. (Lakoff and Johnson 2003) These referents are brought into the space of a virtual environment as well, but they can be parameterised in different modes (flying, lesser gravities, scales, etc.) Still, they are bounded by, and arise from, our experiential lived being.

Fred Previc, of the United States Air Force Human Effectiveness Directorate, has done an extensive study that looks at the neuro-psychology of constructed 3D space and the human's role within it. (Previc 1998) He has proposed an integrated model of four degrees of personal space, based on their distance from the body centre. Previc's *peripersonal* space is in closest proximity to us, essentially within grasping reach, and focused downward. According to Previc, it subtends an angle of about 30 degrees right and left from the body's midline, and is used in eye-hand coordination, among other functions.

The *extrapersonal* spaces include the *focal*, the *action*, and the *ambient*. The focal extrapersonal space is located a bit beyond the peripersonal, focused upwards, and is the space in which we locate and recognise people and objects visually. The action extrapersonal space is implicated in navigation, scene memory and orientation, and fills a full 360 degrees, focused mainly on the upper perceptual field. Ambient extrapersonal is the most distant space, attended to the 180 degree lower field out in front of the body. It maintains spatial orientation and our postures and connects to our vestibular and proprioceptive systems.

Most virtual environments, especially those with enclosed forms of space and narrow fields of view are predominately peripersonal, with additional focal extrapersonal components. I argue that it is because they address these two forms of space, our most immediate surrounds, that they work, even in the absence of equipment that more closely matches our normal perceptual modes. Previc's work on space is the foundation for his neurological investigations of the visual, cortical and subcortical involvements of our spatial interactions. His summary article (ibid.: 135-145) goes into extensive detail on these correlates, an in-depth discussion of which unfortunately falls outside the scope of this section.

While the most complete virtual environments utilise all four of these spatial interactions, and thus stimulate their corresponding neurological responses, it is still a challenge to bring them all together coherently in the virtual space. Nonetheless, Previc's work is bringing important spatial and neurological concepts to the fore that should prove useful to further studies of how we experience space in VEs.

5.2.4 The agency of space and place

Ontologically speaking, space is central to the existence of agency. It provides the potential and the means for actions to occur. Space *a priori* the interaction of the person with it is nebulous and unformed. As previously noted, it requires *emplacement* to transcend its illusory nature and transform it into place. Place and its meanings only become real via the agency of the participant. This does not mean that

space becomes solid or frozen at that point of transition. It remains malleable, even when it comes into being, as the state of that being is never static. Hillis (1999: 81) says of virtual spaces: "… theorists and designers also suggest that users will expand, shrink, or otherwise reshape this space in varying ways, thereby conferring at an individual scale an aspect of relative space onto the macroscale, absolute concept."[66]

Henri Lefebvre discussing the appropriation of space would call this an active investment that produces space:

> Within time, the investment of affect, of energy, of 'creativity' opposes a mere passive apprehension of signs and signifiers. Such an investment, the desire to 'do' something, and hence to 'create,' can only occur in a space—and through the production of a space. (Lefebvre 1991: 393)[67]

Architecture professor Frances Downing in *Remembrance and the Design of Place* (2000: 97) notes how space and the body work together to create place. "Experiential intentions are those that involve active body-memory constructions, event experiences, and significance in conjunction with a sensate experience." These "qualitative attributes and sensate responses" include light quality, texture of materials, colours, and what was learned in the place, and how it acts on us.

5.3 How space and place affect us

"Je suis l'espace où je suis" "I am the space where I am."

–Noël Arnaud, L'Etat d'ebauche (in Bachelard 1958: 137)

Space and place have profound effects on us as human beings. Merleau-Ponty says, "Our body is not primarily *in* space, it is of it." (1962: 148) Perhaps virtual environments tap into what he terms the "primitive spatiality" that underscores normative space, and the virtually-oriented experience becomes (as does non-virtual experience) an "outer covering" that "merges" with our very being, as we understand it from inhabiting our body. In our body we may have been historically tied to a single world but virtual environments extend the number of worlds our body can inhabit. Not simultaneously, perhaps,

but certainly sequentially. And certainly both types of worlds offer unique albeit different experiences to the embodied individual.

As I have noted, emplacement activates our engagement. Spaces gain a valenced charge (effecting us in a positive or negative way) by such engagement. This charge is a large part of what transforms spaces into places. Place (real or virtual) thus becomes an intentional framework by which meaning is transferred.

People often form strong emotional attachments to particular places, imbuing them with special meaning. Often these places are intensely personal and private. Most of us can remember those areas, especially in childhood, which we reserved for ourselves—spaces that we guarded and protected. Downing says of secret places:

> A secret place always has aspects of a 'removed' existence, being a place that, physically or mentally, is created for retreat, intimacy, enclosure, screening, and protection. These often are places of power and control that cannot be known or invaded by 'outside' forces." (Downing 2000: 28)

In enumerating the many domains of the experience of space from accounts of both male and female architects, Downing classifies these as places "secret, ancestral, places of self, sensate places, places of desire, comfort, region, vicarious, gregarious and abstract." She says secret spaces were often unfinished, such as

> … attics, root cellars, or under the stairs. Often their unfinished nature provided a sense of ownership through an ability to complete the place with one's presence. Closets and large furniture also were important in this category. (ibid.)

These alternative universes cry out for agency. The secret space invites the inhabitant to transform it, but also to be, in turn, transformed by the making of it. Clair Marcus says such spaces are where we encountered our earliest "soul experiences"—those that stay with us and influence the course of our lives. (Marcus 1995: 250)

Places of meaning for Bachelard, in his *Poetics of Space* (1958), are just as varied, and include those places that are not at human scale, but at that of the imagination. His list includes the house, from cellar to garret, huts, drawers, chests and wardrobes, nests, shells, corners, miniatures, and "intimate immensity." Downing mentions places too, that "stretch to meet the horizon, and places that enclose and protect." (Downing 2000: 18) In my own work, I find myself drawn to intimate places–the house, crib, womb and tunnels–secure and comforting. For me the endless wide spaces tend to be spaces of transition. In *DarkCon*, for example, once the experient is outside, there is more danger and a sense of urgency to complete the mission. In *The Memory Stairs Release* experience, the underwater scene with the bright light at the surface suggests transformation.

In *Philosophy in the Flesh*, Lakoff and Johnson make a case for the role of the environment and our bodies in shaping our very brains. In their final section, they bring back the idea of the environment for one last look, saying:

> The environment is not an "other" to us. It is not a collection of things that we encounter. Rather, it is a part of our being. It is the locus of our existence and identity. We cannot and do not exist apart from it. It is through our empathic projection that we come to know our environment, understand how we are a part of it and how it is a part of us. (Lakoff and Johnson 1999: 566)

When we look at an experience in a virtual environment just as another experience within the continuum of our world, we can say that it "works" (fools our senses, permits us to achieve a sense of presence, provides a meaningful experience) precisely when it is continuous with what we know of the external world. These are places that can exist outside of us and we outside of them in a phenomenological way. They are constructs, and because we build them, they are born out of the same fabric as our everyday existence. However, we are also beings of imagination and can invent other modes of being, which may have few concepts in common with what we know as the boundaries imposed by the physics of this earthly place. We can create immersive

environments that provide extraordinary experiences. Just by building them, we can experience the ability to fly, the multiplication of selves; or we can become acclimated to sensory synaesthesia. What neuronal circuits would be formed by such extensions to our knowing?

In Robert Heinlein's science fiction saga *Stranger in a Strange Land* (1961), a human being is raised on Mars by aliens, in a way completely outside what we earthly beings know. His introduction to life on earth, in his human body, constitutes what for him is a form of alternate reality. Naturally, it takes him some time to incorporate. He must adjust to a different gravity, learn to traverse space in new ways, understand the strange entities that surround him, looking like him, but not like his erstwhile parents. In the end, he is able to not only to acclimate to this new place, but also to succeed as well as any human being who was born and raised here. A fantasy for virtual environments is that they might provide us equally alien, yet knowable worlds. Or, as we see in Char Davies' nature-based virtual environments, they may provide new insights to the human home in which we already live.

Virtual environments, as Wertheim argues, make a "new home for the self. " Just as secret childhood spaces, and brave new worlds do, immersive environments can provide personal spaces where we can find our own meanings, and thereby serve as ambries for the self and the soul.

5.3.1 Emotional space

Spaces laden with emotions bring us into strongly valenced situations, and such places form stronger memories via a complex neurological process. (Cahill and McGaugh 1998) Emotional situations are first processed by the older emotional brain, the limbic structures, causing us to respond viscerally before we have processed any cognitively effects evoked by the emotion. (ibid.) As cognitive processing occurs later, it adds an additional, yet distanced, dimension to the emotional response.

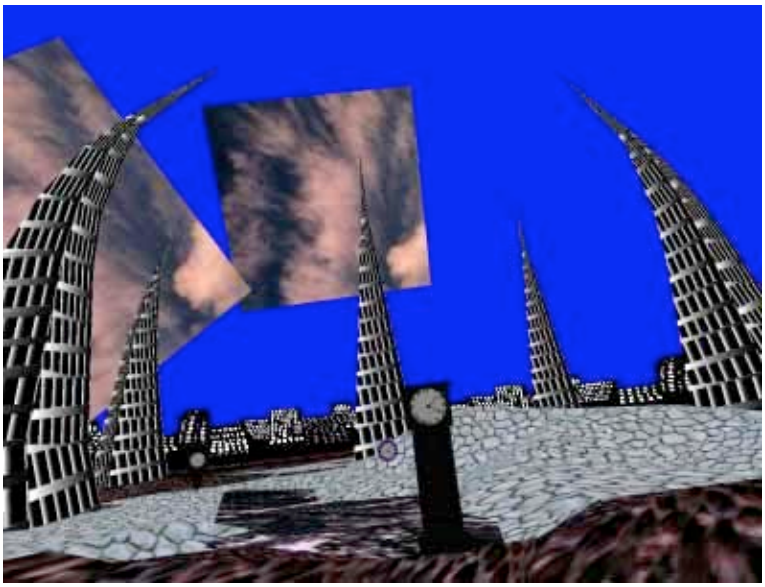


Figure 5.1. The Fang City environment from Virtopia

The environments in my immersive work *Virtopia* (1992-94), created with Mike Goslin, were based on evoking strong emotional responses. *Virtopia* comprised a collection of places an experient could travel to, where each place was designed to stimulate a specific emotion. For example, the *Virtopia* experience entitled *Fang City* was intended to elicit a sense of angst, with jagged buildings tearing through the ground to surround one, with deafening clanging clocks, and pieces of shattered sky whirling through the heavens. In contrast, *Virtopia's Conversation Room* was most likely to bring about a state of nostalgia. My most recent work, *The Memory Stairs* (2007), explores the psychic space of memories and the deeply hidden emotions associated with them.

Anne Dean Berman, a cellist and music expert with a deep interest in narrative, worked with colleagues at the University of Iowa to create space of remembrance and healing for eyewitnesses of the 9/11 tragedy. Entitled *Ashes to Ashes*, this CAVE experience incorporates an encompassing aural envelope Dean Berman created from an Iowa relief worker's spoken word recollections she recorded and converted into a musical score. In addition the team travelled to New York to collect more first hand accounts from survivors—stories that provide an expanded experience for the visitors that choose to explore deeper.

The imagery in *Ashes to Ashes* is extremely evocative and uses more abstracted visuals to evoke core feelings rather that represent the horror realistically. One survivor's words (an evacuee from the North Tower) were illustrated with a field of red particles, with eyes visible through the shapes. (See Figure 5.2.) The words are chilling:

> … there were some people who were burnt up … And when they passed us we had to let them go because that was emergency. And we looked at them and we didn't know whether they were black or white or pink. We didn't know what color they were. We only saw the two eyes. (Dean Berman et al. 2005)

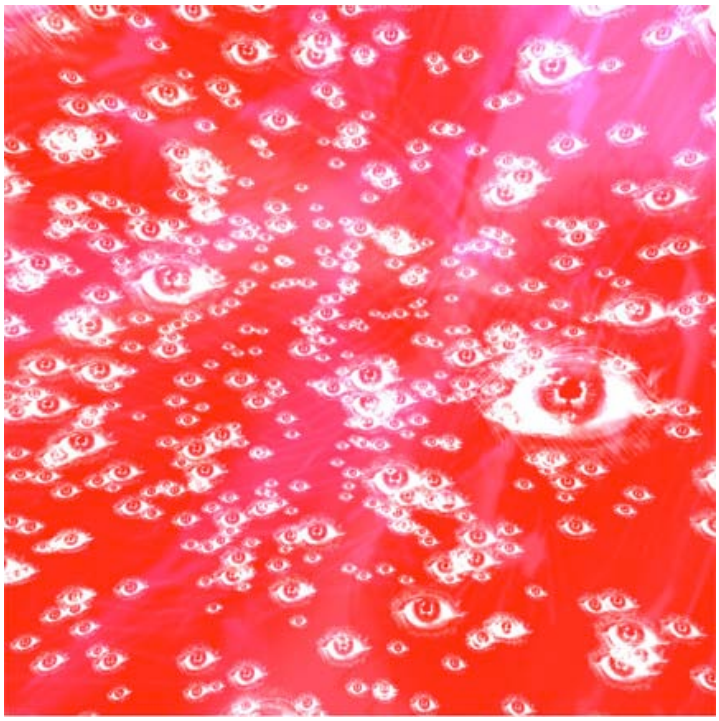


Figure 5.2. Image from Ashes to Ashes[68]

5.3.2 Spiritual space

Earlier I described the work of Char Davies (*Osmose* 1995 and *Ephémère* 1998) as the most salient example of immersive environments providing an intense spiritual dimension. She carefully sets up places for a sublime encounter by employing semi-abstract, ethereal visuals and gentle sounds that enhance the spiritual feeling. The ability to float, fly, or lean in order to move through the world also contribute to an otherworldly sense. One's breath is key to this movement, and its cadence entrains one to a natural, internal rhythm. Participants in

these works have often described their experience as deeply relaxing, indescribable, euphoric, intensely emotional, or as bringing about new modes of perception. (Davies 1998: 149-150)

Figure 5.3. Winter scene from Davies' Ephémère

Predating Char's work is Lawrence Paul Yuxweluptun's *Inherent Rights, Inherent Vision* (1992), another virtual space emphasizing spiritual experience, but made for a very different purpose. A Canadian First Nations artist, Lawrence Paul created a virtual version of his culture's longhouse and the sacred world it encompasses. The work is designed especially for those who do not understand, and might even fear, his spirit world. It provides a rare glimpse into a hallowed sanctum that few outsiders have seen, showing "what it is like being in a possessed state feeling rhythmic sounds in a longhouse, feeling sounds go through one's own self, feeling a spirit inside you." (Yuxweluptun 1996: 316) Lawrence Paul says the experience is "a way to bring others close to my heart so they can understand my belief system." (ibid.) It is also the first use of virtual reality technology to implement a ritualistic space, not by recreating it exactly, but by bringing to life the feelings and essence of the sacred experience so that others could enter into it.

5.3.3 Humanistic space

Space has intimate connections to our human nature. It serves as both shelter and home, and to some, a place to conquer. It provides humans with a way to set certain purposes apart from others, from the sports arena, a shared public space, to the isolated office cubicle, designed for worker focus and economic effectiveness.

Spaces, and the places we make out of them, affect our deep unconscious thoughts, and our subjective private moments. They colour what it means to be a human being existing in this world, this time, this part of the globe.

Abraham Maslow, in the mid-twentieth century, promoted a humanistic psychology that focused on individuals, their being, and their motivations. In his book *Motivation and Personality,* he describes his famous hierarchy of needs, and explains how meeting these needs contributes to a person's sense of fulfilment. (Maslow 1954) The lower levels are concerned with needs that keep the body functioning in a healthy state. Above these are the needs that, when met, enable a healthy psychological state, including safety, belonging and esteem. It is at these higher levels that such spaces can be realised in virtual immersive works. The highest levels, such as self-actualization and spiritual growth, are most applicable to the spaces of artistic immersive works.

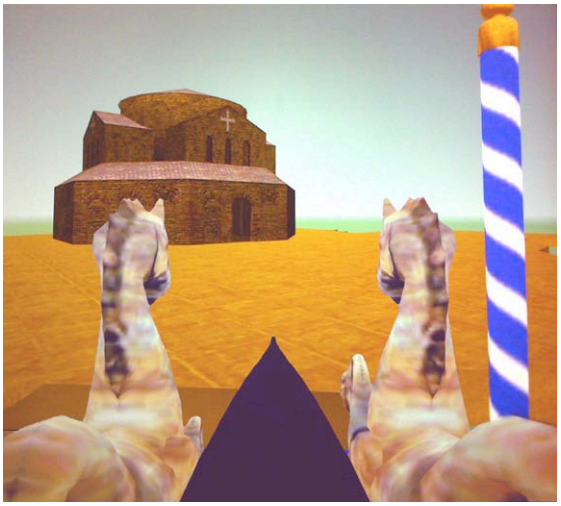
Spaces that are singular havens are acclimated to an individual's inner needs. Take for example, the private space of a child's tree house that, as Frances Downing would attest, serves as a respite from the world of adults, chores, bedtime, and school. In similar fashion, the immersive space can take us away from distractions that might get in the way of our own authentic self. Even in those virtual artworks where there are several entities, questions of ethical choices, courage, relationships, and nobility may come into play.

The mostly solitary nature of virtual worlds means that even social statements can be perused in a personal and private way. Several artists have explored social concerns within their VE works.

The Imperial Message (1992), by Janine Cirincione, Brian D'Amato, and Michael Ferraro (a team collectively known as Softworld), was an early HMD-based immersive work designed to explore social themes between the government and its citizens. Based on Kafka's story of the same name, experients in this world must traverse a space built as a spiral-structured maze to find not only the source of the law, but its deviation in practice as from its pure state. *The Imperial Message* also questions what form law might take in the virtual realm. (Rogers et al. 1994)

Figure 5.4. Image of the empire from Softworld's Imperial Message

Tamiko Thiel's work invariably includes social commentary. In *Beyond Manzanar,* she soundly reminds us that, even today, we are not far from the prejudices that ran rampant during World War II. (Thiel 2001) In *The Travels of Mariko Horo* she looks at the mythic West through the eyes of a woman wanderer named Mariko. Through Mariko's travels and interpretations of the Western world, you enter into various types of church buildings on barren islands. Entering these churches takes you to realms either of the sacred or the profane. Through Mariko's eyes you see a frank view of what we do and have done in the name of our gods and our governments. (Thiel 2006)



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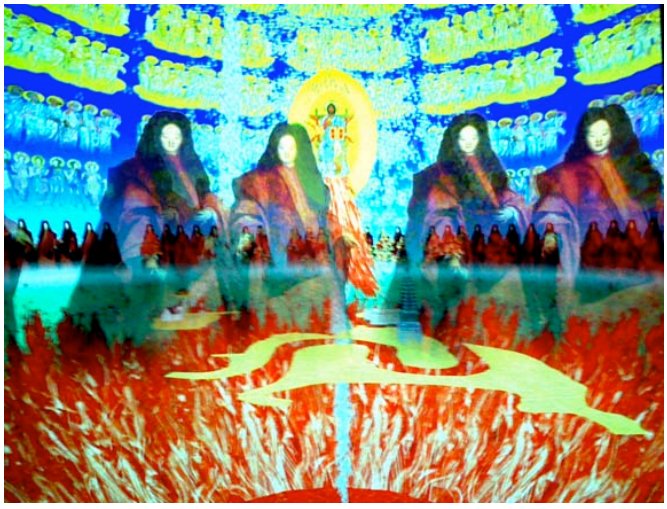

b.

Figure 5.5 a & b. Two stills from Tamiko Thiel's The Travels of Mariko Horo. a. Travelling in the gondola, and b. Surrounded by gods and elders.

Thiel's newest work (in progress), in collaboration with Teresa Reuter, is titled *Virtuelle Mauer / ReConstructing the Wall.* Thiel and Reuter will explore how the Berlin Wall impinged upon life in the ordinary neighbourhoods where it was placed, a symbol of war and difference that could not be ignored or traversed. They hope to portray some of the psychological drama and desperation engendered by the "constant tension" and confining nature of the wall. (Thiel and Reuter 2007)

5.3.4 Aesthetic space

The goal of modern aesthetic works is not only to provide beauty to the viewer, but also to send a reawakening shock to our normal perceptual and cognitive systems. American philosopher John Dewey

recognised this when he said: "The function of art has always been to break through the crust of conventionalised and routine consciousness." (Dewey 1927: 183) Later, in *Art and Experience,* he maintains that an aesthetic experience can introduce us to

> … a world beyond this world, which is nevertheless the deeper reality of the world in which we live our ordinary experiences. We are carried out beyond ourselves to find ourselves. (Dewey 1934: 195)

What exactly attracts us to art and how art affects us is a subject of growing interest, as evidenced by an emerging field called neuro-aesthetics. This nascent discipline looks at neuro-physiological correlates that underlie the artistic experience.[69] Areas of investigation include concepts of ambiguity, beauty, synaesthesia, and how and why art evokes emotion.

