

# *Virtopia: Emotional Experiences in Virtual Environments*

## ABSTRACT

Many contemporary virtual environments fail to provide participants with rich and intriguing experiences. This is true not only because of limitations in display and processing power in graphics computers currently available, but also because few people create virtual worlds in the context of artistic expression. Key to providing intriguing and engaging worlds is an understanding of the power of emotional content. The authors propose that an emotive response can be elicited in a subject through strategic use of imagery and sound in a virtual environment, which will enhance the sensation of immersion in the simulation and thereby help to compensate for the inadequacies of contemporary technology. Their artwork, *Virtopia*, draws on psychology in its implementation of virtual-reality technologies to produce aurally and visually immersive environments that engage the participant on an emotional level.

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**V**irtual environments are places that exist entirely within the memory of a computer. Powerful machines generate and maintain an illusion of being elsewhere by utilizing various specialized tools to simulate the different avenues of human sensory input. With stereo views, three-dimensional (3D) sound and some form of navigation, entire worlds can be created. These worlds can provide access to relatively inaccessible forms of reality: the space of a building that has not yet been built, for example, or terrain unfamiliar to the soldiers about to be sent there.

To date, most of the work in virtual reality (VR) has been done for either military training or entertainment games, with

a few commercial exceptions. Very little has been created by artists working with this technology, mainly because few artists have had the opportunity to work with the costly tools needed to make these virtual worlds. As a new medium for creative expression, virtual environments can also be daunting to even the most intrepid artist, due to the tremendous amounts of time and resources necessary to build these computerized worlds. It takes a team of skilled people to solve even the most commonplace of technical difficulties that regularly arise in the building of virtual environments. We are of the opinion, however, that the creation of these worlds should be as much an artistic endeavor as it is a technological feat.

In creative terms, the advent of this new technology challenges us all to push the limits of how humans create and experience art. Throughout history, artists have shared their visions with others through the media of their time. Through giving form to artistic expression, each of these media—from painting to sculpture to film—has also limited artistic expression in some way. For example, a two-dimensional (2D) painting might represent only one aspect of an artist's fully developed interior world or mythology. By viewing an expression of that artist's vision, we can begin to see the world in new ways. But what if the artist could re-create the whole of that interior world and we could experience it as the artist did? As Howard Rheingold has insightfully stated, "if art is about seeing the world in new ways, and Virtual Reality is an instrument for creating worlds, artists might furnish the clue to a key question: If our technology ever allows us to create any experience we might want, what kinds of experience should we create?" [1] In theory, virtual reality may finally present artists with the potential to create and share entire worlds that could previously have existed only within their own minds.

## BACKGROUND

In 1992, we found ourselves working together on a VR research project for the U.S. Army. This was a project designed to see how well people could navigate within simulated



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worlds, with the ultimate goal of building mission-training scenarios for such things as hostage rescue [2]. In the context of working on this project, we began to have discussions about other things we could do with VR technology, and what we talked about most was creating a work of art.

One of us (Morie) was trained as a fine artist and has 15 years of experience making art, as well as an advanced degree in computer science. The other (Goslin), currently studying for a master's degree in computer science, is an artist with an undergraduate degree in psychology. Out of many talks, we came up with a concept for fully immersive virtual worlds that would do more than give one a space to walk around in or something to shoot at. We wanted to create worlds that would give people who visited them something to remember, worlds that would catalyze different experiences for each visitor. We wanted those experiences to leave lasting impressions.

Morie's previous artwork had been designed to pull the viewer into emotionally charged worlds (Fig. 1). Designing virtual worlds would provide a chance to expand the dimensions of the artwork to fully encompass the viewer. Goslin's interest in the psychological ramifications of art also came into play. Together we hoped we could build worlds that were emotionally engaging and intriguing enough to make people want to visit them again. We were lucky to have the technical resources (in terms of both equipment and expertise) necessary to create such immersive environments in the lab where we worked. We started working after hours on a personal project we called *Virtopia*.

## THE CHALLENGE

Unfortunately, the current state of virtual environment technology is far from the limitless potential that Howard Rheingold envisioned. "Immersion" in contemporary computer simulations is largely restricted to eyes, ears and, to a limited extent, hands and feet. Movement through these worlds is often clumsy and unsatisfying, and involves wearing a large amount of bulky equipment. Even the fastest computers available today can only generate scenes of high complexity and fidelity at speeds that tend to approach the 15 to 20 frames per sec of early motion pictures.

But some of those early films were able to transport the viewer to another

world without any technological support for immersion at all. Well-directed early motion pictures employed intriguing stories and artistic manipulation of images to engage the audience on an emotional level. This allowed people to be drawn into the experience even though the film was projected in only two dimensions and without color or sound.

