

Female artists and the VR crucible: expanding the aesthetic vocabulary

Jacquelyn Ford Morie
University of Southern California, Institute for Creative Technologies
12015 Waterfront Drive, Playa Vista, CA, USA 90094

ABSTRACT

A survey done in 2007 of VR Artworks (Immersive Virtual Environments or VEs) showed that women have created the majority of these immersive works. While this may seem counter to popular ideas that the field has been dominated by men, it seems rather, that the truly unique works appear to emerge from a feminine approach. Such an 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, which 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.

Keywords: Virtual Reality, VR Art, Immersive Environments, feminism, experience

1. INTRODUCTION

Virtual Reality (VR) is defined by Webster's Online Dictionary as "an artificial environment which is experienced through sensory stimuli (as sights and sounds) provided by a computer and in which one's actions partially determine what happens in the environment."¹ VR as a technology had its beginnings in the 1960s, with military research that developed stereo head mounted displays and scientists like Ivan Sutherland envisioning these devices as a means to enter into a "wonderland constructed in computer memory."² By the mid-to-late 1980s, this concept began to find traction outside of military contexts, with a cottage industry emerging to serve automotive, architecture and aerospace users of Virtual Reality.³ During these early days of Virtual Reality it seemed anything was possible. As ideas flew around computer labs and throughout popular media. Jaron Lanier, an early figurehead for ultimate promise held by Virtual Reality said:

The thing that's remarkably beautiful to me about Virtual Reality is that you can make up reality in Virtual Reality and share it with other people. It's like having a collaborative lucid dream. It's like having shared hallucinations, except that you can compose them like works of art; you can compose the external world in any way at all as an act of communication.⁴

While this vision for Virtual Reality focused on the variety of unique experiences that could be imagined, even assigning their creation to the same realm as "works of art", most of the early instantiations of virtual reality experiences were often far from imaginative or aesthetic. This may have been due to the sheer challenge of making virtual environments that were convincing and believable – a goal that entailed many engineering and software challenges. These challenges included higher resolution head mounted displays, faster rendering to enable more realistic graphics to be shown in real time, and new forms of hardware to implement more senses with better fidelity (haptics, scent). The end game for many scientists during VRs first decade was the simulation of reality: the more realistic the better.⁵

Jaron Lanier was unique in his open-ended vision of VR. His worlds did not need to be realistic; he designed them to be incredible, offbeat and novel. The graphics were primitive, even by the standards of the 1990s, but the overall impression one experienced was that of being somewhere entirely new, a jolt to one's everyday sensibility – a new way of seeing, feeling, and being. One might argue, that these concepts are quite similar to the goals of good art.

1.1 Artists' early use of VR as a medium

Lanier's creativity notwithstanding, most people creating virtual environments in the late 1980s were not concerned with making art with this new medium.⁶ The agencies funding research in VR were focused on practical issues, such as developing systems for training applications, or performing basic research into how VR affected us both physiologically and psychologically. There were no funding opportunities or labs addressing the unique artistic potential of VR's fully immersive sensory experiences.

Even so, there were artists who looked to VR as a potential new artistic medium. These artists were determined to find a way to work with it. Their big problem was gaining access to the necessary equipment and software. Most such systems were the purview of scientists in well-funded (and often tightly regulated) laboratories. It was not an easy task for artists to convince the technocrats at the gates that there were valid reasons why they should be creating content for these systems.

Some artists were both determined and lucky, however, and before long artistic virtual environments began to appear. It is unfortunate that a full record of early artistic VR is not readily accessible. This is due partly to the fact that, though this medium is only some thirty years old, no history of the era has comprehensively included the work of artists. Lucky artists who worked in such government or academic labs just to have access to the technology did not often publish about their use of VR for creative endeavors. Also, 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 often unclear and sometimes considered orthogonal to scientific aspects of VR research. Artists seemed more concerned with qualitative rather than quantitative matters. Perhaps scientists found it difficult to incorporate such artistic insights into their more empirical vision of VR. Whatever the reasons, artists working in this realm often 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 were not exhibited, forgoing the wide audience they deserved. And yet the artists persevered, with notable successes, especially in retrospect.



Figures 1 & 2: *Blue Angel* (1992) and *Dynasty* (2009) Nicole Stenger's VR works Images courtesy of Ms. Stenger.