Neuroscientist V. S. Ramachandran has proposed a number of core principles for how we respond to art. These include peak shift, perceptual grouping and binding, contrast, isolation, perceptual problem solving, symmetry, abhorrence of coincidence/generic viewpoint, balance, metaphor, and repetition, rhythm and orderliness. (Ramachandran and Hirstei 1999) Spaces created with these properties in mind will tend to be perceived as aesthetically pleasing.

One artist focused on creating aesthetic experiences is Margaret Dolinsky. She calls the virtual environment a circumstance of experience created by the artist to situate a person in an "alternative" world, where "colours, shapes, textures, size and sound—formal elements of art—establish the lines of navigation and construct the ambience, which encourages participant movement and interaction." What she is most interested in creating is the opportunity, through enveloping and integrated sensory signals, for a "perceptual shift." She sees these perceptual shifts as "a cognitive recognition of having experienced something extra-marginal, on the boundaries of normal awareness, outside of continued attenuation." (Dolinsky 2006)

In Dolinsky's *Interiors* (1998), the inner sanctum is protected by active guardians, in the form of columns, who taunt and gesture to discourage one from gaining entrance via a Face Door. If the experient perseveres, and touches a key to the Face Door, a grand hallway is revealed, lined with arched windows full of light and colour and hypnotic reflections. On closer inspection the reflections start to shatter and fall all around in a shower of colour and sounds, transforming the hallway scene to a new place. This scene is dominated by a fantastically designed TV with faces for knobs, which, when touched via the navigation wand, bring up different shows. *Interiors* also features a room with a spiral stair and wondrous characters that dance about, changing shape in concert with the varying sounds. Each of the places in *Interiors* brings the experient to the perceptual shift in unique ways, and the cumulative feeling is to have been witness to an aesthetic "stream of consciousness" space that could exist nowhere else. All of Dolinsky's virtual environments explore such alternative consciousnesses.

Figure 5.6. Image from Margaret Dolinsky's work Interiors

5.3.5 Psychological or psychic space

Psychological space is space that touches the mind and the soul in ways outside familiar perceptual or physical laws. Two specific types of virtual environments are distinctively psychic in nature, though I acknowledge that they share a substantial overlap with both spiritual and emotional space. The distinction I make is that psychic spaces

provide a transition space, a liminal or liminoid experience that brings about a change in the experient. Examples of this transition space include those with a significant singular entrance like a rebirth, or a cathartic event that culminates within the experience. These spaces call to mind the German term *Taufe*, in its full meaning as immersion and rebirth. (Edsman 1962: 626) Taufe can be found in situations that cause a change of heart, or that provoke one to start over with new resolutions or priorities for life. Situations that provide a catharsis, allowing one to shed a troubled self or to find release from troubling feelings such as fear or sorrow, are Taufe.

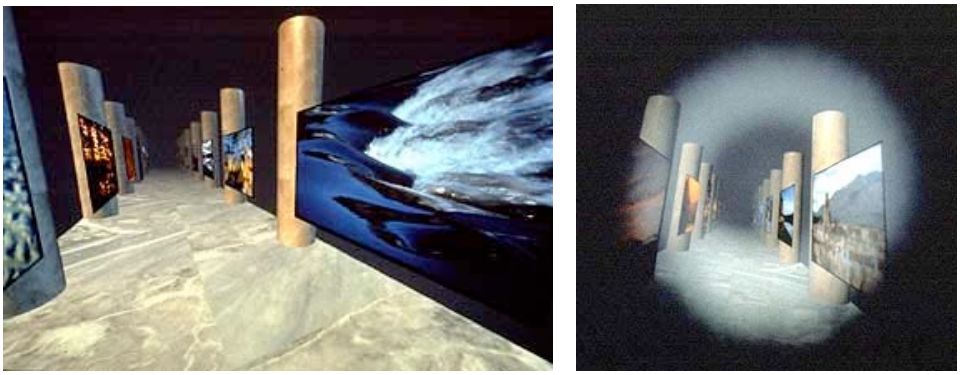

Figure 5.7 a & b. Rita Addison's CAVE-based Detour: Brain Deconstruction Ahead is a personal and "empathic" virtual environment

An example of a Taufe immersive environment is Rita Addison's *Detour: Brain Deconstruction Ahead* (1994), which she calls an example of "empathic VR." (Addison 1995) The content of this installation, created with Marcus Thieubaux, David Zeltzer, and Dave Swoboda at the Electronic Visualization Lab at University of Illinois Chicago, conveys the sensory damage Addison herself sustained due to a brain injury. She wanted to design not the mere representation, but the *essence* of a personal experience that was impossible to describe with words. Through the virtual environment she wanted to convey a sense of the transformative aspects of the original experience, so that others could understand. In so doing she, herself, was better able to comprehend and deal with the trauma. Addison continued this type of work with virtual environments to assist family members of stroke victims in understanding what their loved ones were experiencing.

5.3.6 Gendered space

This investigation of virtual space would be incomplete without touching on the concept of gendered space and its influence on virtual space, though it is not a central theme of this thesis. The Cartesian space on which VEs are constructed is commonly considered to be a strong masculine space. At SIGGRAPH 1995 participants in a panel pointed out to the audience the similarities between the Cartesian coordinate system and male "equipment." (Laurel 1995)

Lefebvre seems to agree with this when he states:

> Space bears clear traces of the process—indeed more than traces: its very form stems from the dominance of the male principle, with its violence and love of warfare; and this principle has in turn been reinforced by the supposedly male virtues, as promoted by the norms inherent to a dominated and dominating space. (Lefebvre 1991: 409)

Mona Domosh and Joni Seager articulate the separate gendered domains of public and private spheres ushered in by the industrial age. Men went out to work in cities or at places of business; women nurtured the family within the enclave of the home. (Domosh and Seager 2001: 5) Beatriz Colomina, in her architectural essay in *Sexuality and Space*, agrees, noting "a radical difference between interior and exterior which reflects a split between the intimate and the social…," a split which she calls "gender-loaded." (Colomina 1992: 94) External is masculine; internal, feminine. Virtual environments encompass a going *within* a space (even if the space within is expansive) and therefore comprise traditional feminine space.

Lefebvre notes that in a male dominated milieu feminine revolts are not surprising (op. cit.: 410) and that in such a situation the male or phallic space might be replaced with a 'uterine space' (figuratively, as well as literally, as in my *Embryonic Chamber* environment of *The Memory Stairs*). Recalling my suggestion that the "feminist crucible" may indeed be connected to immersive environments as the most ideal female instrument of creation, creating these spaces might be considered one such revolt.

5.4 Phenomenological and semiotic space

Space can also be categorised in philosophical terms. Lars Qvortrup (2002) explores two philosophical domains as they relate to the space of the virtual. The first concerns how space is experienced in a phenomenological sense—how we move through it and perceive it. He links the proto-spatial with simple binocular vision. In this form one's spatial focus does not move much beyond what can be taken in by the eyes (much like Previc's *peripersonal* space discussed in Section 5.2.3.1). Virtual reality implementations in this category include passive stereo forms. Adding motions to the layers of objects in the space—indicated by motion parallax, underscores the active stereo forms of virtual space. But it is to full-bodied movement, where our physicality is tracked and thereby causes the most complete interactions, that Qvortrup gives the highest phenomenological stance. (This recalls Previc's *extrapersonal* space.) The immersive environments addressed by this thesis are primarily in this fully embodied category.

Phenomenological categories	**Forms of perception/experience**	**Virtual reality techniques**
Proto-spatial	Binocular parallax	Passive stereo
Movement spatiality	Motion parallax	Active stereo
Body spatiality	Interaction	Interaction and motion-capturing devices, etc.

Figure 5.8. Table 1.2 from Qvortrup (2002: 19): Phenomenological Space

Qvortrup also looks at virtual space from the semiotic standpoint, adapting Pierce's three subcategories of a sign: icon, index, or symbol. Using these subcategories as an economical parsing of types of semiotic space, he describes three basic kinds: iconic space, indexical

space, and symbolic space accomplished by virtual environments. (ibid.: 22-23)

VR as *icon* refers to the reference function. Within this category, VR applications function because of their 3D and dynamic similarity with the real world. VR as *index* refers to the support function. Within this category VR applications function because they are shaped by their position or their function in the real world. Lastly, VR as *symbol* refers to the parallel world function. Within this category VR applications function because of internal laws and conventions of the virtual, dynamic, inhabited 3D world.

While each of these categorizations, phenomenological and semiotic, deserves a fuller course of study, it is my intent to introduce them here to help analyse the philosophical leanings of artistic virtual environments. I have analysed a range of artistic works with this in mind.[70] Of the approximately 90 works studied, all belonged to the phenomenological category of body spatiality, which, of course is the area to which this thesis is directed. Of perhaps more interest is the semiotic indexing of the works. The results of my analysis in this categorization (See details in Appendix B) shows approximately 23 of the 90 can be classified as iconic, only 3 indexical, and approximately 56 (or 62%) fall under the heading symbolic. This makes sense, as VEs allow artists to create worlds that need not conform to the everyday; it is a rich opportunity to explore symbolic space.

5.5 Symbolic to mythic space

A symbolic space is the first step to the formation of a mythological space. The symbol imbues a place with meaning. Many such spaces are liminal in nature.

Michel Foucault, in an article published posthumously in 1967, defines such places as heterotopias, "effectively enacted utopias." (Foucault 1967: 3) He means by this that, while such places are actually located in physical space, they contest and invert reality, as well as, in some ways, represent it. Utopias, by contrast, have no physical existence, being examples of ideal states. Foucault enumerates six principles of

heterotopias. The first and second of these are that these places exist in some form in every culture, and they may change as the culture changes. His primary example for this is how burial places have changed purpose over the centuries, until today we even have picnic lunches in cemeteries. The final four principles are closely aligned with the functions of virtual spaces described thus far.

Foucault's third principle of heterotopias describes their capability to hold within themselves many types of space, including ones that may not intrinsically be compatible. He uses as examples the stage of a theatre or the screen of a movie house. Immersive works, as containers for endless possible environments, also work this way. Foucault's fourth principle describes the relationship of heterotopias to time. He explains that they start "to function at full capacity when men arrive at sort of an absolute break with their traditional time." This aligns very well with the status of time in most types of virtual experience. The fifth principle states:

> Heterotopias always presuppose a system of opening and closing that both *isolates* them and makes them *penetrable*. In general the heterotopic site is not freely accessible like a public place. (ibid.: 5) (Italics mine)

The last principle positions the functions of heterotopias in juxtaposition to functions of ordinary, real spaces. He defines two opposite possibilities here. The first is very much like Baudrillard's views in *Simulation and Simulacra*—that places outside, fabricated places, like Disneyland or Foucault's heterotopias, exist to make the artifice of the real world seem less illusory. Alternately, such places can serve as counterpoints to the real world, perfectly planned and maintaining a flawless form in contrast to the "messy, ill-constructed, and jumbled" real world in which we live. It is possible that virtual environments could serve some of the same functions.

Myths are especially rich material for virtual environments. Cambridge University's Maureen Thomas has created an immersive 3DRTVE environment entitled *RuneCast* (2006), based on mythologies from ancient Norse culture. It is one part of a larger body of work that

explores interactivity through cinematic forms, entitled *Vala – Yggdrasill World*. (Thomas 2003: 416) *Vala's Runecast*, the *World's* digital interactive movie component (first prototype 2000), provides the interactor agency in the form of choosing a rune (a character from the ancient Teutonic alphabet (rune 1989)) that precipitates the main character's (Vala) casting of a divination unique to the individual. (Thomas ibid.: 417, 408-411) The VE version of *RuneCast* provides a 3D landscape for people to explore which emphasizes the feminine principles of the Norse mythic themes, through archetypal symbols such as the seeress Vala and her songs, and the Tree of Life, Yggdrasil. Fabled women care for this mythic tree via a holy "Well of Becoming" (Thomas 2007), reminiscent of the feminist crucible concept from Chapter 3. *RuneCast's* navigable space reifies the ephemeral space of myth; grounded in *l'espace ancien*—the space that defines ancient civilizations—not modern space, which we understand extends endlessly to the stars and beyond.

Virtual environments, as a result of the way they are lived, and the fact that they are set apart, have much in common with Victor Turner's concept of liminal spaces. (Turner 1982) Turner describes these transitional states as those that move us from one stage to another, and in this way they may present a new mythos of space. These are potent mythologies based on our two-phased embodied state *vis-á-vis* the experiencing of them, as well as our creation of place from the space of action.

I see these as mythic because they speak not to the everyday but to the transcendent. Virtual environments require the agency of the hero of the myth to have meaning. They address the higher order signifiers, which Roland Barthes defines as the definition of mythology (Barthes, 1977: 115). Myths provide us ways to understand our world; as Joseph Campbell says, they are metaphors to aid us in the experiences of life. (Campbell 1949: 11)

Myths contain levels of meaning that take us to a deeper understanding of our lived experience. The journey through mythic space begins with the call, which takes us away from our familiar and

comfortable life into the unknown. We can see parallels in entering into virtual environments. The path to traverse that myth is ritualistic action. Professor of philosophy at the University of Lisbon, José Gil says "Ritual action, on this level, consists in forcing the body to go from one space to another, to follow a translation already realised in myth and space." (Gil 1998: 119)

Christopher Tilley notes that the landscapes that constitute our world have undergone a significant shift in modern times:

> Once stripped of sedimented human meanings, considered to be purely epiphenomenal and irrelevant, the landscape becomes a surface or volume like any other, open everywhere for exploitation … it becomes desanctified, set apart from people, myth and history, something to be controlled and used. (Tilley 1997:21)

It may be that virtual environments will escape such a fate. Their commercial failures may prove to be their very protection from exploitation, preserving their potential to realise sanctity, myth, and ritual states in the end.

5.6 Conclusion

From a human-centric space to a rigorously defined mathematical space to expansive space, virtual environments bring us full circle—back to the human, whose very presence makes space tenable, meaningful, and indeed, transforms it into a place.

Hillis discusses the apparent "collapse of space" that the modern world has seemed to exacerbate. He states that virtual worlds have been created, in some fashion, to mitigate this collapse, providing expanded places to visit (open or intimate), even as much of the natural world continues to face destruction. (op. cit.: 171) However, this is a very limited view of the space engendered by virtual environments. Instead I see the spaces of the virtual serving not only to expand our world, but our meaningful experiences from joy to self-discovery.

In this chapter I have argued for a more expansive view of VEs within a set of parameters that view *space* and *place* as separate but linked concepts. I pare down the 'space' of academic discourse by narrowing the field to a few forms or genres for detailed study. In the next chapter, focus shifts to an emerging model of design for virtual environments: my most original contribution to the field of knowledge, built upon the foundations laid in this and previous chapters.

Chapter 6 Towards a design methodology for meaningful immersive environments

Introduction

Virtual environments have been used for many purposes since their inception in the mid-1980s (as mentioned in earlier chapters). My work and focus, however, deals primarily with specific artistic approaches to the creation of meaningful immersive virtual environments. I define such works as those created by an artist with the intent to evoke a meaningful exchange of aesthetic, emotional, or inspiring content. Such virtual environments, because of the connections formed, can deliver experiences that are memorable, and ofttimes unforgettable. In my practice I have established certain methodologies, which I relate and summarize here, that support the making of artistic and meaningful immersive environments.

The creator of unforgettable immersive worlds must focus on intent and approach, as well as content. What is the message the artist wants to get across? What is the extent of the experience to be provided? I have argued earlier in Chapter 3 that immersive environments are fundamentally different from media that rely on full authorial control, yet there are no common guidelines for creating such works. How do you craft a stage where people can, in some real way, weave their own contributions into the experience, not only by interacting with the virtual things and places provided, but also by involving their own memories and emotions within the work? This is not common authorial practice, yet virtual environment artists often find this openness and uncertainty exciting. Allowing the experient a key role in completing the experience contributes to a work's meaningfulness and its ability to connect to each person in a unique way.

I introduce my design methodology by grounding it in a few general design principles (covering graphics, movement, audio, and scent) derived from my own practice in creating virtual environments. I then put forward what I term the *vectors of memorability*—basic ways in which the immersive environment can create strong impressions and

reactions in the experient. I then introduce John Searle's linguistic model of content delivery, and discuss its relevance to presenting memorable virtual environments. I follow this by revisiting James J. Gibson's perceptual *affordances*, their application to the virtual domain, and my extension of *emotional affordances* to Gibson's work. Next I cover design techniques comprised by my model of *coercive design*. Finally, I explain my approach to structuring a rich, coherent encounter with the virtual work. I conclude the chapter by presenting a design methodology derived from my own practice in the creation of both *DarkCon* and *The Memory Stairs.*

6.1 General design principles

In this section, I describe a few of my general practices that support a credible, memorable environment, such as modelling, texturing, lighting, audio, and general principles of animation. Objects in virtual environments are all made of simple polygonal shapes, and enhanced with texture maps—a 2D image wrapped onto the shapes. Making these look credible is sometimes a challenge, but there are many techniques from games and films to make the world look better. I relate a few select ones here only, as there exist a vast number of excellent resources available to modellers, texturers, lighters, and animators that go into extensive detail. I include a brief section on olfaction and passive haptics. This is not meant to be a complete text on these topics, rather a broad and general introduction to my own approach for creating virtual environments.

6.1.1 Quality standards for virtual elements

There are constant tradeoffs between speed of rendering (i.e. how many frames per second) and the amount of data a scene contains (e.g. terrain, models, textures, sounds, and animations) that makes real time virtual environments a challenge to produce. This is often used as an excuse for lack of artistry in virtual environments. Yet, basic design standards can and should be translated into the medium of immersive environments. For example, objects should be modelled to conform to a consistent aesthetic for the work. No distracting facets or polygons[71] should be visible unless that is part of the desired look. Textures on

the objects should be both consistent and meet real-world expectations. One egregious mistake often made in virtual environments is obviously repeating textures. Marbled columns, for example, might have textures with distracting markings repeated in the same spot all the way down a row. Objects that have the same textures, especially if near each other, should have texture parameters shifted, rotated, or scaled. These techniques help avoid identical looking surfaces and objects. Obviously repeating textures across any large expanse, such as a long wall, can be altered just enough per segment to give variety. Adding separate details to different segments along a wall, for example, such as bolts, gratings, graffiti, stains, or broken sections will be much less distracting than repeating textures, which are rarely seen in real life. Another technique, used in my *DarkCon* VE, is to place semi-transparent polygons with differing patterns of dirt, features, or veneers in front of the base-textured objects. (See Figure 6.1.) Objects in life are rarely carbon copies; virtual reality objects should not be either.

Another key design element that affects graphic quality is lighting. Lighting serves not only to make things visible but also sets the mood or emotional tone of the scene.[72] It provides subtle cues about the quality and nature of the environment. Should it be light (high key) or dark (low key)? Lighting can have delicate fluctuations, from almost dark, such as in a tunnel at night, to bright streams of volumetric light coming in through windows or other open or transparent structures (such as gratings). Lighting should have subtle but noticeable effects on the texture maps used on the walls.

Real-time realistic lighting models take heavy computational resources. Few, if any, VR systems can afford to use them and still provide an adequate frame rate. If left to the default, however, lighting tends to look either flat and dull or overly bright. To circumvent these issues, one approach is to use the technique of vertex colouring on the polygons that make up an object. Vertices near a (virtual) light source are made lighter or have the colour of the light added, while vertices farther from the light source are made darker. (See Figure 6.2.) This

enhances texture colours and gives a more variegated and realistic effect, approximating the effect of more computationally expensive techniques.

Figure 6.1. This wall in the DarkCon culvert has a repeating texture. Transparent polygons with dirt, encrustations, and blood stains have been placed over the repeating textures so they are less noticeable.

Figure 6.2. There are no red lights in this scene from DarkCon. Instead the lighting has been simulated with vertex colouring

6.1.2 Living environments

As virtual environments are not static installations they require a design approach that supports their dynamic nature. The work of Disney animators is especially relevant here. They developed guidelines to enable what were essentially two-dimensional drawings to appear alive, a result they referred to as "The Illusion of Life." (Thomas and Johnston 1981) For example, they declared that no character should ever stay perfectly still, even if it was not delivering a line, or centre-stage in a performance, because it would, by looking 'frozen,' compromise believability for the whole scene. Other objects within the scene were also to show subtleties of movement, as fit their range of motion. Thomas and Johnson codified these ideas into the twelve principles of animation, which are still used by animators to this day.

These same principles hold true for virtual environments. As far as possible technically, anything that moves in the real world should move in the virtual world, even if the movement is subtle and slight. A bridge should creak and sway when heavy trucks traverse it. Rocks or stones may fall off a tunnel wall from the vibration. The moon might rise slightly in the sky and clouds might be driven across the front of a star field to suggest a breeze blowing in the night. At a conscious level, these things might not even be noticed, but they are missed when they are not present. Even a small amount of this secondary motion improves believability.

Designers should also think about how the experient affects, and is affected by, certain objects in the environment. In *DarkCon*, the bushes outside the culvert rustle if the experient tries to hide in them or walk through them. In the culvert there is a discarded doll that has a voice box, which produces a sharp sound if stepped on. It is placed where it cannot be avoided. This sound both startles and causes the experient to look more closely at what caused it. This happens at a spot in the tunnel that contains many objects that indicate refugees have been hiding there, and ensures the experient notices them.