Virtual environments today are in a position similar to those early motion pictures due to the limitations of today's technology. As with early films, however, the promise of a satisfying experience is mediated not by the technology in its emergent forms, but by the successful engagement of a participant on an emotional level. Techniques such as a good story or psychological interaction can be used to overcome some of the limitations of this new technology. These are means to draw the participant more fully into the experience.

For virtual environments to succeed at engaging the participant, they need to be immersive, interactive and involving. Most of the virtual environments produced so far contain some elements of immersion and interactivity—even standard building walkthroughs exhibit these aspects. These environments are immersive to the degree that participants experience mobility within a fairly believable 3D space. They are interactive in so far as the computer is programmed to react to certain actions of the participant: doors open at the approach of the participant, for example, or a tank explodes when fired upon. Reactions such as these are simplistic responses to a person's behavior in a virtual world. In

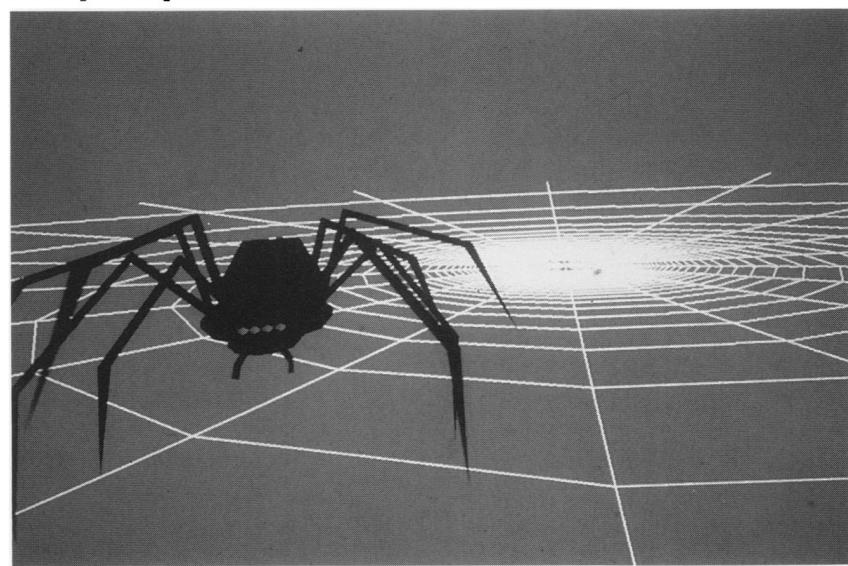
many cases, unfortunately, this interactivity appears to be an end in itself rather than a means of engaging the viewer, especially in the context of games. Here, the potential for virtual environments to provide rich experiences is mediated by a video-game mentality that defines interaction as shooting at things.

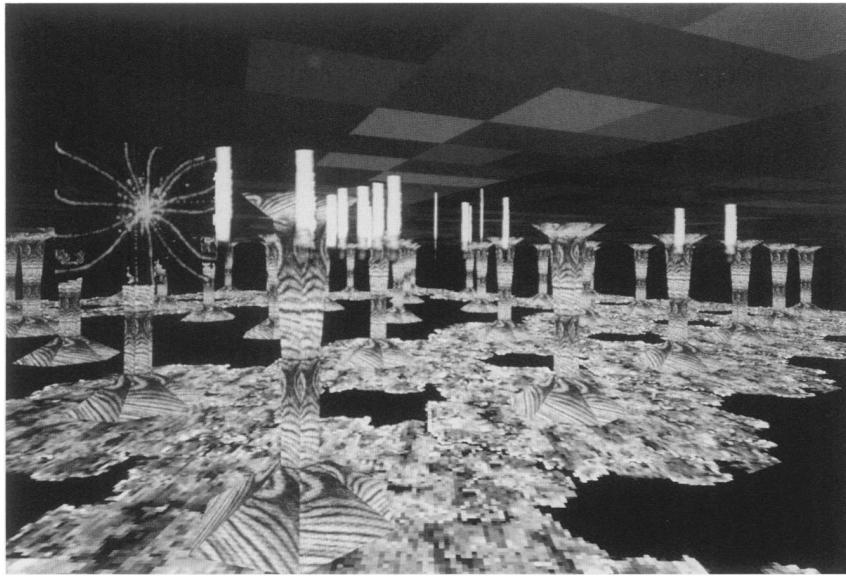
Immersion and interactivity alone are not sufficient to go beyond the level of games or walkthroughs. To provide rich and stimulating experiences, a level of emotional involvement is also needed. We wanted *Virtopia* to employ interactivity and immersion along with rich sonic and visual texturing designed to engage a participant on an emotional level, thereby enhancing the overall experience of the virtual environment. We began by thinking about how human emotions work.