Nicole Stenger was a French artist who was able to work as an artist-in-residence at the University of Washington's Human Interface Technology Lab in 1989, when they were involved with many VR topics of research. This may make her the earliest formal artist to work in virtual reality. Her 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.⁷ Ms. Stenger has recently created a new virtual reality artwork called *Dynasty*, an image from which is shown in Figure 2.

1.2 The Banff Art and Virtual Environment Project

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 1991-1994.⁸ 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 during these early years. I will describe several of these pioneering works that were fully immersive VEs.

The first was created by a traditional artist from Canada's First Nations, Lawrence Paul Yuxweluptun, and was titled *Inherent Rights, Vision Rights* (1992). Yuxweluptun set out 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 participant, using a specially constructed stereo viewing device, first passed through a threshold retaining sounds of the external world (car doors slamming, a passing airplane), and then entered a space beyond everyday awareness that westerners only rarely have glimpsed.⁹

Another Banff work was a collaboration 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 VR 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 participant 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 theater, provided direction to the participants 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 signaled 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.¹⁰

A work by Toni Dove and Michael McKenzie, *Archaeology of a Mother Tongue* (1993), mixed several media, including laser disk, computer and photographic imagery, narrative voice-overs, and interactive sound. Dove described *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. Focusing around the murder of a child, it featured a coroner and a pathologist as the main characters. The participant was led as though through a dream, via a ribcage that functioned 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 participant with hidden thoughts, motivations, and details that related to the overall narrative. It was significant for its length: it required forty minutes to experience the whole mystery.¹¹

The Banff Centre works during the Virtual Art Project were notable for the differences among the artist teams creating VR works. Works by Toni Dove, Diane Gromala, Brenda Laurel, and Rachel Strickland stand out as being more emotionally and evocatively oriented, whereas the work of the primarily male teams at Banff tended to focus on technical or referential themes, such as, for example, *Topological Slide* by Stewart Dickson and Michael Scroggins wherein one could traverse mathematical shapes. (Mosher and MacLeod 1996) Another such work built around a self-commentary about the processes of VR was *VR on \$5 a Day* by Ron Kuivila.¹²

The artistic VR works described above all borrowed 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-embodiment 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

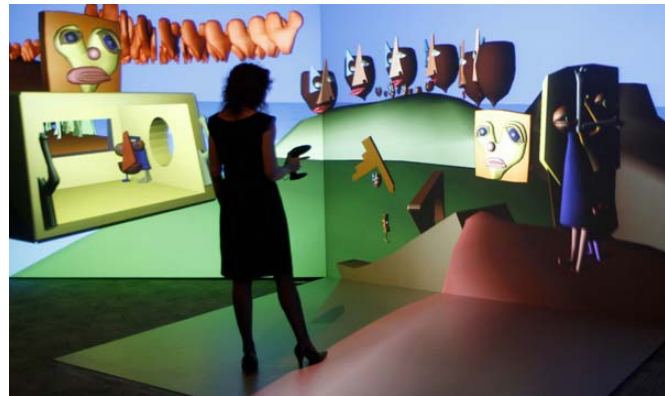
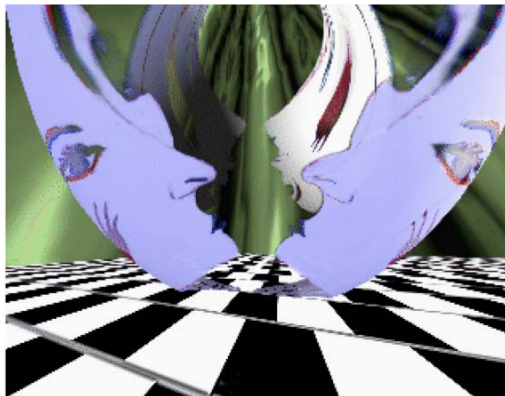
well beyond the scope of most VE works, which typically provide five to fifteen minutes of immersion.