6.1.3 Audio and its effects

In spite of the fact that a movie screen presents an immense visual field in front of the audience, the film-going experience would not be the same without high quality sound. Film sound is able to effect both our emotions and our physiology. (Chion 1994: 34) Sound design for film is a detailed process, typically involving the combination of multiple elements: a musical score, ambient sounds, effects, Foley sounds, and audio dubbing. (Eyman 1999) Sound design, as equal in importance to the design of the visual components of the immersive environments, should not be an afterthought, but designed in from the beginning. Sounds should be rich and overlapping. There are two basic kinds of sound in VEs: ambient, or a background tapestry of sounds, and immediate, those sounds that located with, or emanate from, the sound-producing object.

Appropriate ambient sounds are useful to create a general milieu that supports the content of a scene. These types of sounds, such as cars that honk, radios playing, characters that talk, or perhaps sing should be used wherever possible. A trickle of water, distant sounds of a river, a dog barking, and cars passing by are all atmospheric sounds that increase credibility and immersion. In a virtual environment, ambient sounds can be mixed and played as a looping background tracks.

Of equal importance to a virtual environment are the sounds emitted from key objects or characters in the world. Such spatialised sounds (as introduced in Chapter 3) can come from anywhere in the local space, e.g. over the head, behind the door, off to the right. In *DarkCon*, spatialisation is used to provide highly localized sounds, for example, those that might emanate from a perceived source of danger. Such a sound travelling towards the participant can create a compelling state of concern or fear.

In addition to spatialised and ambient sounds, a musical backdrop can serve to set the pace and emotional direction of the experience. For experiences where music might distract from the intent of the virtual environment, my technique using low frequency signals (described in

Chapter 3) can be used to create a subtle, affective, and viscerally felt emotional score. While a definitive study of correlated effects of infrasound in virtual environments has yet to be done, my own practice has shown that low frequencies can actually augment an experient's emotional state, in ways similar to music within a film. (Morie et al. 2005)

Modulations and syncopations can also be utilised with all the sounds and frequencies discussed so far. This includes the phenomenon of *entrainment*, where a person's bodily rhythms tend to synchronise with the beat of the sounds in the environment. Sounds such as an increasing heartbeat, or a slow rhythm can be thus used to help create states of arousal or relaxation. (Gura 2001) (LeDoux 1996: 48-49)

6.1.4 Scent

Scent, as the most evocative of our senses, should be used more widely in virtual environments. There are now several ways to include it within a virtual environment, and sources for odorants are more widespread than they used to be. Not only are there companies in the United States and the United Kingdom that supply small amounts of odorants, there are several contemporary scent artists designing a unique, high quality olfactory art, including Gayil Nalls and Christopher Brosius.[73] People have a wide range of reactions to odours, however, so gauging exact participant reactions is not always possible. Our reactions to scent are also affected by our past experiences. According to Trygg Engen "An odour sensation is like a state that has no meaning by itself but obtains meaning from the situation in which it is experienced." (Engen 1991: 118) In other words, our current response to any smell is layered on top of all our previous experiences with that smell.

As previously discussed, olfactory research shows that scents add a strong emotional power to our everyday life, and could do the same for virtual environments.[74] Scent is a key component of my personal VE practice. To deliver scents to the experient, I use my custom scent collar (discussed in detail earlier). Via a wireless signal, the collar releases a desired scent directed towards the experient's nose, with the

desired flow rate, interval, and duration for each scent set within the program.

Figure 6.3. The Scent Collar being worn by Dr. Skip Rizzo

A few guidelines should be observed when using scents. They should be released delicately and with care. At no time should a smell overwhelm the participant. Accommodation, or a person's adjustment to the presence of a scent so it is no longer noticed, should be taken into account. Using short bursts of fragrance is preferable, therefore, to a continuous stream of an odour for a constant odour. Finally, since smells are perceived in an extremely personal and unique manner, the designer must remember that there is no way to predict with certainty what memories or associations might be unleashed by a particular scent. Smell is probably the least explored and least understood design challenge faced by the designer of virtual experiences. Yet, its power makes it worth expanded use and exploration, especially within virtual environments.

6.2 Artist and participant roles

There are many reasons to create virtual worlds and many reasons to experience them. Both the artist and the participant carry with them personal intents, motivations, and expectations that shape the final form of the work. Each also has specific responsibilities to the delivery and receipt of the work. As described in Chapter 3, the creator of the

work and the person who experiences that work are active partners, co-creators working asynchronously to complete the final form that work takes.

6.2.1 The role of the artist

Since a virtual environment is meant to be an experience, the artist is essentially an experience designer, similar to those who design theme park attractions, or museum installations. The most successful experiences communicate layers of meaning. These layers of meaning might incorporate ambiguity, provide a sense of mystery and engagement, or lead one to look deeper for access to the meaning of the work. The intent may be to tell a story, share the feelings encased in a personal memory, evoke a moment in time, or provide a playground for an improvisational flow of imagination. The artist should make clear decisions about the type of experience she wishes the work to achieve.

Artistic virtual environments are perhaps the most flexible and creative form of virtual environments, as they do not have to adhere to purely functional outcomes. They can serve to open us up to aesthetic experiences, evoke our empathy, make us nostalgic, or surround us with a story (as in Anstey's 1997 work *A Thing Growing*). Sometimes the artist can purposely subvert expectations. In Margaret Dolinsky's *Dream Grrrls* (1996), her conceit of a dream metaphor makes things that appear at one moment capable of turning unfamiliar the next. Dolinsky does this to "loosen the user from an often passive position." (Dolinsky 1996) The environment contains many objects such as glass vases, and spheres textured mapped with Dolinsky's own paintings. Interacting with many of these objects actually translocates the experient to a new environment, contributing to what the artist calls a "perceptual shift."

The distinction between the two experiences described above comes from the artist's intent, the content of the virtual world, and the participant's experience. The experient must situate his or her own actions within the themes or spaces specified by the artist. These can be straightforward, or purposely ambiguous as to the expectations presented. Such ambiguity in art is often a tool of the artist, and is part

of the inherited role of art in many human societies. (Tormey and Tormey 1983)

However, the artist must also ground the participant in the experience.[75] By this I mean that it is preferable to establish a connection between the experient and the environment from the beginning. This can happen via what the experient is told before going into the environment, or by early interactions that compel a connection. The content of the work should allow the dialogue to be personal, and to evolve throughout the experience, flowing from the individual's natural reactions, and not from someone standing there telling the participant what to do at every turn.

6.2.2 Participant

What do the participants expect from a virtual world? If they already know something about the work, then they may already be aligned with the artist's intent. This will make their expectations very different than if they are not aligned. One participant might wish to play the role of the lead character; another may want to remain a spectator. The way the work is perceived ultimately depends on many factors, including familiarity with or affinity for the content, and how willing the person is to be caught up in the virtual world, to suspend disbelief, and surrender to the experience. If the experient is more interested in, or open to, more spiritual or secular content, what they were told, how they were primed, whether they had read anything about the work ahead of time, what the artist might have described or talked about in the press or other writings—all these aspects can affect expectations going into the artwork. Setting appropriate expectations is part of the artist's responsibility, but in a free will experience such as a virtual world, not everything can be tightly controlled.

Habit may also influence the quality of a virtual experience. For example, the proliferation of video games in our culture provides repeated exposure to what is actually a very predictable set of affordances and expectations. Video-game players have come to expect that every object placed in a game world has been put there for a purpose, and they attempt to spot the most salient elements in the

game space. Gamers tend to approach virtual environments with expectations born of that experience. For them a habit of prioritizing and categorizing information can take precedence over the experience actually to be had in the virtual environment. I found this to be especially true of the experients in *DarkCon*, who sometimes misread background objects designed to contribute supporting atmosphere as providing interactive affordances, as they might have in a game setting. (Morie et al. 2007: 281-282) Such expectations can be a drawback, but can also be an asset if the virtual artist takes advantage of these habits and channels them purposefully into actions that support the immersive world.

6.3 Vectors of memorability

What is the *sine qua non* of a memorable experience? What actually engages us and speaks to our human nature? How can these virtual things, objects, events, and sensory inputs affect us psychologically and spiritually? In addition to the quality of the sensory inputs, bringing emotions into play is key. If one is engaged emotionally, the memory of the experience is more likely to remain strong.

An experience can be memorable for a rich complexity of reasons. It becomes significant along multiple vectors: emotional, experiential, and objective. It can include not only the space or place of the experience, but also the events that comprise it. Such an experience encompasses in some way the ineffable mystery of the human condition

Experiences based in virtual reality have the same potential to affect us as do memorable experiences in real life. VR experiences may be classified according to the means used to enhance memorability, ranging from novelty to emotional connection—large categories into which content might be organized. I group these into novelty, excitement, flow, connections, agency, consequences, and emotions, which I discuss next.

6.3.1 Novelty

The concept most often associated with immersive virtual environments is novelty. From a meta-view, the whole VR

experience—donning the HMD, tracking devices and other accoutrements, interacting with the virtual worlds and its elements—is for most people a novel experience even today. Novelty is a distinguishing characteristic of the VR experience. Humans respond to novelty through inherent biological mechanisms. We feel compelled to understand new things: to discover those aspects that define its novelty and bring them into alignment with our sphere of understanding. Novel things actually take more work for the brain to encode, thus making it more likely we will not only respond but also remember those things. (Tulving et al. 1996)

Novelty, however, may be something to transcend. The first encounter with a VR work will often impress people, if for no other reason than they are thrilled to be putting on such sexy gear and seeing stereo delivered to their eyes. Immersive environments are still too rare for the kind of literacy to develop that allows the technology to 'disappear,' or become unnoticed during the experience. In the near term, some level of technical novelty will most likely be a consistent characteristic of the virtual environment experience.

The content of the virtual world itself can also be novel. There are two basic forms of content novelty. The first is something unique, a completely new milieu. A second form concerns activities such as exploration that turn up novel, contextual (but not unknown) ideas, objects, and occurrences within the exploration. *Fang City*, from my *Virtopia* worlds, is an example of content novelty. A pastoral landscape turns slowly into a raucous clanging city that surrounds the experient with fang shaped buildings tearing through the ground.

6.3.2 Excitement

Related to novelty is the category of excitement. Something exciting is inherently memorable to us. Such excitement can be related to what Roger Caillois calls vertigo or ilinx, those elements of play that affect us viscerally, such as thrill rides, rush experiences and experiences that get our hearts beating fast.

> Ilinx. … includes those [games] which are based on the pursuit of vertigo and which consist of an attempt to momentarily destroy the stability of perception and inflict a kind of voluptuous panic upon an otherwise lucid mind. In all cases, it is a question of surrendering to a kind of spasm, seizure, or shock which destroys reality with sovereign brusqueness. (Caillois 2001: 23)

Exciting things are extremely compelling because they affect us not only mentally but also physiologically through release of hormones such as adrenaline or dopamine. Besides vertigo, excitement can also be manifest when we are engaged in active creation within the process of the experience. One example of this category is the creation system *CavePainting*[76] by Dan Keefe. Keefe, an artist and computer scientist himself developed the idea of *CavePainting* by taking into account artists' input as they tested it and made suggestions. A four-sided CAVE is used for the virtual display; the artist within wears stereo glasses and a tracking system. Thus outfitted, the artist can virtually paint with body-sized brush strokes in three dimensions, stepping back at any time to view the effect of their motions. The system provides an intuitive and yet truly exciting new creation space for three-dimensional painting in virtual space. (Keefe et al. 2001)

Artist Jennifer Grey, known professionally as "Jen Zen," has used a similar system: the *Surface Drawing* created by Stephen Schkolne on the CalTech Workbench. (Schkolne, Pruett, and Schröder 2001) She recounts her experience thusly:

> Drawing in the semi-immersive space of the Caltech Workbench for the first time in 1999 was exhilarating. I felt like a child again, able to make forms floating in space by the simple act of waving my hand in the air. (Jen Zen 2004: 7)

This aspect of excitement also recalls and draws upon performative aspects of being within the virtual space, where one is able to make things happen to ersatz virtual objects by deliberate actions.

6.3.3 Flow

The active and engaged state of creation described above is an example of the "flow state" promoted by Mihaly Csikszentmihalyi.

Csikszentmihalyi describes this as a state of being in which the participant moves outside of regular time/space perceptions into an optimal episode that moves of its own accord in time and space, "flowing from one moment to the next." The user feels in complete control, and "there is a little distinction between self and environment, between stimulus and response, between past, present, and future" (Csikszentmihalyi 1975: 34)

This flow state comprises its own intrinsic rewards: feeling one with the action: the appearance that the goal states are intertwined with and inseparable from the means of achievement. Put another way, the challenge and the inherent skills levels are perfectly matched so that progress appears effortless. Because the experience is most often distinctly pleasurable, a person will most likely remember it. Setting up the conditions where flow might occur in a virtual world thus enhances the formation of a unique and memorable experience.

6.3.4 Connections

The ability to find connections with one's own personal experience sets another powerful stage for memorability. These connections are spatial, social, and evocative. A space that seems familiar or distinctive in some way is one kind of spatial connection. Architects often plan for such spaces in their design process. For example, in her book *Remembrance and the Design of Place*, Frances Downing states:

> If we are to design, and teach others to design, places that are memorable and support a meaningful existence, we must first understand the essence and content that make a place memorable and transfer this content as we design. When we, as designers, understand how memorable experiences translate into meaningful inquiry and design strategies, this understanding points us toward fruitful conjectures and comparisons and helps us develop a broad range of conceivable avenues to pursue and evaluate. (Downing 2000: 7)

VE designers can appreciate this sensibility, as the spatial aspects of visual reality are the primary wrapping or enclosure for anything that happens. Immersive VEs are more similar to architecture in this

respect than to the other plastic arts (as discussed in Chapter 5). The space is three-dimensional. It completely surrounds the experient. Thus the space, rather than being viewed through a two-dimensional screen, has a direct bodily connection. We must navigate through it with much, if not all, of our kinaesthetic sensibilities.

Another powerful form of connectivity is through social interaction. Sherry Turkle early on, and later Nick Yee, have each explored the social aspects of online multi-player virtual environments. (Turkle 1997) (Yee 2006) Although most socially-based worlds are not bodily immersive, social dynamics in online worlds are as complex as they are in real life. Friendships, romantic or sexual interests develop, economies form, and social roles are taken on. Because few of these large multi-player worlds exist in any fully immersive form, I will not explore them in depth. I am interested in virtual experiences that are more intimate or personal in nature, which provide small-scale social interactions. These kinds of intimate social personal experiences have, in my opinion, a high potential to provide memorable opportunities in immersive environments.

Social connections may involve a virtual character, or other real people within the virtual space. There can also be social connections between the participant and others outside the virtual space, though this is not common. The social dimension, because it involves other entities, raises issues of agency. I cover this in more detail in the next section.

6.3.5 Agency

When the experient is able to make choices that affect the outcome of the experience, he or she experiences the feeling of *agency*. Agency gives the experient feelings of purpose, choice, and control in the environment—which path to take, what to do with an object, how to respond to an event. These choices serve to draw the person further into the fabric of the experience. For example, in *Virtopia's Conversation Room*, I gave the experient the agency of moving around the room to trigger conversations, and approaching the photo album to have the pages turn.

Agency can arise from social interaction, as mentioned previously. Strong social agency is best exemplified in interactions between a virtual character and an experient.

Imagine for a moment that you are in a room where you see a small box on a table. You open the box and, with a swoosh! a figure rushes from the box, dancing around you, delighted to be free. The character herself is merely a collection of pastel prisms with unmoving ovals for eyes, but is extremely animated and talkative. (See Figure 6.4.) In thanks for her freedom she offers to teach you a special dance, guiding you in the proper movements and chortling with glee as you perform the steps, and as long as you continue to dance well, the virtual character or agent is a delightful companion.

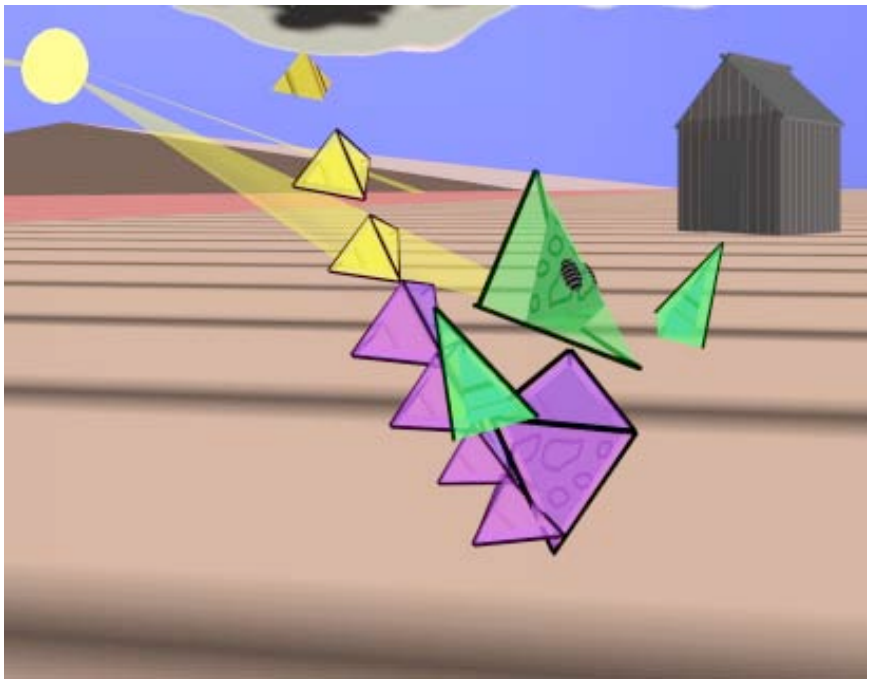

Figure 6.4. The Thing, from Anstey's The Thing Growing

This is the story for Anstey and Pape's *The Thing Growing*—an interactive virtual drama cleverly designed to provide both free agency for experients along with the constraints of the progression of the three acts of the narrative. Its aim is to provide experients with a memorable experience through tensions and strong emotions via a series of encounters with virtual characters that start pleasantly, as described above, but ultimately degrade into an intense negative exchange.

(Anstey 1997) This leads the experient to feelings of betrayal and frustration, but towards the close of the experience, the human is given an opportunity to choose to take revenge on this fickle agent.

The human participants in *The Thing Growing* are rarely neutral in their recounting of their experience with *The Thing*. Here are a few quotes from participants taken from video Anstey shot when people emerged from the VR space. (Anstey 1997-2000)

> "When I got the dance right she was 'good job!' And when I got it wrong she was so mean."
>
> "It does put you into this frenzy like: I have to get them. I have to get them."
>
> "Actually I took a couple swings at it…"

The connections are facilitated through the strong social agency provided by *The Thing's* words and gestures shared with the experients.

6.3.6 Consequences

Experiences are also memorable when there are distinct consequences for one's actions. Knowing that there will be repercussions can provide strong motivation to a participant. Game expert J. C. Hertz relates a high quality of immersion in games to the inclusion of consequences:

> What makes it immersive is a world where no territory is off-limits, anything you see is fair game, and all your actions have consequences. (Hertz 1997: 155)

Ultimately, however, such consequences are still contained safely within the digital space. They do not have real world certainty, or life or death consequences. It is an ongoing question if one can ever achieve a sense of presence without such determinate consequences. D'Aquili states: The degree to which certainty is created depends on a number of factors, including the emotional import and the survival value adherent to the situation. (1979: 12) We can replace the sensory inputs from the real world with those mediated by digital delivery systems, but we may not ever be able to include a true sense of

personal peril. There is a safety in the virtual world that we understand at some deep level as being separate from reality. We can have an emotional reaction, but we do not need to feel physically threatened. We can trust the virtual experience, much as we now take for granted the safety of enormous, spine-tingling roller coasters in theme parks. Thus, full presence may always remain an elusive goal in virtual environments. Even admitting this, I believe that such experiences can still affect us strongly.

6.3.7 Emotions

Underlying all these categories is the key element that makes them unforgettable: emotional engagement at a high level. Emotional responses have a powerful affect on someone's ability to form long-term memories. Many of the techniques in the following sections are meant to facilitate a stronger set of cues that enhance the emotional components of an immersive environment, helping to achieve, as mentioned in Chapter 1, Brian Massumi's "primacy of the affective."

6.4 Tools of virtual illocution

The content of the virtual world is not a neutral package. It can change depending on the way it is delivered and received by the co-creators. In Searle's theory of speech acts (Searle 1975), the term *locutionary* refers to the surface meaning of the words uttered. The basic content of a virtual environment—models, animations, sounds, and smells—equate to a *locutionary* act. The *illocutionary* aspects of speech concern the way the speech act is performed, especially in respect to any emotional overtones. I maintain it is the intent of the artist—how the artist aims to bring meaning to the work—that equates to the *illocutionary* aspect. The illocutionary content of the virtual environment depends on the merging of the artist's intent with the surface content. The *perlocutionary* aspects of speech are the effects of the merger of locutionary and illocutionary acts on the hearer or experient. For meaningful virtual environments, these perlocutionary aspects are critical. This section presents techniques and concepts that highlight the illocutionary and perlocutionary expressions of the designed

virtual environment. These include perceptual and emotional affordances and my system of coercive design.