## THE EMOTIONAL FACTOR

Emotions hold an important place in the psychological make-up of a human being. P.V. Simonov, of the Institute of Higher Nervous Activity and Physiology of the Academy of Sciences of the former U.S.S.R., describes emotions as extremely important aspects of our psychological makeup in that they are processes that help to uniquely define our experience of reality [3]. Behavioral research has demonstrated that an emotive response can be produced through the employment of imagery [4] and sound [5]. William James, a pioneer in the field of the psychology of emotions, most likely could not have envisioned

Fig. 2. *Virtopia*, virtual-reality installation, 1993. A scene from the Spider World, in which a 30-ft spider responds to the actions of the visitor to its web.





**Fig. 3. *Virtopia*, virtual-reality installation, 1993. A view into the Endless Forest, a richly textured world populated by wailing wraiths who run from the participant's approach.**

that man would someday be able to create realistic, high-fidelity simulations using machines when he argued that "mental events (hallucinations, images and memories) may produce emotions only when the observer confuses them with sensory input" [6]. Since a virtual environment is composed entirely of "artificial" sensory input, it is an attractive means by which to elicit emotional reactions based on such stimuli.

In creating *Virtopia*, we hoped to show that psychological and emotional responses produced by the manipulation of imagery and sound within a virtual environment could enhance the quality of immersion for a participant. Our research into the area of human emotions led us to the following observations and conclusions.

When a person is emotionally involved in an experience, he or she is most likely to focus on immediate sensations and less likely to perceive what is happening via analytical thought processes. The more emotionally involved a participant is, we reasoned, the more he or she will "buy into" the virtual world, thinking of it less as a construct and more as a personal experience.

Triggering one emotion can initiate a "chain reaction" of other emotional responses. According to psychologist Carroll Izard's differential emotion theory, "Emotion-induced cognitions may trigger complex memory clusters" (attitudes, beliefs, values, etc.) and "cognitions may act as a positive feedback loop and amplify the ongoing emotional state" [7]. A cleverly designed image

can, in this way, elicit a rich array of emotive reactions by "tapping into" cultural or archetypal concepts. For example, a picture of a spider can produce a disproportionately fearful reaction when it stirs feelings of arachnophobia, a condition that is often a composite of many images, textures and childhood traumas.

At certain levels of emotional arousal, the individual is not only distracted, but his or her analytical mental functioning also becomes somewhat impaired [8]. A person who is aroused to this extent begins to receive less information from the outside world, concentrating instead on the sensations directly affecting this emotional state. In a virtual environment, this could result in greater reliance on the simulated data that is available within the experience.

In a situation of relative sensory deprivation, such as a highly emotional state, the individual compensates for the lack of information by overprocessing what is available [9]. When the available information consists of the artificial stimulus of the virtual environment, the person may begin to perceive it as being more realistic than it may objectively appear, because he or she effectively "fills in the gaps" in order to produce a coherent mental representation of the surroundings.

In this scenario, a participant creates an internalized representation of the virtual environment that is richer than the actual environment. Richard E. Cytowic lends support to this notion when he states that "the ability to pluck salient information from the passing stream

and to act efficiently on fragmentary information is what leads to imagination and an aesthetic capacity" [10]. It is the individual's imagination that allows him or her to generate a more complete world based on the relatively limited information provided by the computer.

A participant from whom an emotional response has been elicited thus has fewer psychological resources available with which to objectively examine the inadequacies that are inherent in today's virtual environments. He or she will tend to concentrate on aspects of the immediate surroundings and buy into the illusion more fully. In other words, the use of emotional stimulation may actually allow us to compensate for some of the shortcomings of the current technology and produce a much more immersive and stimulating experience.

## THE *VIRTOPIA* PROJECT

We began work on *Virtopia* with the intention of creating an artistic virtual environment that would be both emotionally engaging and meaningfully interactive. The goal was to construct an "emotional simulator" with 3D sound and the fastest and richest graphics available, a system that could be appreciated on both aesthetic and technological levels. The result is a collection of diverse environments, each with its own color and tone, bound by the common interface of a barren desert landscape populated by oases that serve as gateways to the other worlds.

Each world in *Virtopia* engages participants on a different emotional level and responds to their actions in a manner appropriate to the setting and tone. These levels range from "biologically primal" emotions such as fear to more complex human experiences such as loneliness or existential angst. We postulated that different types of emotional response could produce their own "flavor" of immersion and thus enrich the overall experience and level of involvement.