This was an extraordinary beginning. Many artists expected other funding sources would open up as a result. This did not happen in any widespread or comprehensive sense, however. Individual artists had to continue to find their own means of realizing their VR visions, and quite a few did manage this, some under the sponsorship of universities, art grants or private funds. Notable artists who created remarkable VR works in the final decade of the twentieth century include Monica Fleischman (1992), Carl Eugene Loeffler (1992, 1993), Ulrike Gabriel (1992, 1993), Janine Cirincione (1994), Rita Addison (1994), Sheldon Brown (1994), Char Davies (1995, 1998), Maurice Benayoun (1994, 1997), Josephine Anstey (1997), Margaret Dolinsky (1997, 1998, 1999), and Rebecca Allen (1997, 1998, 1999). These creations represent some of the furthest reaches of VR ideas during the decade of the 1990s. While this is not a comprehensive list, it does include a majority of those artists working in VR. My own initial work in this medium also hails from this time period.¹³

1.3 Moving into the 21st Century

Virtual Reality as a topic of interest to the general public started to wane after 2000. The reasons are too numerous to cover in depth here, but it is widely acknowledged that VR failed to live up to the hype that was being generated by literary works, films and the press. It was also difficult for the ordinary person to find a place to experience a virtual reality environment. In any case, artists showed no signs of abandoning the medium. From the years 2000 through 2007 there were approximately 28 new works made. Some were new works by the pioneering artists mentioned previously. For example, Banff participant Diane Gromala continued to make evocative VR works such as her 2001 *Meditation Chamber* and the *Living Book of the Senses* in 2002.^{14, 15}

There were also newcomers like filmmaker Alison McMahon, who entered the scene with *Mimesis* (2002), a CAVE-Based work using bio-feedback to determine what elements the participant saw.¹⁶ Anne Deane Berman, working with Carolina Cruz-Neira and others at the University of Iowa in 2003, created a truly haunting interpretation of the day the Twin Towers fell called *Ashes to Ashes*, incorporating complex graphics along with voice recordings from the survivors.¹⁷ At the University of Illinois at Chicago's Electronic Visualization Lab (EVL), students were steeped in the making of VR artworks, with several artists developing new aesthetics for this immersive medium. One of these was Margaret Dolinsky, who, from her early work *Dream Grrrls* in 1996, to her most recent piece *Figuratively Speaking* (See Figures 3 & 4), has produced an important and extremely coherent oeuvre.¹⁸ Josephine Anstey and Dave Pape, also from the EVL, showed a talent for including narrative within a virtual environment, a difficult concept to achieve, given the open-ended nature of immersive experiences. Their 1997 piece, *The Thing Growing*, is a three act play in which the participant has a starring role, interacting with a very capricious virtual character who wants you to follow her dance.¹⁹



Figures 3 & 4: Images from *Dream Grrrls* & *Figuratively Speaking* by Margaret Dolinsky. Images courtesy of M. Dolinsky.

2. DESIGN FOR IMMERSIVE ENVIRONMENTS

A Virtual Reality artist combines varying proportions of computer generated sights and sounds to form a sensory environment through which the participant navigates. This environment must align with his or her intent in building the work. Yet once created, it is not a fully realized work. It might be thought of as a shell or envelope that surrounds the

participant with possibilities, rather than certainties of creation. This is because the participant possesses free will during the encounter with the virtual, and can make individual choices throughout. 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, bypass some elements and fully interact with others, and perhaps miss entire sections the artist has created. The final experience can never be fully mapped out ahead of time by the artist, and therefore the ultimate form of the work will be different for each person who experiences it. The creator will never know exactly what decisions might be made by each participant. This unique characteristic of immersive virtual environments—their emergent nature—compels a distinct design approach.

Compare the concepts of designing for emergence with creating for other media such as films, or literary works. In these productions the director or author has control over exactly what material will be delivered to the audience. He or she also controls the order in which events and elements are delivered. This is considered a high skill – to be able to create a coherent work that will be enjoyed and appreciated by the receiver of that work.

Designing for emergence, however, 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. Imagine a writer relying on a reader's bio-feedback (as Alison McMahon did in her *Mimesis* piece) to determine what that person would “see” next in the story! Or a movie in which a viewer could leave “voicemarks” for others to experience, as was done in Brenda Laurel's *Placeholder*. And beyond these sorts of participant contributions, the system itself might also be an active player, subject to emergent behavior, even if it is not explicitly programmed into the code. Such “accidents” or “glitches” might even provide a new direction, feeling, or motivation for the participant. Thus, the ultimate experience comprises could be considered a triadic relationship among machine, artist, and participant.