6.4.1 Use of affordances

Perceptual scientist James J. Gibson (1979) was the first to define the term affordances to describe the connection between perceptual elements in the environment and the possibilities for action they present to the human perceiver. Gibson's affordances are based on sensory mechanisms. Things that can be seen, heard, smelled, or used: as a key in a lock invites us to open a door, or a pitcher of water and a glass placed on a table offers us an opportunity to drink. Key to Gibson's ideas is the concept of behaviour being influenced by the environment in which it occurs. What we encounter in the world presents us with opportunities for action. Gibson ultimately formulated these concepts into a theory he termed *ecological psychology*. Many VR practitioners and critics have looked at Gibson's ideas as a key element of agency and interaction in virtual environments.

6.4.2 Emotional affordances

Gibson's work, however, is focussed on concrete perceptual possibilities for action. My work builds on Gibson's affordances by expanding the concept to include a wide range of affective elements that provide opportunities for emotional *reaction*. The notion of affective elements requires a broader definition of perception. Perception is usually thought of as conscious reactions to stimuli. (Maitland and Foley 1992: 2) The affordances I speak of here may fall below the levels of conscious perception and still afford mental and physical reactions. (Bornstein 1992) I use the term *emotional affordance* to refer to this concept, and consider it an important aspect of the immersive environment design process. Gibson's affordances are extrinsic; they allow for external behaviour (physical actions or reactions). Emotional affordances are intrinsic; they allow for internal actions or reactions. If a perceptual affordance is a perceptual cue to the function of an object that causes an *action*, then an emotional affordance is a sensory cue to the function of a stimulus that causes an emotional *reaction*.

Besides increasing the likelihood that experients will form stronger memories, emotions also contribute to the ineffable subjective quality of an experience. As the pioneering work of neuroscientists such as Antonio Damasio shows, emotions play a critical role in our creativity, decision-making, and our ability to make sense of and dwell within the world. (Damasio 1999) Because emotions affect us in fundamental biological ways, the emotional salience of an experience will contribute in a visceral way to its memorability.

We can design a wide range of affective elements in virtual environments that provide opportunities for emotional reaction. Strong emotional affordances can contribute to the formation of unforgettable experiences. Placing the emphasis on emotional connections helps to mitigate any limitations imposed by the technology (i.e. making us less aware of it because we are emotionally engaged.) Using this strategy can allow more control within the design process for what is experienced. If we can compel the fabric of technology to achieve what we want, as opposed to simply accepting whatever it permits us to do easily, we can amplify and ennoble the technology in the service of the meaningful experiences it can provide.

Because VR sprang out of a scientific forge, creating VEs started with more technical concerns than humanistic. We are entering a time now when technical explorations can take a back seat to those that search for more affective content that speaks to our very human emotional roots. Experience artists must consider the role that emotions play when they are creating their worlds.

6.4.3 Affordances in the design process

Emotional affordances must be designed to seem natural to the situation. They can serve various purposes, including subtly guiding the participant along a desired path through the virtual environment. Clive Fencott (1999) describes affordances in terms of three basic perceptual opportunities—sureties, shocks and surprises—that could be designed in a virtual environment. He further breaks down these opportunities into attractors, connectors, and retainers. This is similar to a design concept I have developed called *coercive narrative*, or *coercive*

design, which will be described in more detail in the following sections. (Morie 2002) My coercive design includes not only the perceptual elements Fencott outlines, but also subliminal and emotional components that serve to guide a participant along a path subliminally. All of these factors contribute to what I term a *continuum of affordance*, as illustrated in Figure 6.5. I propose this continuum of affordance to show complementary and overlapping realms of perception *and* emotion. All affordances are user contingent; in an immersive environment, they are essentially triggers that result in an action (physical response) or a reaction (emotional response) from the participant.

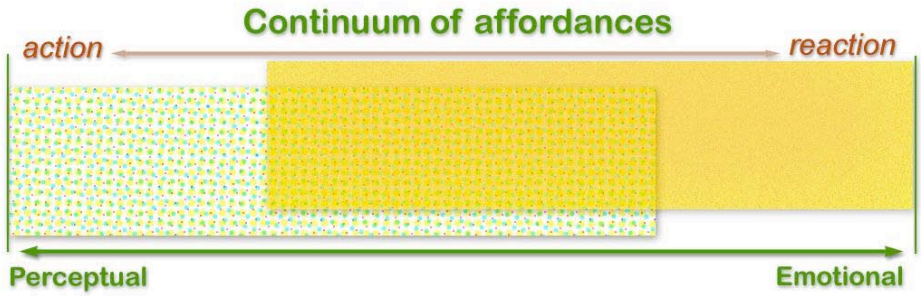

Figure 6.5. The affordance continuum

The *DarkCon* environment is rich with both types of affordances and coercive design. For example, the culvert in which the journey begins limits the path of the experient's movements. The detritus experients see evokes speculations of who might have left these things and what they were doing here. The small creatures in a dark and unknown space heighten the sense of unease, as do the myriad unidentified sounds and deep rumbles from the trucks passing overhead. These last two sensory cues not only elicit fear, they also tend to lower an emotional threshold that may cause other stimuli to have effects they might not have in more familiar emotional territory. In addition, use of the infrasound frequencies discussed earlier may cause people to avoid its presence if possible, and thus affects movement (as a detractor) that is not only subliminal but that might not otherwise seem warranted. I also use perceptual cues (attractors) such as loud sound and flashing lights to attract the subject's gaze towards an important event in the landscape. I rely on startle mechanisms (Fencott's shocks)

in the tunnel where the experient has to walk under a bat colony disturbing them so that they abruptly fly off through the darkness. While this serves to evoke a startle response in most people, for navigation purposes it also subtly shows experients the way out of the tunnel.

6.4.4 Coercive design

Coercive design refers to the practice of placing elements in the environment that influence the participant to move along a desired or optimal path. I use the word *coercive* to describe the inducement of a desired behaviour or response. Coercion exists in almost all forms of traditional media: from teaser clips on the nightly news that make you stay tuned through the commercials, to trailers for movies that convince you to see the film. However, as virtual environments are much more immersive and interactive than traditional narratives, and often with a less dramatic or defined story structure, we need new techniques to encourage active engagement that elicits continued and desired responses in the user.

Since virtual environments are co-created experiences, an experient could make choices that may be at odds with the artist' intent. Coercive elements can help direct these choices to provide the user choices that align with the artist's intent. Coercive elements should emerge seamlessly from the story, experience, or worldview. They should subtly constraint the user's action within the context of the experience in a natural, and therefore unnoticed, way.

Coercive elements have at least three basic functions: attraction, detraction, and corroboration. While the first two have a valence, the third might actually be quite neutral. It serves mainly to heighten the feeling, or confirm the purpose of the virtual world. Visual elements we can use to coerce include colour, motion, contrast, high focus, and strong design elements—things that our neural mechanisms compel us to notice.[77] Other sensory triggers can be used, such as smells, loud sounds, infrasonic vibrations, and startle or surprise elements (all these are used together in the encounter with *DarkCon's* bats in the tunnel). Time can be coercive, as can certain objects, events, and information.

Opportunities for interactions and exploration have a high coercive pull. So do other entities: agents, characters, other interactors, even live audiences, as social connections are a natural part of our everyday existence.

I now describe these elements in more detail and provide a few specific examples of coercive narrative as used in virtual environments. It should be noted that many of these concepts are taught within art and design studies, but growing evidence from neurological studies is beginning to explain why they work as they do. Such knowledge can inform design decisions and enhance virtual environment creation. While this section is not meant to be a comprehensive study of these findings, some will be mentioned here.

6.4.4.1 Movement

Our eye is drawn to movement; we are wired to pay attention to it. Visual stimuli that move, such as lights, people, or vehicles, naturally attract attention (Palmer 1999/2002: 482) and actually trace a shorter path in the brain allowing for a rapid response (Vilis 2006: 6-4). Value judgments about whether to approach or withdraw from these moving elements can then be made. In the still night of *DarkCon*, one of the few moving elements is the welder as he goes about his task. The combination of his movement and the pulsing light of his torch attracts the user to this part of the scene. By contrast, a lack of movement or interesting objects and sounds to the left of the culvert opening subtly coerces one not to explore in that direction.

6.4.4.2 High contrast

Some of the same areas of our eyes that detect motion are also implicated in attention to high contrast or luminance distinctions, along with the corresponding sections of the brain that process such inputs. The magnocellular, or M cells, of the retina (both rods and cones) send signals to the magno section of the lateral geniculate nucleus (the part of the brain that processes visual information and sends it on to the primary visual cortex). These sections attend to high contrast (sometimes called edge detection) and motion. The parvocellular, or P cells,

(mainly cones) similarly send signals to the parvo area of the LGN and focus on colour and spatial resolution. (Palmer 1999/2002: 150)

6.4.4.3 Strong design elements

Strong design, based on visual design principles will naturally attract attention. Certain objects can demand attention by virtue of their size, placement, or importance to the experience. Objects can also be mysterious, such as the ghost children in *The Memory Stairs* that appear and disappear. Closely related to this concept is the visual attention category of visual pop-outs. This refers to an object that is distinct from the rest of the objects in one's visual field, for example the shape of a cross in a field of circles. Our attention is naturally drawn to the singular shape (or the ghost in the room). (Palmer 1999/2002: 554)

6.4.4.4 Sound

We derive much spatial meaning about our world through sounds, and the quality of the sound provides valenced information: sounds can compel or repel. An interesting or mysterious noise may cause someone to head towards it, while a frightening sound may make a person head in the other direction. Since sounds can be spatialised, they can be especially potent in this regard. In *DarkCon*, I used certain sounds to attract the experient towards things that should be investigated. Specifically, the sound of a welding tool is extremely loud and draws the experient's attention to the direction from which it emanates—an area where a figure is working on a vehicle. Later on, shouts, and the barking of an angry dog, are used as detractors to move the experient back into hiding.

6.4.4.5 Time

As previously described, in Anstey and Pape's *The Thing Growing*, the narrative structure of three acts is imposed on the participant. The primary catalyst for the transitions between acts is the expected actions taken within the world. However, if these actions are not performed, the passage of time forces the end of one act and the beginning of the next. In Davis' *Osmose* and *Ephémère*, you have little control over your time in the VE. The scenes change on a predetermined time basis, taking you on a single path through specific visuals and sound. Each

of these artists uses the coercion of time as a means to provide a more cohesive experience.

6.4.4.6 Smell

Smells may prove to be one of the most powerful coercive elements at our disposal. Because the human brain is wired to react to smells viscerally before they are perceived cognitively, olfactory cues are difficult to ignore (as discussed in Chapter 3). *The Memory Stairs* environment *Just New* uses the smell of baby powder throughout to evoke the time of babyhood. When the mother's face comes into view, the scent of a mother's perfume is also released.

6.4.4.7 Information/exploration

When people desire more information, they are likely to be drawn to something that provides it. Exploration appeals to our natural desire to discover. Reading a book contains elements of this: turning each page is a process of mental exploration and discovery, usually (but not always) in a linear fashion. The desire to explore can coerce a player further and further into the experience. In Jeffery Shaw's *Legible City* (1989-1991), the interface of a bicycle the participant pedals, coupled with the changing views of the city of words it enables, encourages such exploration.

6.4.4.8 People and entities

In *The Thing Growing*, the main character's voice prompts the participant to complete certain tasks. In Brenda Laurel's *Placeholder*, experients are coerced by an outside director (typically Laurel herself), who delivers suggestions and taunts to them throughout.

While not an artwork, Mel Slater's recent research in VR on audience phobias is germane to this point. Slater provides virtual audiences that listen to patients practicing public speaking. The audience may be attentive, bored, or outright rude, forcing the speaker to face that which they fear most. Slater's studies show that people respond to these virtual audiences in much the same way they might to real ones, even though the characters are not at all photorealistic. They do, however, have credible behaviours, thus giving the impression that

they are intelligent and responsive. (Pertaub et al. 2002) Credible behaviours for virtual entities in artistic immersive environments should also render such characters extremely compelling.

6.4.4.9 Interaction/Reaction

Environments can be designed so that the user must supply some form of input to move the experience along. Interaction is a coercive element in and of itself because the interaction and the pending result are inherently engaging. However, the interaction must happen intuitively or else the nature of these elements breaks from the sensibility of the virtual world. This relates back to our human desire to be active participants in our environment. Being able to decide where we want to go, what we want to look at, what we decide to pick up, whom we want to talk to, and whether to proceed or retreat is a valuable resource for making immersive virtual environments highly engaging.

Reactive worlds that respond to one's actions are much more coercive than static environments, which adds to credibility as well. By reactive worlds I mean those that respond when the experient performs some action. This can be as simple as a sound that happens when the participant bumps into a wall. It can be complex, such as opening a door that sets off a series of events. Such interaction has consequences, as similar actions might in real life. For example, if experients trip on a rock in their path, or make noise and get discovered, they will feel more physically present than if these actions do not have any consequences. By comparison, the game world does use these techniques; there is no technical reason virtual environments should not incorporate them more widely.

6.4.4.10 Corroborative details

VR environments tend to be fairly barren spaces, with little extraneous information. However, we are accustomed to this extra detail in real life and unconsciously miss it in the virtual. Detail breathes life into a virtual space. In *DarkCon,* I use detritus in the culvert, lots of flora such as bushes, and typical night sounds to simulate a level of detail consistent with that of the real world. In the *Memory Stairs*, the smell of baby powder in the Crib memory, the dirt on the walls of the old

wallpapered rooms, and the magazines tossed carelessly around in the Forgotten Rooms memory serve this function. Clive Fencott calls such details *Sureties*—"mundane details that are somehow highly predictable, but nonetheless make the VE seem more like the real world." (Fencott 1999) Clichés fall into this category, because they are typical amalgamations of common experience. Rats, bats, and mysterious noises make the culvert of *DarkCon* a frightening place even though they seem cliché.

6.4.4.11 Focus

This technique is not often implemented in virtual environments due to technical limitations, but is one that could be quite useful. When a participant focuses in a certain direction through other coercive means, we can then visually defocus the areas we do not want him to look at, and sharpen the object of attention, thus forcing attention on what we deem to be important.[78]

6.4.5 The role of the environment

The environment, virtual or otherwise, is not a neutral container; it carries within it the basis for how people will respond to it. The person entering the space brings equally important influences for the perceived ambience of the virtual environment. It is up to the designer to be aware of how to utilise both these aspects—the space and the person who will experience it—to achieve desired goals. The designer should take affective aspects of the environment into consideration at the earliest stages of the design process. As important as devising a traditional map of the space to be built is formulating the emotional map of the experience.

As discussed in Chapter 3 (section 3.2.1), the virtual environment in unique in its potential to seal its inhabitants off from reality and *emplace* them a truly unique space of unknown possibilities. The art is in being able to set up that immersive space of possibilities.

Educational pioneer Maria Montessori's concept of the "prepared environment" uses related design concepts to facilitate maximum independent learning and exploration. In Montessori's philosophy, the

classroom is a container, set up in such a way that the objects within provide possibilities for interaction, and ultimately for memorable experiences. Taking exception to the educational practices of the day, Montessori wrote:

> Scientific observation then has established that education is now what the teacher gives; (whereas) education is a natural process spontaneously carried out by the human individual, and is acquired not by listening to words but by experiment upon the environment. The task of the teacher becomes that of preparing a series of motives of cultural activity, spread over a specially prepared environment, and then refraining from obtrusive interference. (Montessori 1989: 45)

Likewise, the task of the immersive experience creator must be nothing less: to set the stage for the prepared environment, wherein a meaningful experience can be had. Designing for the intimate space of a virtual world requires thinking like an architect who approaches designing a building, or perhaps even a mother who is raising a child. By designing for a space of possibilities, we allow each person to have his or her own *expression* within that space. The space is the shell, virtual and emotional, in which everything happens.

6.5 Structuring the experience

I believe that the experiential elements described above should be integrated, as much as possible, within the full experience. By the full experience I mean not only the work proper, but also what happens just before and while one enters the work, and the transition from the experience back to the real world. I also mean that the experience itself should be self-contained with no instructions imposed from the outside world during the experience, unless that is an integral part of the work's design (as it was in Laurel's *Placeholder*). For example, voices from the real world asking if the person is okay, or giving instructions on what to do, I feel diminish the feeling of being in a separate place.

In this section, I describe an ideal format for separating the immersive experience from the ordinary world and lifting it into a more

sacramental milieu. As I see meaningful immersive environments as having much in common with ritual, much of what I relate here comes from concepts shared with ritualistic encounters.

While a museum setting is most desired (being the modern aesthetic equivalent of a separate, sacred space), it is often the case that a laboratory setting, which likely has nothing to do with the content of the VE experience, is the locale. Such a setting will, by default, emphasize the VR technology over the VE content. Yet even this setting should be designed, as far as possible, to support the content and de-emphasize the technology.

6.5.1 Priming and associative memories

The structure of the experience should start even before the person enters into the virtual world. One way to steer this process in an unobtrusive way is by using the mechanism of *psychological priming*. (Tulving and Schacter 1990) (Schacter and Buckner 1998) Priming sets a person up for something to follow, typically by presenting to them some form—a stimulus—of what is to come. Priming can be conceptual or perceptual (e.g. semantic or sensory mechanisms) and works best when not consciously perceived.[79] Priming can be incorporated into the pre-experience to accomplish several effects. In a narrative situation, it can establish a context-driven emotional connection by providing an element of a back-story. It may serve to construct expectations for the user experience, or supply reference points that allow a user to make associations and fill in gaps as the experience unfolds. Priming can promote motivation by providing a goal to accomplish or milestones to meet. It can also serve to set a mood, or present subliminal cues that steer subsequent interpretations of the objects and events in the environment, and can contribute to the form of the narrative an experient might later relate about their time in the VE. Finally, it can lend substance to the environment, making the total experience more convincing.

Priming can be subtle, as in soft music or themed background decorations for the entry space, or it might be implemented as a short video that precedes the experience proper. While priming does not

have to be used, such a beginning can be a powerful tool for delivering a more directed experience to the participant. It can help set the desired attitude with which to approach the experience. Priming mechanisms encompass part of the illocutionary elements of the experience, taking into account not only the words that are spoken, but also how they are delivered. The tone of voice, what persona is projected, any costumes that might be worn, and the accoutrements of the setting, are all clues that users will internalize, whether they are aware of it or not.

6.5.2 Entering the virtual environment: Providing thresholds

Creating the ideal setting for an alternate experience involves *sanctifying* a setting for the immersion to take place, free of physical distraction. This consists of several phases, each of which provides a transition from the real world to the virtual one. These increasing degrees of separation are instrumental in creating a *clean and open slate* within the experient's mind, thus enhancing the quality of the experience. This traversal of a threshold serves to not only emplace the experient within the work, it also aligns virtual environments with certain forms of ritual activity.

6.5.2.1 Entrance

Entering the presentation space, whether a dedicated theatre, museum gallery, or more mundane area, is the experient's initial departure from the real world. Care should be taken, as much as possible, for the location to support the theme of the work. As a distinctly set off area, the space lets the person know that he/she is to be the featured performer/experient of this experience.

6.5.2.2 Stage

Some sort of stage, whether physically elevated or delineated in some other way should separate the experient from the physicality of the room, the audience members in the room, and his/her real-world existence. Stepping onto the stage serves to reinforce the message that the experient is indeed the primary player within this space.

6.5.2.3 Setup

Once in place, the experient should receive a short introduction or explanation of the role they are to play within the environment. What is said here is very important as it sets the mental stage for the experience. The setup should not be overly verbose, nor give away all aspects of the experience. There should still be much for the person to discover for herself.

6.5.2.4 Suit up

The act of putting on the VR equipment is another important step not to be underestimated. The donning of the HMD constitutes the last threshold that ultimately seals the separation from the real world and opens the door to the virtual one.

6.5.2.5 Instruction

A guide or facilitator now should interact with the experient to provide all necessary instruction in regards to his/her movements and interactions (e.g. wand navigation, safety issues, use of other interaction devices). If possible, a tutorial room that allows the person to practice could be provided here, but it may be better to do this in advance so as not to distract from the actual experience. Some instruction will nearly always be needed, however, to provide both capabilities and a sense of security. After the person is comfortable with the mechanisms, all further audible and visual (sensory) input should come solely via the immersive environment's equipment, to differentiate the internal existence from the outside world.

6.5.3 Within the experience

The main actions of the experience take place after the final instruction. The experient will be able to make personal choice based on what the artist has provided using the design techniques described earlier. These decisions will ultimately determine the experience to be had.

6.5.4 Closure: Leaving the virtual environment

Many experiences in virtual environments end by an attendant interrupting the experience to tell the experient that time is up. Though this might be acceptable in experimental situations, in artistic

ones it can diminish the quality of an otherwise engaging encounter. Just as we traversed several stages in the entry to the environment, the artist and facilitator need to be mindful of the way in which experients journey back to the real world from the virtual.

In keeping with the liminality of the encounter, experients need time and space to close the experience in their minds. They have experienced something wondrous and apart from the ordinary. Just as trying to remember a dream first thing in the morning is compromised by the intrusion of waking life (the alarm clock, birds chirping, cars going by in the street), memorability suffers from the distractions imposed by suiting down, leaving the stage, and exiting the experience space.