2.1 A Gendered Medium?

The topic of gender in making and using immersive virtual environments has been a discussion point as long as the medium has existed.²⁰ In fact, the 2001 Who's Who in Virtual Reality listing from the University of Washington's HIT Lab, which attempted to catalogue all developments in VR, names ten females to ninety males in the business.²¹ So, not without evidence has VR been long considered a male domain. Yet, even with this as its history, it appears that a preponderance of artistic VEs have been designed and created by women. In 2007 as part of my doctoral thesis, I completed a detailed survey of nearly one hundred Virtual Reality works that were primarily intended as artistic expressions. The survey showed that approximately 62% of them were designed and/or created by women. In trying to understand why this would be so, I looked for differences in how men and women approached creating with VR. 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. Rob Milthorp, in his essay *Fascination, Masculinity and Cyberspace*, says “Cyberspace is a new tool. It mirrors prevailing cultural values and is a powerful instrument in conserving a power structure of male values and masculine behavioral characteristics.”²³ He notes that creation of such works entails elements of maintaining individual power and control.

However, it is obvious that there is a different aesthetic at work in female-designed artistic immersive environments. 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 more examples serve to illustrate my conjecture.

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 participant's avatar, a non-photorealistic dervish of color, sound and movement.²⁴

Tamiko Thiel, whose virtual environments are shown in a secluded darkened room with a large screen at one end, and a bespoke jeweled joystick for navigation, brings a poetic sense to political injustice in her work *Beyond Manzanar* where she emplaces the participant 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 the times gone by, 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.²⁵

UK artist 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.”²⁶ Last, but certainly not least, Margaret H. Watson’s *Liquid Meditation* (1999), done at the EVL mentioned earlier, provides CAVE-based immersion in an environment where “water pulses and flows infinitely in a world where moments can continue for an eternity.” Watson’s work is made to help re-instill a bond linking humans and nature.²⁷

All VR artists have all helped expand the possibilities of what can be done aesthetically with VR, but it does turn out that a majority of them happen to be women. It is not that there are no men working in the field, but I argue that the truly unique works –those that serve to push the aesthetic boundaries of the medium 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.

2.2 Neurologically: Differences between Men and Women

My ongoing research into why men and women might create immersive VR work differently led me to study the differences in how men and women each think and react to their worlds.

It appears that some of the characteristics that define their divergent approaches to creation may actually originate in how our brains work. Recent studies by neuroscientist Larry Cahill and colleagues have revealed some interesting differences. Under resting conditions it appears that, in females, the left side of the amygdala (the primitive emotional centre of our brain) shows 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 a woman’s left side is connected to areas attuned to “attending, to and controlling aspects of the internal milieu.”²⁸ This outward/inward orientation, neuroscientists hypothesize, may explain why females get digestive ills when they have an emotional occurrence, and men may have the urge to go somewhere. Such research continues to explore several sexual-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.^{29, 30, 31}

Decision-making too, seems to have sex-related differences.³² Social psychologist Shelly Taylor at UCLA, in 2000 proposed gender differences in the “flight or fight” reaction so often cited in emotional arousal literature. Noting 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 neurochemicals released in males (vasopressin) and females (oxytocin) during intensely stressful situations.³³

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.

2.3 Philosophically: A Feminist crucible

Feminist theorists study how gender is created and/or destabilized within the structure of a medium, with a particular focus on writing. In the view of noted feminist Hélène Cixous (and others), the quintessential male gendered implement of creation is the pen, both for its output of logical writing as well as its phallic symbolism. She asks what could be the

female equivalent of this – "l'écriture féminine?"³⁴ While VR technology may have originated in a predominantly male-gendered milieu, I argue that many VE experiences have transcended these origins, and have become more of an "embryonic chamber", not unlike the place a woman provides to a developing baby. In my view the immersive environment is the perfect vehicle for feminist aesthetics, becoming in some sense, Cixous' perfect "l'écriture féminine."

Building on feminist theory, if a text is inherently male, then a virtual environment is inherently female. It is a "writing through the body" in Cixous' primary sense. For feminist Julie Kristeva, the maternal body that protects and nurtures the process of a human's becoming, makes the feminine aspect sacred.³⁵ While not all feminists agree with Kristeva's concepts of the maternal body (see, for example Judith Butler's work c.1990), the concepts of the "two-in-one" and a "subject-in-process" (or what Kristeva has termed the semiotic chora³⁶) resonate with my own views of the VE participant.

Charlotte Perkins Gilman, many decades earlier than these writers, in her 1911 book *The Man Made World*, said 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."³⁷ 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. From one perspective, a cyborg world is about the final imposition of a grid of control on the planet. But as Donna Haraway states in her foundational Cyborg Manifesto: "the relation between organism and machine has been a border war."³⁸ She puts both the enjoyment of these borders and the "responsibility" for their "construction" (emphasis hers) on us. 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.

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.

Even though we may not fully know why women tend to approach Virtual Environment art from a different mental state – it seems that numbers bear some support for the arguments mentioned above. As mentioned previously, in 2007, I compiled an exhaustive listing of all the immersive VR artworks I could find that had been created from the earliest days (not only including Jaron Lanier but even back to Myron Krueger's 1975 *VideoPlace*, executed long before such immersive work was known by the name VR). While the chart itself can be found online, there are some necessary explanations about it that will be presented next.



Figures 5 & 6: Two images from my 2007 *Memory Stairs* that take the embryonic chamber metaphor literally.

3. ABOUT THE SURVEY CHART

My survey of Artistic Virtual Environments represents a fairly exhaustive search of art and technology books, exhibition records and catalogues, and Internet resources examined over a five year period from 2002 - 2007. Even at that, some notable immersive VR art works may have been inadvertently missed. While it was not my intention to continually update this chart, I would be open to hearing from those who know of such works as would help complete this record, especially in the years since it was first completed. I am especially interested in knowing of new works by artists who have a history of Virtual Reality art-making.

For this research, my first criterion for inclusion was that the work had to have been created as an artistic expression, first and foremost. 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 participant from the real world during the experience) or a CAVE, or a very large screen at the least. I have included some of these in the latter category, as many artists chose this delivery mechanism for the practicality of transporting these works and showing them in gallery spaces. The intent was to be immersive, and to take one outside of the ordinary world during time of the experience. 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, yet often incorporate 2D imagery or video within the environments. I deliberately avoided works designed to be viewed on a small computer screen. All included works involve the phenomenological space that involves one's body as a means of experience, and small screens do not support this in a meaningful way. I have added a column in the chart based on the work of Lars Qvortrup, who has written extensively about Virtual Environments and their phenomenological and semiotic characteristics.³⁹ Within his schema the majority of the artistic VR works fall into a category of 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 my long held suspicion 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 in the chart. 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 sections. Each page is displayed 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.

	A	L	M	N	O	P
	Artist	Singular/Shared	Semiotic category (per Qvorstrup)	Body representation	Exhibited or main reference	Short description or quote
1	Agnes Hegedus	Singular	Symbolic	None	Chapter in Mailby:V2 Archive at http://framework.v2.nl/archive/archive/node/work/xml/t/nodenr-146808 and SIGGRAPH 1993 Machine Culture	Users see a virtual world within the clear sphere when they move the camera inside
2	Agnes Hegedus	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
3	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
4	Agueda Simó	N/A	Symbolic?	N/A	N/A	inspired by Mimeticism, a co-evolution phenomenon of nature; modifiable by users.
5	Aison McMahon	Singular	N/A	Yes, partial, grey abstract	www.waguedasimo.net/me.htm	Several sections: Claustrophobia, Haunted Mansion, Biofeedback determines what the user sees.
6	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
7	Brenda Laurel, Rachel Strickland, Rob Tow, Michael Naimark	2-person	Symbolic	None except by voice	Banff	Networked guests become animal spirits
8	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
9						

Figure 5. A sample page from the 2007 survey. Full survey is at www.ict.usc.edu/~morie/VR_ArtChart2007.pdf

4. CONCLUSIONS

As a fairly young artistic medium, Virtual Reality is only two decades old.⁴⁰ While a hundred or so works may not seem an impressive total for that amount of time, given the challenges of accessing equipment to both create and exhibit such works, it should be considered quite an accomplished start. Surely in the future we may see increasing additions to this oeuvre, as equipment that was out of reach even ten years ago now is becoming more available and affordable. Not only is such work less expensive to create, upcoming generations raised on games and interactivity have a higher threshold for getting involved with an artist's creation, and perhaps also for making this kind of participatory art. They see interactivity as a mainstream way to experience things, rather than previous generations who might have considered it novel, or as something that required more effort than familiar passive viewing or reading, and were therefore less accepting.