The exit path should therefore be carefully planned to facilitate the integration of the experience in the mind of the experient. This can be as simple as allowing a few quiet seconds to pass after the experience ends, before the facilitator, with a gentle voice, welcomes the experient back to the real world. If the artist wishes to query the experient, this time, before he leaves the enclosure of experience, could be used, or the divestiture of equipment might take place first. In any case, the experient should be given some time in a quiet place before having to depart altogether. Attention to designing closure that reinforces and supports the type of particular experience may be important for enhancing the meaningfulness of the work.

6.5.5 Private or shared experiences

In some cases, VE experiences are designed with not only the experient, but also with spectators in mind. The visuals, audio, and other channels of sensory information (where possible) can be projected to a nearby space for the spectator audience. The experience of the audience is of another nature than the one being undergone by the experient, but it can serve a number of secondary functions. For example, it can act as a preview of what might happen, and allow some people to become acclimated to the virtual work, or allay any concerns that might be present. This is done extremely well in the exhibition of Char Davies *Osmose* and *Ephémère* where the "immersant" stands behind a screen so he is seen in silhouette. The visuals being

seen by the immersant are projected on a second screen placed alongside the first. The audio is also available for the spectators to hear. Benches are provided in front of the screens, so one may comfortably watch the experient and share in part of the experience.

Figure 6.6. Setup for showing of Char Davies' Osmose and Ephémère

6.6 A design methodology

The techniques and thought processes described above are ones I have developed and used over my fifteen-year practice of creating immersive virtual environments. They form the foundation for a design methodology for approaching the creation of meaningful immersive virtual environments. What is covered here was worked out in my experience with *DarkCon*, and refined with *The Memory Stairs*. I hope that artists will be able to apply these concepts to a wide range of artistic virtual environments, and it is in that spirit that I offer them.

6.6.1 Experiential approach

I base my design philosophy for the creation of virtual environments on replicating some realistic facsimile of the *human experience*. I ask the question: Is there an underlying experiential fidelity that *feels-real*, through which the quality of the participant experience can more closely match the subtleties of non-mediated human living? *Feel*, as I

am defining it here, means *to undergo the experience of*. Humans perceive and qualify experiences primarily through an emotional reading of that experience. (Johnston 1999:184-186) Therefore, a *feels-real* environment would be qualified according to its mediated stimuli's ability to induce within the experient a pattern and degree of emotional response equivalent to that induced within the same individual by a perceptually-equivalent *real* environment. Meaningful experiences are the most memorable no matter what their purpose. My desire is to create immersive experiences that are meaningful within the context of the specific goals of the world. Emotions are salient in both these respects. (Ulate 2002) (McGaugh 2000)

When designing a virtual experience, I identify or try to predict patterns and degrees of emotional response to orchestrated multi-modal sensory stimuli, using the design concepts enumerated earlier, such as affordances, corroborative detail, coercive design, and emotion inducing techniques. Such implementation helps steer the actions and behaviour of an experient within the environment, and thereby makes possible predictable patterns of emotional response within a simulated *human experience*.

6.6.2 Design process

To begin the design process, I define the *experience space* in both spatial and temporal terms. In Figure 6.7, the solid vertical lines represent the thresholds separating the *actual* (real world) experience from the *virtual* one. The arrowed line at the top indicates the progression of time throughout the entire experience, including both *actual* and *virtual*. The two different timepiece icons denote the perception of time during the participant's experience: the clocks indicating a more discreet awareness while outside of the *experience space*, and the hourglass indicating the increased ambiguity (by design) felt within it. The three-coloured gradient between the thresholds of the *experience space* represents *sights*, *sounds*, *smells,* and other sensory modalities comprising the multiple sensory inputs that delineate the *virtual environment*.

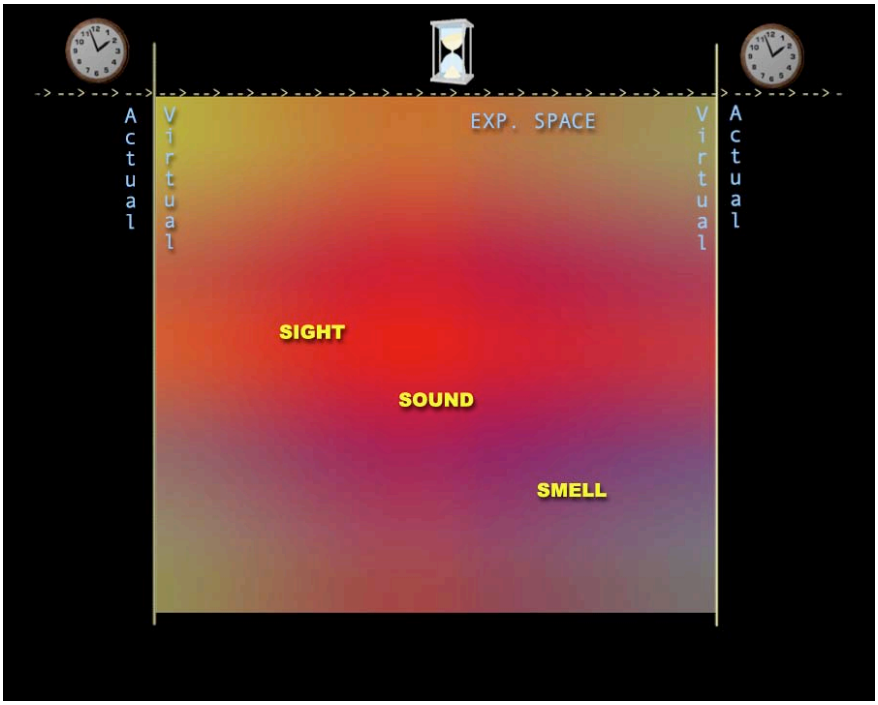

Figure 6.7. Design Process 1

In Figure 6.8, I depict the *experient's* existence within the *actual* and *virtual* experiences as a solid trajectory shown to enter and exit the *experience space* in rough accordance with *time*. Although this trajectory, referred to hereafter as the *journey* of the experient, is not specifically expressive of the experient's spatial position in relation to time, the aforementioned temporal ambiguity within the experience space corresponds to the environment's ability to compress and expand time as necessary. For example, we can control (postpone or speed up) the occurrence of an event until the proper (or most effective) time for it to happen (denoted by the back looping curves). Also represented in Figure 6.8 are the experient's real world expectations allowed or brought into the *experience space* or come in with the experient anyway (the solid centre section). Equally important is the set of expectations elicited from any form of *priming* just before the virtual experience (the bordering lighter area) by the any instructions given to the person concerning this specific virtual world. Such priming becomes a "contextual filter" through which the environment is perceived.

Figure 6.8. Design Process 2

The elements contained within the description thus far should hold true for the entirety of virtual environments, granted their variation by design and available display modalities.

In Figure 6.9, I introduce further techniques developed for my design methodology. First is the concept of *corroborative detail*. Depicted in the diagram as small dashes alongside the journey, such details constitute the marks of time and humanity. These include effects for aging, weathering, use, and abandonment. Often omitted from virtual environments as too computationally costly, these details substantiate the expectations we bring in from the real world, and provide a sense of temporal coherence and persistence.

The plus and minus signs denote *attractors* and *repulsers* metaphorically placed by way of *coercive design* or the perceptual and emotional affordances already delineated. These might best be thought of as *nodes* within the environment, composed of orchestrated multiple sensory inputs, and experienced as part of the environmental setting (static) or an environmental event (dynamic). The acts of attraction and repulsion, in each case, play upon both responses to sensory

stimuli we might expect from studies in cognitive science (such as common phobias and normal reactions to bright light, loud noises, etc.)

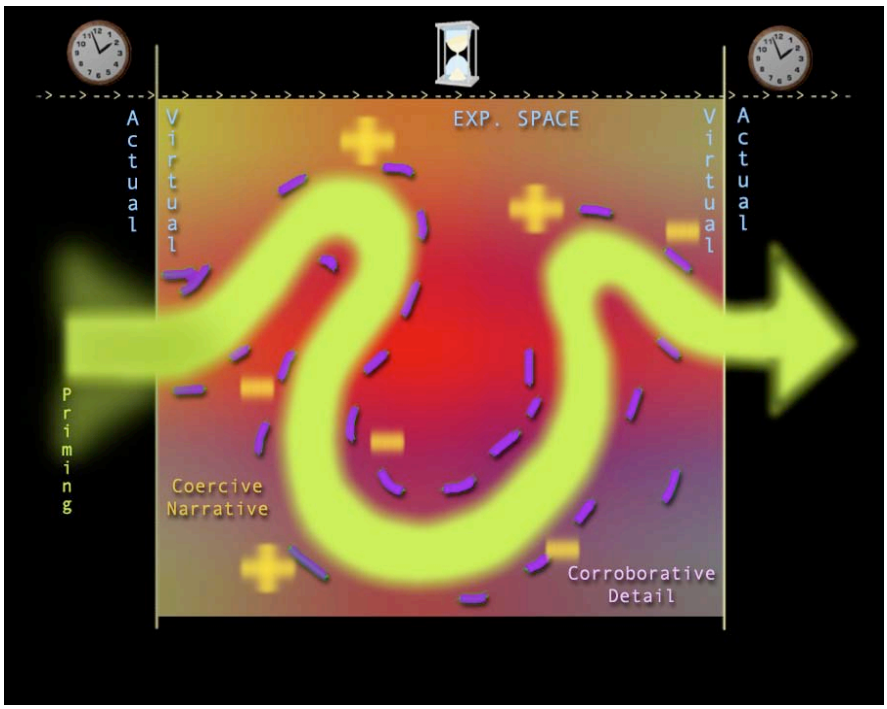

Figure 6.9. Design Process 3

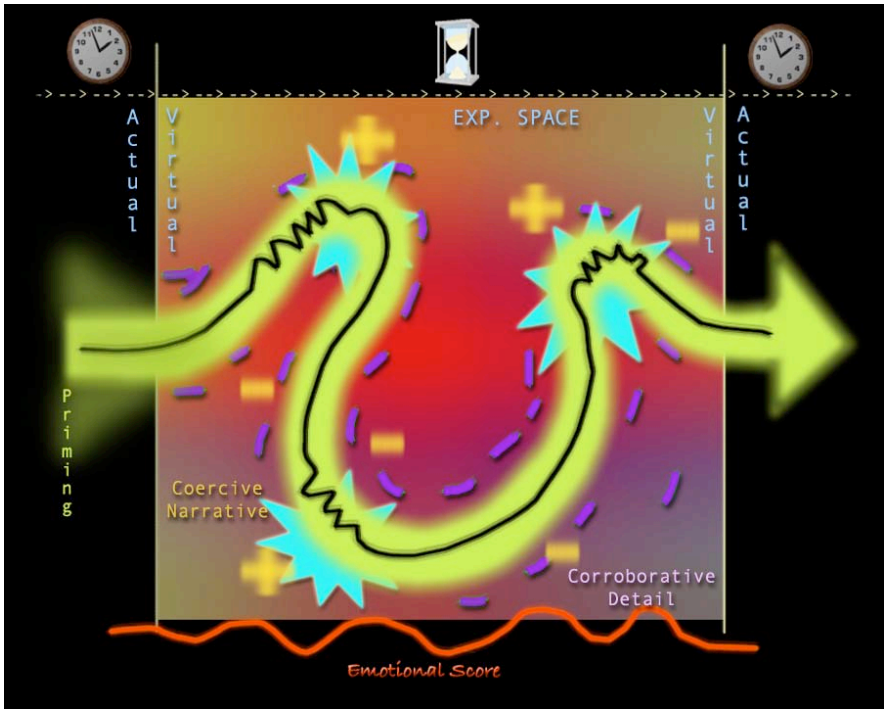

Figure 6.10. Design Process 4

as well as predicted actions or reactions promoted within the experient by the *priming* administered beforehand.

It is important to note that the environmental event nodes can be temporally and spatially independent, making possible their triggering at any time and in any place in accord with the experient's behaviour. Given the careful placement of *attractors* (designed to draw in the experient) and *repulsers* (designed to force the experient away), the experient's trajectory becomes more predictable. In Figure 6.10, this trajectory is indicated by the black line, a conceptual path, and not a spatial or physical one. High frequency sections can indicate a range of acceptable deviations from the planned experience.

Given the relative consistency of the environment ensured by *corroborative detail,* and the predictions set up by affordances and *coercive design*, I am now in a position to augment the predicted emotional responses. The turquoise coloured bursts in the diagram correspond to carefully design emotional cues or hot spots within the environment. I construct these from audio or visual techniques that provide a jolt, either positive or negative, as desired. Another method to augment the emotional response is to use the previously described low frequency *emotional score*, which can pervade the entire experience, much like a soundtrack in a film. This score is typically unheard but perceived through visceral means, and uses techniques such as entrainment (synching the user's heartbeat up to specific rhythms) and the modulations of low frequency sounds (to intensify or mediate the participant's arousal state). It is indicated in the diagram by the red line across the bottom of Figure 6.10.

6.6.3 Iteration

My *DarkCon* scenario was the first virtual environment where I put all these ideas into practice. *DarkCon* had an overall purpose or "mission" associated with the experience: it was a reconnaissance trip to gather information. In the scenario, the experient is set up to role play a scout with a mission (though they can choose just to explore). Complementing the earlier priming the experient has received, more details of the

mission are revealed once the scenario begins. This happens via the *Memory Briefing* construct described in Chapter 1.

Sometimes however, even an element as carefully crafted as the *Memory Briefing* can have unexpected results. One experient asked if she could play the role of a refugee rather than the scout in the scene. When asked why she wanted to do this, she responded that she thought it would be a more engaging experience. A military visitor to a very early version of *DarkCon* took his mission so seriously that he totally ignored the *Memory Briefing*, rushing through the straight tunnel to better cover outside. The reality of the recon mission and his position in that environment overrode any inclination he might have had to stay and watch the briefing. He later explained that he felt like a target that could be seen from either end of the tunnel, which resulted in his speedy exit. As a result, we added twists, turns, and alcoves to the culvert, so anyone in it would be less visible to the outside world. Such an iterative design process is invaluable during the building of these environments as it is difficult to predict responses in advance. Additionally, the artist can use iterations to help refine the coercive elements so they are more effective.

Increased showings will provide me with insights to allow further refinements of these techniques, which will contribute to future virtual worlds that provide more meaningful immersive experiences. While more practitioners and participants are needed to validate the techniques described here, responses to my work to date have closely matched what I designed for and expected.

6.7 Conclusion

This chapter has put forward a new design method and argues for its relevance to emerging VE forms. The design constructs described in this chapter can be thought of as elements of an emerging immersive grammar. We can draw obvious parallels to the early years of film. In the beginning, anything was great; just having motion was amazing, and novelty was more important than content. Then slowly, the way the images were presented became part of the message. Innovators

established techniques that seemed radical at first: moving the camera, designing the frame, extreme close-ups to indicate a character's internal state. Now, however, there are widely agreed-upon terms and methodologies for the film medium. Some of this filmic language has spilled into in video games (Bolter and Grusin's *remediation*), though these works are slowly exploring elements for their own intrinsic grammar. (Thomas 2005: 51-64) Maureen Thomas refers to these works as *navigable storyscapes* to contrast them to filmic media. (op cit.: 62) The creating of virtual environments is still in the nascent stage of developing its unique language. It is, as Douglas and Hargadon in describing other modern cybermedia, fraught "with paucity of conventions, fixed genres and precedents." (Douglas and Hargadon 2004: 193) Yet paucity opens up opportunities to create new conventions that will become the basis for a distinct grammar of fully immersive environments.

The techniques I defined and refined in both *DarkCon* and *Memory Stairs* are shared in these pages, and are offered to future scholars and practitioners of virtual environments, in the hope that they may be of use and of interest to them and others.

Chapter 7 Conclusion

Charting the worlds of the virtual is a vital journey into little understood experiential and philosophical territory. I have attempted to explore this territory, both in practice and in exposition within this thesis.

In Chapter 1, starting with the emergence of virtual reality in the twentieth century, I traced the many influences that gave rise to its technology, its expectations, and its implementations. I considered the role that artists had to play in expanding the possibilities of the virtual environment and the difficulties they had gaining access to this technology. The role of the Banff Centre in bringing together the first group of artists to create with virtual reality technology was the catalyst for the worldview that immersive environments could be viable artistic expressions. I recounted my own path to becoming an artist working in virtual reality, and describe two of my immersive environments: *Virtopia*, done in the early 1990s, and *DarkCon*, created as part of the practical work of this thesis. Both of these were built with the goal of providing rich, emotional, meaningful immersive experiences. In Chapter 2, I described my most recent immersive virtual environments, created especially for this thesis—*The Memory Stairs*. In additions to the poetic descriptions of the four experiences, I also explained why I chose to work with memories and emotions along the conceit of a life journey, and what I hoped experients might gain from their experiences.

Chapter 3 presented the foundations of my arguments that immersive virtual reality is a unique medium among computer-based media, or what I term cybermedia. I showed how we are *emplaced* within a three dimensional space defined and supported by specialised equipment that tracks our movements, and brings the images engendered by those movements in the virtual environment to our eyes. This is not the situation for most cybermedia, which tend to be presented on flat screens firmly situated in front of our eyes, which we experience as if looking through a window. I discussed how multiple sensory systems are made possible by the VR technology, and how this allows the artist

to create with a gestalt sensory palette. The form of the virtual environment thus created, is more a space for becoming, an emergent space, rather than a fully completed work. The actions of the experients contribute to what the immersive experience becomes, not simply the thoughts of the creator. Artist and experient become asynchronous collaborators in the realization of each virtual environment experience. Lastly in Chapter 3, I looked at the real effects of the virtual, and cited experiments that are beginning to show the power of these environments to affect us in ways similar to the physical world.

In Chapter 4, I discussed the ontological qualities of *being* in a virtual environment, from the viewpoints of interaction, embodiment, and experience. I explained the concept of Presence as researchers involved with virtual environments currently define it, and argued why I believe trying to achieve it is an impractical goal. I touched on phenomenology as it applies to the virtual, especially looking at the work of Maurice Merleau-Ponty concerning embodiment. I proposed my idea of the bifurcated body that exits isochronically in the virtual and the real worlds as we experience an immersive environment. Having a body in a virtual space begs the question of what form that virtual body should take, or if there should be one at all, as this impacts the experience the experient has. There are many possibilities and I addressed the various types of representations of the virtual form, or how we "see" ourselves during the virtual experience. Since this experience is a firmly embodied one, I also looked at bodily actions in the virtual space. These include methods of navigation and movement, various types of agency, roles played as an experient, and the performative aspects elicited. I closed Chapter 4 with my thoughts on the primacy of experience over story, arguing that meaningful experiences can be had without a narrative, only later being woven into a life story.

In Chapter 5, I explicated the nature of virtual space, its relationship to historical forms and understandings of space, and how space, and the places we make from it, affects us. I identified several types of space that provide meaning, including spiritual, humanistic, aesthetic, and

psychological space, and relate some examples of their use in artistic virtual environments. I touched on gendered space, which has been an ongoing concern in virtual environments, though I believe artists have taken us past these concerns. I also looked at more conceptual views of virtual space, using both Fred Previc's neurobiological readings of personal space, as well as Lars Qvortrup's definitions of phenomenological and semiotic space. Lastly in this chapter I explored the concepts of symbolic and mythic space in the context of immersive environments. All these spatial constructs serve to affect the nature and quality of the experient's encounters with the virtual.

In Chapter 6, I described my methodology for creating meaningful immersive virtual environments, identified, articulated, and distilled from my almost two decades of practice in building them. I discussed my overall approach to design, general design principles, standards for graphics, audio and scent, and concepts I define as vectors of memorability. Next I covered the roles and responsibilities of both the artist and the experient as co-creators of the experiential work. I also introduced my concept of tools of virtual illocution, based on linguistic concepts from John Searle. These include affordances, both perceptual and emotional, coercive design techniques, and the role of the environment. I offered my thoughts on how to best structure the experience, from before it starts—including priming, establishing thresholds, and isolating the experient—to its closure, which should be gentle, and provide time for the experients to absorb their responses to the encounter. Finally I described my higher order process for a design methodology that takes the totality of the experience into account.

My conclusions gained from the work of this thesis, and my practice of creating virtual environments, are many. I believe that immersive virtual environments are, in some ways, a continuation of our everyday environment and that they "work" (fool our senses, permit us to achieve a sense of presence, provide a meaningful experience) precisely because they are continuous with what we know of the external world. They are also places that exist outside of us in latent form, and do not become 'real' until we are emplaced within them,

until we phenomenologically engender them. Yet, they are our constructs, and because we build them, they are born out of the same fabric of our everyday existence. We are also beings of imagination, however, and can invent other modes of being that may have limited commonalities with what we know, and with what we are bound by in the physics of this earthly place. We can easily create virtual environments that provide experiences beyond what we can have in everyday reality, ones that eventually might even affect our continued evolution. Virtual environments also share much with ritualistic concepts; they can provide a separate or sequestered space, a place beyond the ordinary, both within it and outside of it simultaneously. I am convinced that the virtual environment is a living medium, one that transpires and emerges with the living of it, one that is capable of evoking new forms of meaning within our lives. It is, perhaps, what Ronald Grimes calls a "nascent ritualizing process." (Grimes 2006: 80) The possibilities could be extraordinary.