However, for those involved early, VR was nothing short of magic for that time. This quote from Jaron Lanier provides one explanation for its intense effect:

I tell you the most vivid experience of Virtual Reality is the experience of leaving it. Because after having been in the reality that is man-made, with all the limitations and relative lack of mystery inherent in that, to behold nature is directly beholding Aphrodite; it's directly beholding a beauty that's intense in a way that just could never have been perceived before we had something to compare physical reality to. And that's one of the biggest gifts that Virtual Reality gives us, a renewed appreciation of physical reality.⁴¹

While he was speaking about all Virtual Realities, I am sure he would agree that the artistic ones such as those described here were the most successful examples of allowing us to perceive those things that "could never have been perceived

before.” These works were expressions of aesthetic vision that opened the veil between the physical world and the inner worlds of the artist. Virtual Reality allowed us to not only share that world, but traverse it at our own pace, in our own way, because the artists using this new medium set it up to enable this – a space that could become what we made it, that we could complete.

REFERENCES

- [1] <http://www.merriam-webster.com/dictionary/virtual%20reality>. Accessed December 20, 2011.
- [2] Sutherland, I. E., “The Ultimate Display,” *Proceedings of IFIP 65*(2), 506-508 (1965).
- [3] Nathaniel I. Durlach and Anne S. Mavor, Editors, [Virtual Reality: Scientific and Technological Challenges]. Committee on Virtual Reality Research and Development, National Research Council. (1995)
- [4] Heilbrun, A. and Stacks, B. "An Interview with Jaron Lanier: Virtual Reality," *Whole Earth Review* 64(Fall) 114 (1989).
- [5] Nathaniel I. Durlach and Anne S. Mavor, Editors. Op. cit. See Chapter 8 (247-303) for coverage of the issues surrounding generating realistic scenes in VR.
- [6]
- [7] Popper, F. [Art of the Electronic Age]. Harry Abrams, New York, NY. 102-103 (1993).
- [8] Moser, M. A., and MacLeod, D., [Immersed in Technology: Art and Virtual Environments], Massachusetts Institute of Technology (1996).
- [9] Lozano-Hemmer, R. “Floating Trout Space – Native Art in Cyberspace.” Interview with Lawrence Paul Yuxweluptun, Available online at <http://www.heise.de/tp/english/inhalt/sa/3029/1.html>. (1998). (Accessed Nov. 23, 2011).
- [10] Laurel, B., Strickland, R. and Tow, R. “Placeholder: Landscape and Narrative in Virtual Environments”. *ACM Computer Graphics Quarterly* (28)2 118-126 (1994).
- [11] Dove, T. and Mackensie, M. “Archaeology of a Mother Tongue.” in [Immersed in Technology: Art and Virtual Environments]. Mosher, Mary Anne and Douglas MacLeod (eds.), The MIT Press, Cambridge, MA, 275-280 (1996).
- [12] Kuivila, R. “VR on \$5 a Day” in [Immersed in Technology: Art and Virtual Environments]. Mosher, Mary Anne and Douglas MacLeod (eds.), The MIT Press, Cambridge, MA, 291-295 (1996).
- [13] For a full listing of these and other VR works, please see the extended documentation at http://people.ict.usc.edu/~morie/VR_ArtChart2007.pdf
- [14] Shaw, C. D., Gromala, D., and Seay, A. F. “The Meditation Chamber: Enacting Autonomic Senses” in [Proceedings of ENACTIVE/07], 4th International Conference on Enactive Interfaces Grenoble, France (2007).
- [15] Gromala, D. “Living Book of the Senses” documentation available at <http://www.lcc.gatech.edu/~gromala/livingbook/> (2002) Accessed December 27, 2011.
- [16] McMahon
- [17] Cruz, C., Deane, A., Williams, V., Berman, A. D., Cruz-Neira, C., Berman, S. L., and Tuch, L. “9/11 Building a World of Survivor Memories.” Presented at the 11th International Conference on Human-Computer Interaction. Las Vegas, NV (2005).
- [18] Dolinsky, M. “Transformative navigation: energizing imagery for perceptual shifts” *Technoetic Arts: A Journal of Speculative Research*, 7(10) 49-64 (2011).
- [19] Anstey, J., Pape, D., and Sandin, D. (2000) “The Thing Growing: Autonomous Characters in Virtual Reality Interactive Fiction” in [Proceedings of the IEEE Virtual Reality 2000 Conference], New Brunswick, NJ, 71-78 (2000).
- [20] Laurel, B. “Grids, Guys and Gals: Are you oppressed by the Cartesian Coordinate System?” SIGGRAPH 1995 Panel Session. Los Angeles, CA, (1995).
- [21] Available at http://www.hitl.washington.edu/projects/knowledge_base/who.html Accessed December 15, 2011.
- [22] Available at http://people.ict.usc.edu/~morie/VR_ArtChart2007.pdf Accessed December 27, 2011.
- [23] Milthorp, R. “Fascination, Masculinity, and Cyberspace” in [Immersed in Technology: Art and Virtual Environments]. Mosher, Mary Anne and Douglas MacLeod (eds.), The MIT Press, Cambridge, MA, 129-150 (1996).
- [24] Allen, R. “The Bush Soul: Traveling Consciousness _in an Unreal World.” Available online at <http://emergence.design.ucla.edu/>. (Accessed December 12, 2011).

- [25] Thiel, Tamiko (2001) Beyond Manzanar: Constructing Meaning in Interactive Virtual Reality, COSIGN 2001 Conference Proceedings, Amsterdam, Holland.
- [26] Thomas, Maureen (2007) Taking a Chance on Losing Yourself in the Game. From the Women in Games 2007 Conference Program. Available online at www.womeningames.wordpress.com/2007/04/16/wig-2007-non-games (Accessed 8/6/07).
- [27] Watson, Margaret H. (1997) Liquid Meditation. Available at Ars Electronica website: http://www.aec.at/en/archives/festival_archive/festival_catalogs/festival_artikel.asp?iProjectID=8511 (Accessed 2/11/06)
- [28] Kilpatrick, L. A., Zald, D. H., Pardo, J. V., and Cahill, L. F. "Sex-related Differences in Amygdala Functional Connectivity During Resting Conditions." *NeuroImage* 30: 452-461: 454 (2006).
- [29] Cahill L., Haier R. J., White N.S., Fallon J., Kilpatrick L., Lawrence C., Potkin, S. G. and Alkire, M. T. "Sex-related Difference in Amygdala Activity During Emotionally Influenced Memory Storage." *Neurobiology Learning and Memory* 75: 1-9 (2001).
- [30] Canli, T., Desmond, J., Zhao, Z. and Gabrieli, J. D. E. "Sex Differences in the Neural Basis of Emotional Memories." *Proceedings of the National Academy of Science. USA* 99: 10789-10794. (2002).
- [31] Cahill, L., Uncapher, M., Kilpatrick, L., Alkire, M. T. and Turner, J. "Sex-related Hemispheric Lateralization of Amygdala Function in Emotionally Influenced Memory: an fMRI Investigation." *Learning and Memory* 11: 261-266 (2004).
- [32] Tranel, D., Damasio, H., Denburg, N. L. and Bechara, A. "Does Gender Play a Role in Functional Asymmetry of Ventromedial Prefrontal Cortex?" *Brain* 128: 2872-2881 (2005).
- [33] Taylor, S. E., Klein, L. C., Lewis, B. P., Gruenewald, T. L., Gurung, R. A. R, and Updegraff, J. A. "Biobehavioral Responses to Stress in Females: Tend-and-Befriend, not Fight-or-Flight." *Psychological Review*, 107(3) 441-429 (2000).
- [34] Cixous, H. "The Laugh Of The Medusa in Literature in The Modern World." Walder, R. (ed.), Oxford University Press. Oxford, UK (1990).
- [35] Clément, C. and Kristeva, J. "The Feminine And The Sacred." Translated by Jane Marie Todd. Columbia University Press. New York, NY (2001).
- [36] Kristeva, J. "Revolution in Poetic Language." translated by Margaret Waller, Columbia University Press. New York, NY (1984).
- [37] Gilman, Charlotte Perkins [The Man Made World, or Our Androcentric Culture]. Carlton, New York, NY 46 (1911).
- [38] Haraway, D. "A Manifesto for Cyborgs". *Socialist Review* 80: 65-108 (1985).
- [39] Qvortrup, L. [Virtual Space: Spatiality in Virtual Inhabited 3D Worlds]. Springer-Verlag, London (2002).
- [40] Unless one goes back to the 1970s work of Myron Krueger which prefigured and closely resembled VR.
- [41] Heilbrun, A. and Stacks, B., Op. cit., 119.