We may not be able to foresee what the mature form of virtual environments will ultimately be. We can, however, envision that as more artists are enabled to work with VR technology they will create immersive 3D experiences that encompass new worlds, meanings, and memorable encounters. Maureen Thomas portrays the production capabilities of digital media as "as arena for creative performance," malleable in the hands of a "playwright" who can create a dramatic experience that brings players together within the neoteric play engendered by digital possibilities. (Thomas 2003: 128) Similarly, artists exploring the nascent immersive virtual environment medium are also (as Thomas says of the digital playwrights) not writing, but *making*, shaping, moulding, in the sense of having wrought. (ibid.)

As that exploration is affirmed by new insights of theory applied to this body of practice, then both the field of VE and the wider domain of digital media will be enlivened. In this twenty-first century, the medium of immersive virtual environments may become, as Steve Dixon imagines, "as important and revolutionary an artform as cinema was to the twentieth century." (Dixon 2007: 394) As artists and

experients co-create and evolve original forms of immersive virtual art, we can expect to encounter remarkable worlds of experience that will enrich both our intellects and our spirits.

No one can predict the ultimate direction for immersive VR, for, like Benedikt's cyberspace, it is "an elusive and future thing." (Benedikt 1991: 22) Recent online communities such as Second Life have started to claim the hallowed status of the metaverse (Gibson's cyberspace) that was once presumed to be VR's ultimate fate. So be it. It just may be that VR is destined for a very different, yet-to-be determined, but just as vital, end.

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Appendix A Lexicon

Agency I use this in its connotation of providing opportunities for interaction, for the participant to have an effect on his or her environment, whether real or virtual.

Affordance Perceptual scientist J. J. Gibson's term that states objects provide opportunities for action when we perceive them.

Artificial Reality A term used to describe immersive computer-mediated environments coined by early virtual environment pioneer Myron Krueger in the mid 1980s.

Cyberspace A term coined by novelist William Gibson in his cyberfiction novel *Neuromancer*. It refers to a virtual construct, formed of connected data space generated by computers that can be inhabited by people in some semblance of reality. Gibson also called it a *consensual hallucination* due to its ultimately virtual nature.

Cybermedia My term to include all media based on computer technology.

Displays A display is not limited to mechanisms to produce visual imagery but can include any means to deliver any sensory phenomenon via technological means. Thus, a device that produces odours, sounds, taste, or tactile sensations can all be termed "displays."

Embodiment I use the philosophical definition of this term, meaning the body as the source of what makes us human. Embodiment theories have negated the long held Descartian concepts of mind and body as separate entities, each barely requiring the other. Modern neuroscience has upheld the significance of the body as the substrate on which our mind develops.

Emplacement The privileged nature of how one experiences the form and content of the created world through a sense of total immersion. Emplacement represents a twofold aspect of

immersion by unifying the special characteristic of being able to go *within* the created, virtual space, with the coincident *exclusion* of the perceptual inputs of the ordinary world.

Experient My term for the person who is undergoing the immersive virtual environment experience. See also *immersant* and *participant*.

Experience Artist, Experience Designer The person primarily responsible for the content and form of the virtual environment, even if the full work was implemented by a team of people.

Gestalt I use this term in both its psychological and its neurobiological senses. Psychologically it refers to a 'whole form' definition of perception, in which all our sensory mechanisms work together to create a greater holistic pattern than any single sense could in isolation, the result of which is a higher level apprehension of perception. Neurobiologically it means our sensory stimuli converge and are combined in the limbic system, deep within the forebrain (Freeman, 1998). The particulars of the patterns that relate to the structures of the eye, ear, nose and skin are overwritten in the formation of multisensory percepts known as Gestalts. These integrated patterns are the basis for recognition and awareness of the broader contexts in which they are perceived. (Freeman 2000)

Haptics This term refers to the sense of touch, or tactile sensations. It also refers to a body of current research in reproducing or producing tactile sensations via technological means.

HMD Head Mounted Display. A specific type of visual display that consists of small optics placed in front of the eyes within a device worn on the head. Images from the computer program are computed and sent to these optics so that the wearer sees a stereo view of the virtual world.

HUD Heads Up Display. This type of display refers to an overlay onto either the real of virtual world. Its name derives from its

original use in airplane cockpits, where the instrument dials were projected onto a display in front of the pilot so he did not have to look down to read them, thus "heads up" display.

Immersive media This term, as I use it, refers to media that fully encompass the participant, not allowing distractions from the real, non-mediated world to intrude. This can be accomplished by means of a head mounted display most easily at this time, though a CAVE system that is set apart from the rest of the space can provide immersion, or a private room with an alternate display device.

Immersant *Immersant* is the term that Virtual Environment artist Char Davies conceived that she uses to refer to the participant experiencing her creations. See also *experient* and *participant*.

Immersion Immersion is the psychological state of being surrounded by a mediated environment. It can be created through several different means: *sensory immersion*, where a person's normal sensory perceptions are replaced with computer generated or triggered ones, *social immersion*, where the presence of others in the mediated space provide the sense of being within a separate psychological space, and finally *spatial immersion*, where the computer generated spatial constructs are perceived as being the perceiver's immediate surrounding world.

Infrasound Infrasound refers to audio signals that are between 4 and 20 Herz, most often below the threshold of ordinary hearing. Played at loud decibels, these signals can be felt as mild or intense rumbles, and can be used to augment arousal states in virtual environments.

Liminal A term from Arnold van Gennep, French ethnographer and author of the foundational work *The Rites of Passage*. The term indicates the state of a ritual activity being outside the boundaries, norms, social mores, and rules of the ordinary. A liminal state is a requirement for rites of passage, for unless one

destroys all ties to an old life, and enters a liminal state, the new life cannot be gained.

Liminoid Victor Turner expanded van Gennep's concept of liminal, which was a distinctively social obligation in pre-industrial cultures, to a less obligatory means of escaping the ordinary in industrialized societies. Liminoid states, like liminal, also serve to subvert the ordinary, but more in the form of entertainment, games, parties, sporting events, and the like.

Odorant A basic elemental scent compound. Odorants can also comprise mixtures of more basic compounds.

Participant I use this word, as a synonym for my word *experient*, to refer to the person who is experiencing the virtual environment. See also *experient* and *participant*.

Presence Presence is a concept that describes that state of a person being immersed in a virtual environment believing it to be true, in place of the real world. There are many subtle variations to the Presence definition.

Real time Used to describe computer-generated images that are processed for viewing (rendered) at the frame rate of 24 to 30 frames per second. Sometimes a lesser frame rate is also considered real time, but the ideal rate matches or exceeds that of film, which is 24 frames per second. If it doesn't the viewer of the images does not see smooth movement.

Render The process of taking the virtual geometry in a 3D computer scene and processing it into a 2D screen based representation composed of individual coloured picture elements called pixels.

RT3DVE Real-time three dimensional virtual environment. This term is used when describing an immersive virtual work that is experienced primarily though means of a large screen, often with stereo glasses for a 3D effect. The environment has been designed as a fully three-dimensional world that could be entered into if full VR equipment was employed.

Spatialised Most often applied to audio, this is the capability of placing sounds in discreet locations in the 3D space of the computer environment. Sound thus processed appears to come from the correct locations in the 3D space. This can be done as a pre-rendering process, or in real time, the latter required for use in a virtual environment.

Scent Collar The Scent Collar is a bespoke scent release device worn like a necklace by a participant in an immersive virtual environment. It allows for release of four discreet scents, triggered via BlueTooth signals during the experience. It was invented by Jacquelyn Morie and Donat-Pierre Luigi and was patented in 2004.

Tracker, tracking unit A device work on a body part, such as the head or a hand, that enables the computer running a simulation to receive signals that situate the wearer's position in relation to the 3D virtual space and the moves he makes via a navigation device. Trackers measure the X,Y,Z location in three dimensional space, as well as rotational information about those same axes (called pitch, roll, and yaw, respectively). These measurements are termed Degrees of Freedom, or DOFs. Trackers are made with several forms of technology, including acoustic, magnetic, gyroscopic and video-based.

Valence A state that defines variation from a neutral stance. A valence can be positive or negative. It is most often used in conjunction with psychological or emotional states to describe attraction or repulsion reactions to a stimulus.

Virtual Environments (VEs) Virtual environments are created constructs that permit a participant to exist *fully immersed within* their computer generated space or place for a period of time. As such, VEs tend to be experiences for one to a few people, sometimes with spectators. They are not usually persistent, so the experience setting begins anew with each visitor. I also use

the term to refer to the *content* of the environments enabled by Virtual Reality technology.

Virtual Reality (VR) The general term which I use to refer to the overall technology that enables the creation and experience of virtual environments. The term itself was coined in the 1980s by Jaron Lanier, an early developer of this technology and proponent of its uses.

Virtual Worlds This term was originally used as a synonym for virtual environments. In the last decade its use has become more focused to describe environments that are persistent, multi-player, and networked, much as online game worlds are.

Appendix B Chart of artistic virtual environments

This survey of Artistic Virtual Environments represents a fairly exhaustive search of art and technology books, exhibition records and catalogues, and Internet resources examined over the last five years. Even at that, I cannot be sure it is complete, and may have therefore inadvertently left out some very notable works. It is my intention to continue to update this chart in my Post Doctoral work, especially those data items for which I could not locate appropriate information.

My first criterion for addition to this list was that the work be artistic. This eliminated dozens of outstanding examples of immersive virtual reality done for practical or specific commercial applications, including environments designed specifically for scientific experiments. My next criterion was that the work be immersive. My own definition of this is that the work must use an HMD at best (given this is the most effective means of separating an experient from the real world during the experience) or a CAVE at the least. This specification requires some explanation, because an attentive reader will notice that there are works included that are shown primarily on a large screen. I have included some of these even so, because the reason for the artists using the screen delivery method was not mainly for artistic purposes, but for the practicality of transporting these works and showing them in gallery spaces. The intent is for these included works to be immersive, to take one out of the ordinary world for a period of time. I would venture a guess that, if the truly immersive equipment was more widely available and reasonably priced, that these works would have taken advantage of it for display and showings. Some of the listed works have little in the way of graphics, being instead immersive auditory or haptic space. These are rare, but some examples do exist.

In terms of graphics, most of these works are primarily three dimensional (some say they are four!), yet often incorporate 2D imagery or video within the environments. I have deliberately avoided works designed to be viewed on a small computer screen.

All these works involve the phenomenological space Qvortrup calls Body Spatiality (as opposed to Movement Spatiality or Proto Spatiality; see Chapter 4 for details), so I felt it unnecessary to add a column for this data item. In the category of Qvortrup's semiotic space a different picture emerges. Most fall into what he calls Symbolic Space (a parallel world function), at 60%. The next largest category is in Iconic Space (some correlation to the real world) at 25%, and only a few fall into his Indexical category (functional VEs that support real world work), a mere 3%.

One of the points I had hoped this data would bring to light was a long held belief of mine that more immersive virtual environments have been made by women than men, and indeed this was proven to be so, with 62% being designed, directed, or built by women (even acknowledging that the full effort is almost always collaborative). Those works done primarily by women are indicated by shaded blue rows.

Finally, in terms of statistics, it is clear from this survey that the majority of the artists who have done two or more virtual environment works are also women, and that more women seem to be taking up this cybermedium as their primary artistic mode. I find this extremely encouraging, and believe this trend lends additional credence to my assertion that virtual environments may be the perfect "l'écriture feminine."

Note on how to read the chart: As this is quite a large chart, I have broken it up into page-sized section for inclusion in this thesis binding. Each page is printed as a separated two page spread. In other words, Page 1A includes the data for the first 11 columns. The second page, 1B, repeats the artist's name, and includes the data for the final 5 columns. There are eight pages like this in the full chart. The full Excel Spreadsheet is included on the documentation and media disk included in this thesis.

	A	B	C	D	E	F	G	H	I	J	K
1	**Artist**	**Project**	**Year**	**Display type**	**Sound type**	**Interaction**	**Smell**	**Haptics**	**Other senses**	**Indiv/Collab**	**Laboratory or company**
2	Agnes Hegedüs	*Handsight*	1992	Custom Transparent Sphere	N/A	Via spherical camera	No	No	No	Collaborative	Zentrum fur kunst & Medientechnologie, Karlsruhe
3	Agnes Hegedüs	*Memory Theater VR*	1997	Custom circular space of theater flats	N/A	3D Tracked hand-held device inside mini-plexigals museum model	No	No	No	Collaborative	Zentrum fur kunst & Medientechnologie, Karlsruhe
4	Agueda Simó	*Microworlds, Sirens and Argonauts*	1999	Single wall CAVE	Spatialised	Mouse	No	No	No	Collaborative	USC
5	Agueda Simó	*Mimesis*	2000	N/A	N/A	N/A	No	No	N/A	Collaborative	Pompeu Frabra University's A/V Institute and the Phonos Foundation, Barcelona
6	Alison McMahon	*Mimesis*	2002	CAVE	N/A	N/A	No	No	Bio-feedback	Collaborative	Vassar
7	Anne Deane Berman, Steve Berman, Carolina Cruz-Neira, Larry Tuch	*Ashes to Ashes*	2002-2004	CAVE	Music and Narrative	Wand	No	No	No	Collaborative	University of Iowa
8	Brenda Laurel, Rachel Strickland, Rob Tow, Michael Naimark	*Placeholder*	1992	HMD	Spatialised	Grippers, Walking	No	No	No	Collaborative	Banff/Interval Research
9	Carl Eugene Loeffler & Fred Truck	*The Labyrinth*	1993	HMD	N/A	N/A	No	No	No	Collaborative	STUDIO for Creative Inquiry CMU

Page 1A

	A	L	M	N	O	P
1	**Artist**	**Singular/Shared**	**Semiotic category** (per Qvorstrup)	**Body representation**	**Exhibited or main reference**	**Short description or quote**
2	Agnes Hegedüs	Singular	Symbolic	None	Chapter in Malloy; V2 Archive at http://framework.v2.nl/archive/archive/node/work/.xslt/nodenr-146808 and SIGGRAPH 1993 Machine Culture	Users see a virtual world within the clear sphere when they move the camera inside
3	Agnes Hegedüs	Singular	Symbolic	None	Christine Paul Digital Art and Media Art History, ed. by Hans-Peter Schwarz, ZKM Media Museum, Munich/Amsterdam 1997, p. 121 ZKM Media Museum	Four virtual worlds: museum, fantasy, plus 2. Move nav device above the model to open compass, select N,S,E,W to get to them
4	Agueda Simó	Singular	Symbolic?	N/A	SIGGRAPH 99 and Museum of Science of San Sebastian (perm)	Based on sirens from Jason & the Argonauts with attractors
5	Agueda Simó	N/A	Symbolic?	N/A	N/A	inspired by Mimetism, a co-evolution phenomenon of nature; modifiable by users.
6	Alison McMahon	Singular	N/A	Yes, partial, grey abstract	www.aguedasimo.net/me.htm	Several sections: Claustrophobia, Haunted Mansion. Biofeedback determines what the user sees.
7	Anne Deane Berman, Steve Berman, Carolina Cruz-Neira, Larry Tuch	One driver, other observers	Iconic	None	Berman et al. paper	Guest is immersed in the stories and images of the 9/11 disaster
8	Brenda Laurel, Rachel Strickland, Rob Tow, Michael Naimark	2-person	Symbolic	None except by voice	Banff	Networked guests become animal spirits
9	Carl Eugene Loeffler & Fred Truck	Singular	Indexical	None	SIGGRAPH 1993 Machine Culture Show	Guest experiences the myth of Daedalus' escape from the prison of Minos using a da Vinci Flying Machine

Page 1B

	A	B	C	D	E	F	G	H	I	J	K
1	**Artist**	**Project**	**Year**	**Display type**	**Sound type**	**Interaction**	**Smell**	**Haptics**	**Other senses**	**Indiv/Collab**	**Laboratory or company**
10	Carl Loeffler	*Fun House*	1992	HMD	Stereo?	N/A	No	No	No	Collaborative	STUDIO for Creative Inquiry CMU
11	Catherine Ikam Louis Fleri	*Face a Face*	2000	CAVE	Stereo?	Spoken word?	No	No	No	Collaborative	Ars Electronica visiting artist
12	Char Davies	*Osmose*	1995	HMD	Spatialised	Full Body with breathing	No	No	No	Collaborative	Independent w/Softimage
13	Char Davies	*Ephémére*	1998	HMD	Spatialised	Full Body with breathing	No	No	No	Collaborative	Independent w/Softimage
14	Christian Gruel	*Still Life*	1991	HMD	N/A	Joystick?	No	No	No	Individual	N/A
15	Dan Sandin et al., inc. Anstey, Dolinsky, Pape	*Alive on the Grid Looking for Water*	2001	6 networked CAVEs	Stereo?	Wand	No	No	No	Collaborative	EVL, Interactive Institute and others
16	Daria Tsoupikova Sound by Brian Soleilhac	*Rutopia*	2003	CAVE	Spatialised (Bergen)	Wand	No	No	No	Collaborative	EVL
17	Daria Tsoupikova Sound by Brian Soleilhac	*Rutopia 2*	2005	CAVE	Spatialised (Bergen)	Wand	No	No	No	Collaborative	EVL
18	Dena Eber, Greg Little, Brian Betz	*Organs without Bodies*	2006	HMD	Stereo?	N/A	No	No	No	Collaborative	Bowling Green State University
19	Diane Gromala	*Meditation Chamber*	2001	HMD	Headphones	Tactile feedback I/O devices	No	No	Biofeedback	Collaborative	Georgia Tech
20	Diane Gromala, YacovSharir	*Dancing with the Virtual Dervish:Virtual Bodies*	1994	HMD?	Spatialised	Joystick?	No	No	No	Collaborative	Banff
21	Diane Gromala, Lily Shirvanee	*Living Book of the Senses*	2002	Headset (augmented reality) and camera	Stereo?	N/A	No	No	2 Biofeedback devices	Collaborative	Georgia Tech & MIT

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	A	L	M	N	O	P
1	**Artist**	**Singular/Shared**	**Semiotic category** (per Qvorstrup)	**Body representation**	**Exhibited or main reference**	**Short description or quote**
10	Carl Loeffler	Shared	Indexical	No, but attach yourself to objects and they to you	Expedition 92, Munich, Germany and SIGGRAPH 1993 Machine Culture	Networked between Munich and the US
11	Catherine Ikam Louis Fleri	Singular?	Symbolic?	None?	Ars Electronica Center Exhibition 2000	What makes faces believable to us? Emotions, something else. This VR attempts to find out.
12	Char Davies	Singular	Symbolic	None	Many shows world wide	Seasons in landscapes, body and earth
13	Char Davies	Singular	Symbolic	None	http://www.immersence.com/index.html	Starts w/ Cartesian grid, can go to tree, leaf, pond, etc. or to code and text
14	Christian Gruel	Singular	N/A	N/A	N/A	Processed senses and music driven VR
15	Dan Sandin et al., inc. Anstey, Dolinsky, Pape	6 people networked	N/A	3D photoreal face	Commissioned by Ars Electronica	Visitors can change worlds and leave ghosts; persistent worlds, many worlds.
16	Daria Tsoupikova Sound by Brian Soleilhac	Singular	Symbolic	None	http://www.evl.uic.edu/animagina/rutopia/	an ideal garden, a fairy Park, which shows a unity of technology, man, and nature. Russian folk art & fairy tales
17	Daria Tsoupikova Sound by Brian Soleilhac	Singular	Symbolic	None	SIGGRAPH 2007	V.2. an ideal garden, a fairy Park, which shows a unity of technology, man, and nature. Russian folk art & fairy tales
18	Dena Eber, Greg Little, Brian Betz	Singular	Symbolic?	None	BGSU	described as psychedelic, but not clear on content
19	Diane Gromala	Singular	Indexical	1st and 3rd person for different segments	SIGGRAPH 2001	Biofeedback-driven virtual environment for visual, auditory, and tactile meditation
20	Diane Gromala, YacovSharir	Singular	Symbolic	N/A	Banff	Based on her chronic pain; large body coupled with the transcendence of a dervish dancer (video insert)
21	Diane Gromala, Lily Shirvanee	Singular	Symbolic	Full body (but not described)	Banff New Media Institute	"a provocative new sensory experience, participants' bodily states transform relationships among physical book, symbolic representation & sensory experience"

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	A	B	C	D	E	F	G	H	I	J	K
1	**Artist**	***Project***	**Year**	**Display type**	**Sound type**	**Interaction**	**Smell**	**Haptics**	**Other senses**	**Indiv/Collab**	**Laboratory or company**
41	John Waterworth	*The Interactive Tent with the Illusion of Being*	2001	Tent	Spatialised	Head sensors detect head movement while lying down	inlet put in but smell not implemented	No	No	Collaborative	Interactive Institute UMEÅ
42	Josephine Anstey	*PAAPAB*	2001-2004	6 networked CAVEs	Spatialised?	Wands)	No	No	No	Collaborative	EVL
43	Josephine Anstey and Dave Pape	*The Trial The Trail*	2005	CAVE	Spatialised?	Wand	No	No	No	Collaborative	Buffalo
44	Josephine Anstey and Dave Pape	*Human Trials*	2006	CAVE	Spatialised?	Wand(s)	No	No	No	Collaborative	Buffalo
45	Josephine Anstey and Dave Pape	*The Thing Growing*	1997	CAVE	Spatialised?	Wand and gesture	No	No	No	Collaborative	EVL and Buffalo
46	Kathleen Rogers	*Sleepless Dreaming*	1993	HMD	Stereo	Data Glove	No	No	No	N/A	N/A
47	Kazuhiko Hachiya	*Interdiscommunication Machine*	1993	Two HMDs; 2 participants; images switched	Sound switched with partners	Wireless mikes and trackers	No	No	No	N/A	NTT Japan and Eyebeam
48	Knowbotic Research	*SMDK: Simulation-Space Mosaic of Mobile Data Sounds*	1994	Large room with text-based HMD	Sounds contributed to a data base;	Tracker on hand	No	No	Kinaesthetic	Collaborative	Academy for Media Art Cologne
49	Lawrence Paul Yuxweluptin	*Inherent Rights, Vision Rights*	1992	Stereo Viewer	Stereo?	Buttons	No	No	No	Collaborative	Banff
50	Lucy Petrovich, Johnie Hugh Horn	*Under Control/In Control*	2005	CAVE	Stereo?	Mouse/joystick	No	No	No	Collaborative	University of Arizona

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	A	L	M	N	O	P
1	**Artist**	**Singular/Shared**	**Semiotic category** (per Qvorstrup)	**Body representation**	**Exhibited or main reference**	**Short description or quote**
41	John Waterworth	Singular	Symbolic (Narrative)	None	Luleå Science and Cyberconference	Filmed events, text & sketches, spoken words, 3D stories run in parallel. Guest turns head to go between versions.
42	Josephine Anstey	Shared	N/A	None	Ars Electronica	Several EVL art pieces connected via a virtual atrium called Confluxus
43	Josephine Anstey and Dave Pape	Singual	Symbolic (Narrative)	None	http://www.ccr.buffalo.edu/anstey/VDRAMA/TRAIL/index.html	Guests sent on an absurd quest with intelligent agents; virtual drama
44	Josephine Anstey and Dave Pape	Networked	Symbolic (Narrative)	None	Resolutions 2006 festival, Buffalo Fringe Festival	Participants play Patofil and Filopat in a weird psychological virtual drama
45	Josephine Anstey and Dave Pape	Singular	Symbolic (Narrative)	None	Shown widely, http://www.ccr.buffalo.edu/anstey/VDRAMA/THING/	encounter with a fickle 'thing' character, 3 act drama
46	Kathleen Rogers	Singular	Symbolic	3D cursor	The State of the Image Festival Antwerp	Visitor travels corridors of strange objects and experiences; parapsychological
47	Kazuhiko Hachiya	Two people	Symbolic?	None	Christine Paul Digital Art and http://eyebeam.org/engage/exhibitions.php?subid=24&id=10	allows for the exchange of one's view and the soundscape for that of another person
48	Knowbotic Research	Singular	Symbolic	None	SIGGRAPH 1994	Guest play the sampled sounds by interacting with them
49	Lawrence Paul Yuxweluptin	Singular	Iconic	None	Banff	Guests visit the ceremonies in an aboriginal longhouse
50	Lucy Petrovich, Johnie Hugh Horn	Singular	Symbolic	None	Scottsdale Museum of Art www.arts.arizona.edu/lucy/work.html	deals with issues of control

	A	B	C	D	E	F	G	H	I	J	K
1	**Artist**	***Project***	**Year**	**Display type**	**Sound type**	**Interaction**	**Smell**	**Haptics**	**Other senses**	**Indiv/Collab**	**Laboratory or company**
51	Lucy Petrovich, Johnie Hugh Horn	*DesertViews, Desert Deaths*	2004-2007	CAVE	Stereo?	Mouse/joystick	No	No	No	Collaborative	University of Arizona
52	Maggie Parker	*StarWorld*	2007	Screen	Stereo	Mouse/joystick	No	No	No	N/A	N/A
53	Marcos Novak	*Dancing with the Virtual Dervish: Worlds in Progress*	1994	HMD	Spatialised	Joystick?	No	No	No	Collaborative	Banff
54	Margaret Dolinsky	*Straight Dope*	1997	CAVE	Spatialised?	Wand	No	No	No	Collaborative	EVL
55	Margaret Dolinsky	*Interiors*	1998	CAVE	Spatialised?	Wand	No	No	No	Collaborative	EVL
56	Margaret Dolinsky	*Blue Window Pane I*	1999	Tracking panorama screen	Spatialised?	Wand	No	No	No	Collaborative	Indiana
57	Margaret Dolinsky	*Blue Window Pane II*	2001	CAVE	Spatialised?	Wand	No	No	No	Collaborative	
58	Margaret Dolinsky	*Beat Box*	2001	6 networked CAVEs	Spatialised	Wand	No	No	No	Collaborative	EVL
59	Margaret Dolinsky and Grit Sehmisch	*Dream Grrrls*	1996	CAVE	Spatialised?	Wand	No	No	No	Collaborative	EVL
60	Margaret H. Watson, Eric Butkus	*Liquid Meditation*	1999	CAVE	Stereo?	Wand	No	No	No	Collaborative	EVL/Ars Electronica
61	Marianne Selsjord, Natashe Barrett, Thomas Oppl	*The Gardens of Earthly Desire and Beyond*	2006-in progres s	Large curved screen	Stereo?	N/A	No	No	No	Collaborative	Individual
62	Mark Bolas	*Interpretation of Piet Mondrian's 1917 Composition with Lines*	early 1990s	BOOM	N/A	BOOM	No	No	No	Individual	FakeSpace

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	A	L	M	N	O	P
1	Artist	Singular/Shared	Semiotic category (per Qvorstrup)	Body representation	Exhibited or main reference	Short description or quote
51	Lucy Petrovich, Johnie Hugh Horn	Singular	Iconic	None	ISEA 2004, SIGGRAPH 2007, Arizona Biennial 2005	Comments of the needless deaths of Mexican illegal immigrants
52	Maggie Parker	Singular?	Symbolic	2006?	handout from Maggie at Women in Games 2007	a 'game' that shares many features with virtual environments
53	Marcos Novak	Singular	Symbolic	Banff	Mosher and McLeod Book	Worlds within worlds: stageworld, bodyworld, virtual world, and within these 3 many others.
54	Margaret Dolinsky	Singular	Symbolic	None	N/A	Strange psychaedelic objects, colourful, dreamlike
55	Margaret Dolinsky	Singular	Symbolic	None	http://dolinsky.fa.indiana.edu/CAVE/	Rich interiors , travels through the interior psyche, real tv feed into graphic world
56	Margaret Dolinsky	Singular	Symbolic	None	SIGGRAPH 1999	Mosque-like setting with angels, faces and other psychic imagery
57	Margaret Dolinsky	Singular		None	Walker Art Centre ,Ars Electronica	,further development
58	Margaret Dolinsky	6 people networked	Iconic	None	Ars Electronica	People in many locations can play virtual instruments together
59	Margaret Dolinsky and Grit Sehmisch	Singular	Symbolic	None	Ars Electronica Showing	3D objects act as doorways to other worlds, heads as doors, metaphorical objects
60	Margaret H.Watson, Eric Butkus	Singular	Symbolic	None	Ars Electronica Museum of the Future	Abstract liquid shapes
61	Marianne Selsjord, Natashe Barrett, Thomas Oppl	Singular	Symbolic	in progress	http://home.no.net/mselsjor/index.html	Based on Hieronymus Bosch
62	Mark Bolas	Singular	Indexical	None	SIGGRAPH date?	Guest can walk around a 3D construction of Mondrian's painting.

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	A	B	C	D	E	F	G	H	I	J	K
1	**Artist**	***Project***	**Year**	**Display type**	**Sound type**	**Interaction**	**Smell**	**Haptics**	**Other senses**	**Indiv/Collab**	**Laboratory or company**
63	Maureen Thomas	*RuneCast*	2006?	Large Screen?	Stereo?	Joystick?	No	No	No	Collaborative	Cambridge University
64	Maurice Benayoun	*Is God Flat?/Is the Devil Curved?*	1994	N/A	N/A	N/A	No	No	No	Collaborative	Z.A. productions
65	Maurice Benayoun	*Art Impact/Collective Retinal Memory*	2000	CAVE	Stereo?	Wand?	No	No	No	Collaboration	Z.A. productions
66	Maurice Benayoun, Jean-Baptiste Barriére	*World Skin*	1997	CAVE	Stereo	Camera or joystick (for driver)	No	No	No	Collaboration	Z.A. productions
67	Michael Scroggins, Stewart Dickson	*Topological Slide*	1994	HMD	Spatialised?	Tilting platform	No	No	No	Collaborative	Banff
68	Monika Fleischman, Wolfgang Strauss	*Home of the Brain*	1992	HMD	HMD Headphones	Data Glove	No	No	No	Collaborative	Art+Com
69	Myron Krueger	*Video Place*	1975	8'x10' rear projection screen	Stereo?	Full body	No	No	Kinaesthetic	Collaborative	Independent
70	Nicole Stenger and Diane Thome	*Angels*	1992	HMD	Stereo?	Data Glove	No	No	No	Collaborative	Commissioned by the Paris Museum of Science for the show Machines a Communiqué
71	Patrice Clair	*C.L.A.I.R.*	1994	BOOM	Spatialised (Beachtron)	BOOM	No	No	No	Collaborative	SRI and Stanford
72	Peter Kogler, Franz Pomassl, Dietmar Offenhuber	*CAVE*	1999	CAVE	Sensoround Sub Sound System	Wand	No	No	No	Collaborative	Ars Electronica Future Lab
73	Petra Gemeinboeck & Roland Blach	*Uzume*	2002	CAVE	Stereo?	Wand	No	No	No	Collaborative	EVL and Fraunhofer

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	A	L	M	N	O	P
1	**Artist**	**Singular/Shared**	**Semiotic category** (per Qvorstrup)	**Body representation**	**Exhibited or main reference**	**Short description or quote**
63	Maureen Thomas	Singular?	Symbolic	None?	N/A	Based on Norse mythology
64	Maurice Benayoun	N/A	Symbolic	None	Made for Imagina; www.benayoun.com	"digging" through bricks and blue sky to reveal god/devil images.
65	Maurice Benayoun	N/A	Symbolic	None	Pompidou Centre	N/A
66	Maurice Benayoun, Jean-Baptiste Barriére	Singular	Iconic	None	Ars Electronica documentation and www.benayoun.com	Commissioned by Ars Electronica
67	Michael Scroggins, Stewart Dickson	Singular	Symbolic	None	Banff	Participant rides on mathematical surfaces
68	Monika Fleischman, Wolfgang Strauss	Singular	Symbolic	Articulated figure?	Ars Electronic Golden Nica award 1992	Four houses are placed around a central labyrinth. Trees of knowledge are invested with ancient characters. It is an archaic world of symbols.
69	Myron Krueger	Shared	Symbolic	Mirror	Krueger's books	Many different types of playful interactions
70	Nicole Stenger and Diane Thome	Singular	Symbolic	None?	In VR Through the New Looking Glass by Pimentel and Tex. Pp238-39	Angels woven together to finally become one.
71	Patrice Clair	Singular	Iconic	None	several showings in 1994 in San Francisco http://ai.sri.com/~cire/cyberhead.html	Flythrough of her head via MRI and photographic imagery
72	Peter Kogler, Franz Pomassl, Dietmar Offenhuber	Singular	Symbolic	None	Ars Electronica web site	Labyrinthine paths with unusual configurations of virtual space; can navigate or be carried along a path
73	Petra Gemeinboeck & Roland Blach	Singular	Symbolic	None	SIGGRAPH 2002, Ars Electronica	Swirling strange attractors

Page 5B

	A	B	C	D	E	F	G	H	I	J	K
1	**Artist**	***Project***	**Year**	**Display type**	**Sound type**	**Interaction**	**Smell**	**Haptics**	**Other senses**	**Indiv/Collab**	**Laboratory or company**
74	Petra Gemeinboeck & Roland Blach	*Maya-Veil of Illusion:*	2004	CAVE	Stereo?	Wand	No	No	No	Collaborative	EVL and Fraunhofer
75	Rebecca Allen and Emergence Team	*The Bush Soul 1*	1997	3 Large Screens	Spatialised	Haptic Force Feedback joystick	No	No	No	Collaborative	UCLA
76	Rebecca Allen and Emergence Team	*The Bush Soul 2*	1998	3 Large Screens	Spatialised	Haptic Force Feedback joystick	No	No	No	Collaborative	UCLA
77	Rebecca Allen and Emergence Team	*The Bush Soul 3*	1999	3 Large Screens	Spatialised	Haptic Force Feedback joystick	No	No	No	Collaborative	UCLA
78	Rita Addison	*Detour: Brain Deconstruction Ahead*	1994	CAVE	N/A	Wand	No	No	No	Collaborative	Several
79	Ron Kuivila	*VR on $5 a Day*	1994	HMD for one; projection for others	Spatialised	Joystick?	No	No	No	Collaborative	Banff
80	Scott Fisher, Susan Amkraut, Michael Girard, Mark Trayle	*Menagerie*	1993	BOOM & Projection	Spatialised (Beachtron)	BOOM	No	No	No	Collaborative	Telepresence Research
81	Sheldon Brown	*Apparitions*	1994	Large Screen	N/A	Recliner chair with large wheels, gun, joystick	No	No	No	Collaborative	UCSD/Vital Signs
82	Sheldon Brown	*Smoke and Mirrors*	2003	Large Screen 7' x 5' (portrait)	Stereo?	Joystick	No	No	No	Collaborative	UCSD

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	A	L	M	N	O	P
I	**Artist**	**Singular/Shared**	**Semiotic category** (per Qvorstrup)	**Body representation**	**Exhibited or main reference**	**Short description or quote**
74	Petra Gemeinboeck & Roland Blach	Two-networked	Symbolic	None	http://www.psychnology.org/File/PSYCHNOLOGY_JOURNAL_3_1_GEMEINBOECK.pdf	Shared veil moves via the mould of two separated participants interpreted as three-dimensional interference patterns.
75	Rebecca Allen and Emergence Team	Singular	Symbolic	3rd person avatar	Christine Paul Digital Art	Travels in the country of the "bush soul"; looks at the roles of avatars and human presence in a world of artificial life
76	Rebecca Allen and Emergence Team	Singular	Symbolic	3rd person avatar	SIGGRAPH 1998 "Touchware"	See above
77	Rebecca Allen and Emergence Team	Singular	Symbolic	3rd person avatar	SIGGRAPH 1999, Ars Electronica	See above
78	Rita Addison	Singular	Symbolic	N/A	SIGGRAPH 1994	based on sensations from her brain injury
79	Ron Kuivila	Shared	Iconic	None	Banff	One person in the HMD see data generated by others in the room; they see what he sees plus a bird's eye view of the simulation.
80	Scott Fisher, Susan Amkraut, Michael Girard, Mark Trayle	Singular	Iconic	None	SIGGRAPH 1993 Machine Culture Show	Immersed in a world of very active animals
81	Sheldon Brown	Three	Iconic	None	Shown at UCSD http://www-apparitions.ucsd.edu/	A clinic setting serves as entry into a world of commentary on questions such as how we see ourselves.
82	Sheldon Brown	2 to 6 visitors	Iconic	Visitor faces are scanned when t hey arrive and these are affixed to a 3D avatar	commissioned by the Reuben H. Fleet Science Center in San Diego	Mazes where visitors explore cultural images of tobacco usage, many eras, many cultural views

	A	B	C	D	E	F	G	H	I	J	K
1	**Artist**	***Project***	**Year**	**Display type**	**Sound type**	**Interaction**	**Smell**	**Haptics**	**Other senses**	**Indiv/Collab**	**Laboratory or company**
83	Simon Penny	*Traces*	1999	CAVE		Full Body	No	No	No	Collaborative	CMU and others
84	Softworlds (Janine Cirincione, Brian D'Amato and Michael Ferraro)	*The Imperial Message*	1994	HMD (Virtual Research)	Spatialized (Beachtron)	N/A	No	No	No	Collaborative	Independent
85	Stahl Stenslie	*The First Generation Inter_Skin*	1994	Body suit	N/A	I/O haptics	No	Yes	N/A	N/A	N/A
86	Tamiko Thiel	*The Travels of Mariko Horo*	2006	Large screen	Stereo	Joystick	No	No	No	Collaborative	Independent
87	Tamiko Thiel and Teresa Reuter	*Virtuelle Mauer / ReConstructing the Wall*	in progres s	N/A	N/A	Joystick	No	No	No	Collaborative	Independent
88	Tamiko Thiel and Zara Houshmand	*Beyond Manzanar*	2000	Large screen	Stereo	Joystick	No	No	No	Collaborative	Independent
89	Teresa Wennberg	*Parallel Dimensions, Digital*	c 1994?	CAVE	Spatialised?	Wand	No	No	No	N/A	N/A
90	Toni Dove, Michael McKenzie	*Architecture of A Mother Tongue*	1993	"Camera"	Interactive	Data Glove	No	No, but can pick up objects	No	Collaborative	Banff
91	Ulrike Gabriel	*Perceptual Arena (Arena Life?)*	1993	HMD	HMD HeadPhones	Data Glove	No	No	No	N/A	Canon ARTLAB, Tokyo

	A	L	M	N	O	P
1	**Artist**	**Singular/Shared**	**Semiotic category** (per Qvorstrup)	**Body representation**	**Exhibited or main reference**	**Short description or quote**
83	Simon Penny	Singular (though a networked version was planned & not realised)	Iconic	Image-processed Mirror with growing semi-autonomy	Showed at Ars Electronica Festival Traces doc by Penny	User's body image processed by camera and code to and interactive 3D semi-persistent representation
84	Softworlds (Janine Cirincione, Brian D'Amato and Michael Ferraro)	Singular	Iconic	No	Softworlds 2.1 catalog, personal correspondence	
85	Stahl Stenslie	Singular	N/A	N/A	Christine Paul Digital Art	N/A
86	Tamiko Thiel	Singular	Symbolic	No	http://www.klara.be/ramblasblog/video/tgis_horo.mov Shown at ISEA at San Jose Art Museum 2006 and SIGGRAPH 2007	You (Mariko) travel to four 'churches' and finds heavens and hells
87	Tamiko Thiel and Teresa Reuter	Singular		N/A	http://www.virtuelle-mauer-berlin.de/english/index.htm	Berlin Wall theme
88	Tamiko Thiel and Zara Houshmand	Singular	Several	No	Christine Paul Digital Art	internment camps for Japanese-Americans/Iranians
89	Teresa Wennberg	Singular	Symbolic	N/A	Unesco Digital Arts Portal	Space is used as a metaphor for the body; Brain Chamber, Breathing Cathedral, Thought Cabinet, Dream Chamber, Flesh Labyrinth, etc.
90	Toni Dove, Michael McKenzie	Singular?	Symbolic	Hand	Mosher and McLeod book	40 minutes, part movie and part performance
91	Ulrike Gabriel	N/A	N/A	N/A	Canon Art Lab Tokyo, 1993 and V2 Exhibition http://www.t0.orat/video/ug.htm	Creates an audio visual space texture as a coding of the user interaction data

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	A	B	C	D	E	F	G	H	I	J	K
1	Artist	Project	Year	Display type	Sound type	Interaction	Smell	Haptics	Other senses	Indiv/Collab	Laboratory or company
92	Ulrike Gabriel	*Breath*	1992	1-4 Surfaces Projection HMD	Stereo?	Breath via belt sensors biofeedback)	No	No	No	Individual	N/A
93	Will Bauer, Steve Gibson	*Objects of Ritual Desire*	1994	4 large screens	N/A	N/A	No	No	No	Collaborative	Banff
94											
95											
96											
97											
98											
99											
100											

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	A	L	M	N	O	P
1	**Artist**	**Singular/Shared**	**Semiotic category** (per Qvorstrup)	**Body representation**	**Exhibited or main reference**	**Short description or quote**
92	Ulrike Gabriel	Singular	Symbolic	N/A	http://www.medienkunstnetz.de/works/breath/	participant's breath was projected onto four surrounding screens in the form of changing polygons by means of abstract computer graphics.
93	Will Bauer, Steve Gibson	Shared four people	Iconic?	None	Mosher and McLeod book	participants watch the screens, then build in 3D, then leave and their world collapses
94						
95						
96						
97						
98						
99						
100						

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Notes

[1] From the neuroscience realm Antonio Damasio (1994, 1999) has been especially influential in showing the importance of the body to our mental processing, and from philosophical approaches embodiment writers such as George Lakoff and Mark Johnson (1999) have reached similar conclusions.

[2] Games are still, in 2007, gendered preponderously for male players. (See, for example, Bryce and Rutter 2005: 301-302). Unlike gendered game cybermedia, gender discrepancies are not as endemic to the virtual environment domain. This is perhaps due to those who work in the different media: the games industry is dominated by male creators, and VEs, as I will show in this thesis, have a percentage of higher female artists.

[3] Many artists I have talked to say they would use full VR equipment if it was: 1) more affordable, 2) less cumbersome, and 3) easier to install in the museum settings where their work is shown. Because of these issues, many 3D immersive environments are only experienced on a large flat screen, even if the artist has created a fully inhabitable creation.

[4] Better training was the driving goal for this work from the United States Army's perspective, and not, as some (who lacked direct experience of making VEs) have argued, the military's need for control. See for example Hillis (1999: xxv), and Manovich (1995), both of whom attributed 'control' as more influential than it truly was, in my experience in those early phases of research with these emerging tools.

[5] Being involved in the VR community in the early 1990s, I was able to try most of these applications. Matsushita created a virtual kitchen to aid Japanese customers in the designing the layout of their kitchens; W Industries/Virtuality's *Dactyl Nightmare* was a 4-player networked game; the Hero perfume environment was an early VR branding application that utilised a puzzle-based VR. The creator of the Hero experience, Dave Polinchok, went on to set up an experiential branding company, The Brand Experience Lab, in 2000.

[6] Some of this is due, no doubt, to the constituency of the scientific profession at the time of VR's debut, which was predominately male, and–in general–somewhat suspicious of disciplines that were not testable in the terms of 'hard science.' In the succeeding decades, much research has been conducted, and the impact has been a certain level of 're-fusing' of the old divide between science and art. Notably, for instance, recent neurological research indicating that the brain is a more holistic organ than was previously thought, and that it is indeed capable of integrating the divisions of logical and emotional thinking. (Damasio 1994)

[7] The Institute for Simulation and Training (IST) was associated with the University of Central Florida, located in Orlando, Florida, a city that was a hub for simulation companies and government support

agencies. IST had several laboratories working on simulation technology for various American defence divisions. I was part of the Visual Systems Laboratory, which looked at perceptual and collaborative concerns with emerging virtual reality technology.

[8] See, for example Simon Penny's section on Direct Neural Jacks (Penny 1994: 202-203), or Lusted and Knapp's article in the October edition of Scientific American (Lusted and Knapp 1996: 58-63). Since 2003 the US DARPA agency has sponsored a new research program called AUGCOG, which stands for Augment Cognition, where brain signals can be used not only to control but also for computers to monitor humans for cognitive overload. See (Schmorrow 2005) for the full report on the first phase of this research work.

[9] Scott Fisher at NASA saw the potential in a glove invented by Thomas Zimmerman to play air guitar and connected him with Jaron Lanier. Under Lanier's fledgling company, VPL, the glove became somewhat of a limited commercial success for the VR community. (Pimentel 1993) Between VPL and a later version by Abrams Gentile Entertainment who licensed the technology from VPL, thousands of these gloves were sold, and the method of navigation for virtual worlds they promulgated, a "finger gun" (my term) became a gesture that anyone involved in VR would recognise as a symbol for navigation. (Pausch 1991:266)

[10] Timothy Leary, the Harvard Professor of psychedelic persuasion became involved with VR by way of its perceived correlation to his famous hallucinatory consciousness experiments of the 1960s. (Wooley 1992:24) Jaron Lanier was, in fact, a good friend of Dr. Leary's.

[11] All the works at Banff were actually collaborations as Banff engaged technical experts to enable the virtual reality equipment to realise the visions of the artists.

[12] Recall that early VR training systems were mainly flight simulators, which only needed a distant view of the landscape. Using it for close up ground work, such as would be needed by an infantry, required an entirely new set of capabilities, including stereo, and more detail at the ground level, including representations of other humans.

[13] Some of the conversational fragments overheard included: "But they are your children. You want them to grow up." and "It's a feeling like you were standing on a cliff and someone pulled the cliff out from under you." The photographs had attached phrases like: "It was the holiest of times. We did not know it then, but it was." (This for a snapshot of two children at their First Holy Communion.)

[14] While I do not believe a story or narrative is necessary for an immersive experience, I also do not discount the possibility of its use in the content of a virtual environment. *DarkCon* does have a story as a wrapper for the possible actions, however, the experient's journey through that story space becomes their own experience.

[15] The scent collar was patented in 2004.

[16] It should be noted that while *DarkCon* encouraged the experient to role play and to achieve a goal of finding information, there was almost no narrative structure within the experience. Rather, a situation was set up for the participant to interact with; they could choose to look for the requested information or not.

[17] Marcel Proust, in his magnum opus *À la recherche du temps perdu* (*Remembrance of Things Past)*, dips his 'petite madeleine,' not only into the tea, but into a river of the past, and drowns in its swirls and eddies.

[18] Alessandra Piontelli, Visiting Professor of Child Neuropsychiatry at the University of Milan, summarizes the key questions of this debate. (1992: 18-19)

[19] The pioneering study that determined this preference this was done by Dr. Robert Franz in 1961. (See References) It has been corroborated many times in the ensuing decades.

[20] Previc (2006: 512-513) discusses this "higher plane of existence" thought to be inhabited by gods in most cultures, and our equating of the holy with the highest. He mentions also monasteries being built atop mountains to be closer to the heavens, and that the spires of churches carry out the same function.

[21] There exist several types of tracking systems, the primary ones being based on either video, magnetic sensors, or acoustic and gyroscopic techniques. All serve to provide six (or more) degrees of freedom (positional and rotational data). For a more thorough description of these see (Rolland et al. 2001).

[22] Only recently have tracking systems progressed to wireless. HMDs are, unfortunately, still tethered, as of this date of this writing.

[23] Natural navigation is an ongoing issue in VEs. Many attempts to deal with it, including single-use methods: seated in chairs, tracker placed under a trampoline for surfing, etc. the omnidirectional treadmill, sensored floors, and even a human hamster ball, have been developed in recent years. (VWN 2006) Still, in 2007, the most common navigational device is the joystick, which, while demanding a transposition of normal experiential movement to a thought/motion sequence of pushing to go forward, pulling to go back, and side-to-side for left and right movements, is simple enough for most people (perhaps because of game use, or because of the directional correspondence) to comprehend and use with minimal cognitive effort.

[24] These tracking systems were initially used for VR systems but the technology was quickly adapted to motion tracking, where key body parts were outfitted with sensors while a person was performing some action, with the goals of capturing that movement to be able to later apply it to a digital character. The initial cost of these motion tracking systems was very high, due to the number of tracking units employed.

[25] Of course, there are sometimes obvious mismatches. When the brain cannot correlate the sensory data, especially for movements

where the vestibular systems are not entirely fooled, a form of motion sickness results, most often experienced as a slight to severe nausea.

[26] The term cyberspace is used in this quote as a synonym for virtual environments.

[27] The Autodesk company was started as a maker of Computer Aided Design software (AutoCAD) and later used their expertise to create virtual environments with a research project they named as *Cyberia*. Meredith Bricken was a part of the research team on *Cyberia*. (Rheingold 1991: 180 and 185-6).

[28] "To design a virtual cockpit, we created a very wide field of vision," said Furness, who now directs the University of Washington's Human Interface Technology (HIT) Lab. "About 120 degrees of view on the horizontal as opposed to 60 degrees." In September of 1981, Furness and his team turned on the virtual-cockpit projector for the first time. "I felt like Alexander Graham Bell, demonstrating the telephone," recalled Furness. "We had no idea of the full effect of a wide-angle view display. Until then, we had been on the outside, looking at a picture. Suddenly, it was as if someone reached out and pulled us inside." (As quoted in Cipalla 2000)

[29] For the areas of the out the window scene that required a higher resolution, such as the landing strip, extra computing resources were devoted to making that area as accurate as possible. At first, a special vector processing unit was used to render lights, such as approach or landing strip lights. Because these elements were based on a vector, and not a grid of pixels, the final appearance seemed sharper. Later this was accomplished with a central section that had additional pixels and was overlaid on the top of the wider (lower resolution) view. (IST 1990: 15)

[30] In a study by Randy Pausch, M. A. Shackelford and Dennis Proffitt (1993), head mounted displays were shown to reduce completion time in a generic search task 23% over the same task performed via a standard computer screen. The authors hypothesized that the immersive properties of the display allowed users to build up a better mental map of the environment, facilitating the search task.

[31] These movements are called saccades and microsaccades. Saccades are triggered by the frontal lobe of the brain, and last for durations of milliseconds. Microsaccades are constant vibrations of the eye. Both serve to keep the photons from the scene in front of the eyes moving across the variability of the photoreceptors locations and sensitivity, so that a composite “mental map” can be accumulated. This gives the illusions we are looking at a stable scene. (Palmer 2000: 520-526)

[32] Added to this diminution of the visual field is the current tendency for people to look only straight ahead, a situation that might be encouraged by our constant connection to a 2D computer or film screen. David Michael Levin describes this as “frontal ontology.” (Levin 1993) It became very apparent to my VR team, and me as we put subjects through our VR experiments, that they never looked up,

down, side to side, or behind them. We ultimately had to create a "tutorial room" that forced them to go through a full range of motion with the head mounted display on. This may have been due to the low field of view of the display unit (approximately 50 degrees) but the frontal fixation may be exacerbated by Levin's "frontal ontology."

[33] The exact reasons for the postural instability in these experiments were not isolated. The most common reasons for this, and "Sim sickness" in general seem to be the mismatch between the inner ear motion and perceived motions, or a lag in updating the visuals, which even on the order of microseconds can cause some people motion distress. See Kolasinski (1995) for an in depth coverage of the simulator sickness phenomenon.

[34] The quality of the wider field of view display cannot be overemphasised. In 1994 I was fortunate to use what was, for the time and even today, a fairly wide FOV head mounted display for the showing of my work *Virtopia*. This was the N-Vision 90 degree device, which effectively doubled the view angle of the original display we had in the laboratory. This HMD seemed to elicit from participants much more engagement with the scene than we had noted with the standard HMD, though we were not able to do any formal comparison studies.

[35] For an excellent detailed technical explanation of spatialised sound for virtual environments see Chapter 5 in (Blauert 1999).

[36] The primary computer in use for VR work in the 1990s was a Silicon Graphics Reality series, which had the requisite power to run the graphics in real time. The Crystal River solution used a Digital Signal Processing unit that worked only in a PC. The order of the internal data storage was different for the two types of computers, which complicated the real time two-way communication. The solution implemented for my *Virtopia* project that used this system required writing low level assembler code to connect the data streams of the two computers.

[37] There were very few places one could go to get a personalised HRTF, and thus the Convolvotron shipped with a general purpose one based on an "average" ear. I was fortunate in 1992 to be able to visit Fred Wrightman's audio research laboratory at the University of Wisconsin in Madison, where he was gracious enough to create a personal HRTF for me. In their anechoic chamber where the recording took place, I was literally suspended in mid-air in a chair, with all walls covered by deep sound dampening material. The array of speakers was attached to a half circular arm that moved around me at some speed, sending out sounds to the two microphones in my ears. Unfortunately we were never able to implement my personal HRTF in *Virtopia* due to time constraints.

[38] Entrainment has been used for millennia in ritual ceremonies, or at the start of a meditation session, where it serves to align people in a common experience. Used in VEs this process can help align the experient with the creator's intent.

[39] More details about the scent collar include the configuration of each cartridge. At the bottom is the scent reservoir that holds the oil/scent. The reservoir space fills with molecules from the evaporating oils. The covering of the reservoir has a hole that allows the scent molecules to escape, and a computer-controlled servo arm can open or close (or partially close) this hole, controlling the amount of molecules that enter the chamber in the middle of the cartridge. A small fan is situated at the top of the cartridge, and is also under computer control. The fan serves to deliver the scent molecules directly to the vicinity of the experient's nose.

[40] Scent suppliers predominately serve the flavor and fragrance markets. Most commercially successful scents or scent components are ones considered fragrant, not odorous, so the selection of scents available is somewhat limited. There are devices that can collect a sampling of odorant molecules in a particular place (such as a dank forest), which can then be analyzed and reproduced synthetically in a laboratory, but these are not available for general use. (Dr. Clint Brooks, personal conversation, 2002)

[41] Touch is our first sense to develop, happening while still in the womb, before any other senses develop. (Maurer and Maurer1988: 8-9) There is much evidence to support the role of touch in keeping us alive: not only is our skin our most direct interface to the external world, babies who are not touched develop the "failure to thrive" syndrome and often die as a result. (ibid.: 169-170)

[42] The "data suit" created by Jaron Lanier's company, VPL, is the most well known full suit used for VR. It was not a tactile suit, however. It used the fiber optic sensors and the amount of bending, as measured by light attenuation, to send information to the systems about the movement of the full body parts. Some of these were sold commercially, mostly to Japanese customers. (personal conversation, early 1990s)

[43] While an in-depth discussion of these experiments is outside the scope of this thesis, the reader is directed to an excellent review recent overview of these and other related neuroscience experiments by Larry Cahill (2006) in *Nature Reviews Neuroscience*, available online at http://www.nature.com/nrn/journal/v7/n6/full/nrn1909.html

[44] The effects of the female oxytocin, according to Taylor's studies, actually seems to mitigate the effects of vasopressin, which is the male hormone released during the flight-or-flight response.

[45] Leon Battista Alberti was a Renaissance painter deeply involved in promulgating the new technique of one-point perspective. He wrote a treatise (*Della Pittura* -1435-1436) describing this method, which is still in use by artists today.

[46] In many early virtual reality environments there was no collision detection to let the participant to know when he is hitting a solid object. It was easy to pass through virtual walls and objects. This was done precisely because it was the easiest and least computationally

expensive solution. As a result, many contemporary writers commenting on VR noted this unreal nature of virtual environments. Today's computers can handle collision computation and much more, rendering this problem obsolete (unless deliberately done for some aesthetic effect).

[47] It can be argued that this functionality is indeed now available in digital social worlds like Second Life and There.com. Indeed, residents of these metaverses have become adroit at building amazing creations that both they and others can explore and use. Still, these worlds are limited by the barrier of the screen; they are experienced by looking through Alberti's window.

[48] This is not to demean the second-order experience, which is the experience one has watching the movie—it is the movie-watching experience, combined with the taking in of the film's content.

[49] A large number of factors influence the quality of presence. A good overview can be found in Sadowski and Stanney (2002).

[50] An excellent summary of current theories about presence can be found in Schuemie et al. (2001).

[51] In depth coverage of simulator sickness causes and effects can be found in Kolasinski (1995).

[52] One need only compare the difference in body form between athletes and dancers with those who get much less physical exercise. Cultural and gendered experiences, too, contribute variously to not only how the body develops, but also how we feel about it. (See for example, Susan Bordo's book, *Unbearable Weight*. (Bordo 2004)

[53] Krueger started working in unencumbered full body computer applications in the 1960s before virtual reality was named a concept. He coined his own term for his work–*artificial reality*–and later wrote a book by that name, espousing his ideas. His term never caught on, rather Jaron Lanier's term, *virtual reality*, became the accepted designation for immersive environments.

[54] Kreuger's work brings to mind Lacan's concept of the child's first experiences with mirror, and how these encounters help form the image of self. Krueger's work is extremely attractive to children and adults alike, not only for, I suspect, its playful qualities, but also due to the mirror image present during the interactions.

[55] This was a state I found myself in recently. In the Wide5 demo world, I had an avatar representation that was a graphical human figure. When I looked down at my virtual body, however, I found I was a male figure, and a naked one at that!

[56] In addition to the dolly move mentioned by Hillis, there are also movements along the up/down axis (typically the Z-axis, with the ground plane being the X/Y). Sometimes an alternate scheme is used, with the Y-axis indicating the up/down axis and the ground plane defined by X/Z.)

[57] I have expanded Gibson's concept of perceptual affordances to include emotional affordances. This is discussed in Chapter 5.

[58] Presence researchers term these breaks in the continuity of the virtual environment *bips*, standing for "breaks in presence." Bips can be mild, as when an external sound leaks into the VE and is heard, or they can be extreme; enough to fully remove one's consciousness from the virtual world altogether. (Slater and Steed 2000)

[59] In my work *Virtopia* (1994), I used the pools in the dessert oases as the portals to enter from one environment to the next. I was asked by someone who had experienced *Virtopia* if I had based the pools on the sixth book of the *Chronicles of Narnia* stories by C. S. Lewis. I had not, but upon re-reading them, I found that Chapter III "The Wood Between the Worlds" indeed used a similar concept for the children to travel between various worlds. (Lewis 1970: 28-40.)

[60] A virtual environment can, of course tell another's story; even let you play a starring role, such as in the previously discussed work, *The Thing Growing*.

[61] In computer games, such as *The Sims*™ by Maxis, we see the same sort of story emerge after the playing. In *The Sims*, you exert control over characters, helping them make decisions about how to live their lives. That is *your* first-order experience, not theirs. Stories about the characters and events (which may, in fact, include your actions as well as theirs, or only theirs alone) come after you've played the game for a time. Players become attached to characters and their unfolding lives, take snapshots of events as they occur and place them on websites in "albums" that tell stories about "family" groupings and occasions.

[62] This view is typically mathematically precise enough that one can recompute the exact position and often the lens information of the original "camera" that was the origin of that view.

[63] *Trompe L'oeil* paintings are perhaps the best example of this. They look correct from a particular angle, and less convincing if the angle of viewing the painting is off-axis from the original point of view of the artist's eye.

[64] While much has been written about the male gendered bias of most computer games (See for example, (Bryce and Rutter 2005) and (Kafai et al. 2008)) this thesis maintains that artist-made virtual environments do not suffer from this prejudice. Gender issues are therefore not covered in detail, as they would need to be for computer games.

[65] Such experiments include various forms of knowledge transfer, such as room geometry, landmark finding, general navigation, maze traversal, food finding, memory of a space, etc.

[66] A wonderful example of this is from my time the Institute for Simulation and Training's Visual Systems Lab at the University of Central Florida in the early 1990s. Researcher Dan Mapes had created a pair of gloves by which a person could actually manipulate the objects populating the virtual space. In one of the lab's test-bed

applications called *Polyshop*, a user sat at a physical architect's desk that could be felt with the forearms. On this desk, via the HMD, the user would see virtual objects sitting on the desktop–in fact, a scrollable menu on the left hand side that had miniature 3D graphic replicas of all stored virtual environments and objects. By using the two handed glove interface to pick up one of these miniature menu items, the entire contents of the file were retrieved and could be placed on the virtual/real desktop for use or modification. Objects could also be placed elsewhere in real space. Even more remarkably, with hands placed at each side of the iconic 3D image, one could stretch the contents out to a size large enough to walk around in comfortably. Of course, any size in between was also possible. (Mapes and Moshell 1995) One day, a researcher's young daughter, no more than six years old, was allowed to try the system. With no instruction, she intuitively selected objects from the side menu and placed them upon the floor, where she played with them as virtual building blocks! (Personal experience)

[67] Certainly the young girl mentioned above, with the range of her own experience she brought to the virtual environment learned that she could produce the space that supported the experience she wished to create.

[68] Image courtesy of the Virtual Reality Applications Centre, Iowa State University, used by permission, A. Berman

[69] Research into how humans experience art is a recent and rapidly growing field of both neuroscience and cognitive studies. See for example, Martindale et al. (2007) Aiken (1998) and Zeki (2003). Semir Zeki founded and runs the Institute for Neuroaesthetics at University College London. Zeki says "...the artist is in a sense, a neuroscientist, exploring the potentials and capacities of the brain, though with different tools. How such creations can arouse aesthetic experiences can only be fully understood in neural terms. Such an understanding is now well within our reach." More can be learned at http://www.neuroesthetics.org/index.html.

[70] Full details can be seen in Appendix B.

[71] Objects in virtual environments are made of polygonal shapes. Each discreet surface is called a facet. While 3D models made for film and television as constructed from curves that do not appear faceted, the need to render the objects in real time makes polygons, which are much faster to process than curves, the standard for real time environments, including VEs and games. However, increasing the number of polygons that make up an object, especially if it is an important one, can make it appear less faceted, and still achieve real time run rates.

[72] Many people have reported colours in virtual environments that are "exceedingly radiant;" that the "brightness is dazzling," (Hillis 1999) but this is mainly true in virtual worlds that use default colours supplied by the system, or those not designed with an aesthetic eye.

[73] See documentation of Gayil Nalls's work at http://www.worldsensorium.com/. The work of Christopher Brosius site is referenced on his site at: http://www.cbihateperfume.com.

[74] This idea is supported by a wealth of experimental evidence: see for instance the solid summary of such experiments in (Herz, Schankler and Beland 2004).

[75] In my experience, this aspect of virtual world design has often been neglected. In the majority of virtual reality works I experienced over twenty years, I was typically told little (beyond a cursory introduction to how the VR accoutrements work), and perhaps a sentence or two about what the world was supposed represent. A well-meaning person often stood by to coach me through the entire process, explaining what to do at every turn, often to the detriment of the experience.

[76] *Cave Painting* is not an artistic immersive environment, but rather a system for creating within a virtual space. The content is created by the artist using the system. It is used here as an example of how excitement might be elicited in a VE.

[77] Rudolf Arnheim, a perceptual psychologist, wrote several books on the topic of the visual perception of art and its psychological underpinnings. (See, for example, Arnheim 1954/1974) These concepts, many of which are touched on here, are part of design theory learned by artists in their formative years. Neuroscience, because of sophisticated new tools, is reinforcing much of Arnheim's conclusions.

[78] FakeSpace's new Wide 5 HMD, discussed in Chapter 2, may now permit designs that utilize this technique.

[79] Most experimental studies of priming suggest that priming works best when it is below the conscious threshold. This is detailed in Robert Zajonc's theory of *affective primacy* (1984; Monahan et al. 2000). It was informed by the foundational work of R. F. Bornstein in his studies that found people responded more positively to faces they had seen subliminally prior to the selection process. (Bornstein 1992)