We employed a variety of mechanical tools typical of virtual environment technology to bring *Virtopia* to life. To provide the best stereo views of our worlds, we used a state-of-the-art head-mounted display (HMD) capable of a higher resolution than most commercially available HMDs [11]. In order to maintain a participant's location and orientation within the simulated environment, we attached a tracking device to the top of the HMD. This device transmits an electromagnetic signal to a nearby receiver,

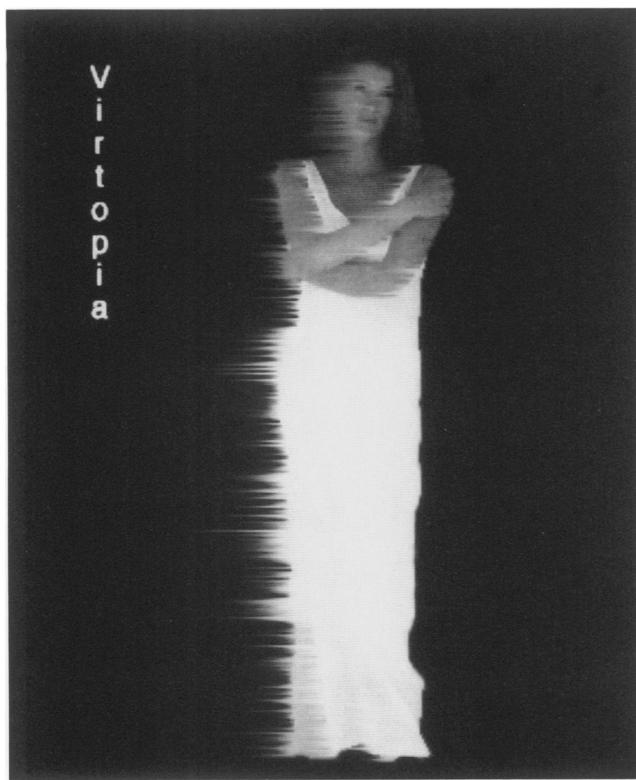


Fig. 4. *Virtopia*, virtual-reality installation, 1993. A close-up view of a wraith from the Endless Forest.

tificial environment of brilliant color and motion. The feeling is both liberating and disconcerting, as one's brain struggles to reconcile ambiguous and often contradictory sensory input.

## VIRTOPIA EXPERIENCES

How does *Virtopia* provide its visitors with emotional experiences, and how well does it succeed? Upon donning the HMD, a visitor to *Virtopia* is instantly transported to a vast, lonely and barren desert. There is the sound of strange music in the air, and sand extends as far as the eye can see. Punctuating the monotony of the desert are clusters of objects begging to be explored. Moving through the world with the joystick, a participant seems to fly over the sands, finally arriving at one of the clusters, which turns out to be a small oasis. There are many of these oases sprinkled around this landscape. Each oasis contains a colorful pool edged with rocks. Coming close to or diving into the pool transports the visitor to another world. The pools, much like the pools in the sixth book of C.S. Lewis's *Chronicles of Narnia* (as one observer of *Virtopia* pointed out to us), are portals to another time and place [12].

We wanted these portals to allow participants to stumble upon different experiences, each of which would provoke some response. The specific response would be based not only on the content of the world, but also on whatever psychological baggage each person brings to the experience from past life circumstances. The various worlds, however, are designed to convey specific emotional moods ranging from primal fear to confusion and angst. Some worlds are designed to start out with one feeling, but contain twists that change the feeling drastically as the experience progresses. Our intention was to make *Virtopia* flexible and expandable, so that it could eventually contain dozens of worlds encompassing a wide range of emotional experiences. The ultimate test of whether or not our theories worked would be passed when we could see some evidence that the participants were indeed reacting to the worlds of *Virtopia* in emotional ways.

Our efforts were rewarded at the premiere of *Virtopia* in May 1993 at the Florida Film Festival in Orlando. Our setup was such that only one participant at a time could don the HMD and have the full immersive experience, but all

which is then interpreted and translated into spatial coordinates ( $x$ ,  $y$ ,  $z$  and angular orientation) by the computer. The device is fairly fast and accurate to a range of about 6 ft from the receiver.

Three-dimensional sound in *Virtopia* comes from a small but complex network of audio devices. When events within the simulation trigger sounds, the main computer sends a request to a synthesizer, which outputs a prerecorded sound sample. The sound is then passed through a machine called a Convovotron (developed during the late 1980s at the Ames Research Center of the National Aeronautics and Space Administration [NASA] in Mountain View, California). The Convovotron computes a mathematical relationship between the participant's location and orientation (measured by a tracking device) relative to a given sound source and processes the sound in such a way as to simulate its apparent location within an imaginary sphere surrounding the person's head. The sound source is also "convolved," or combined, using a mathematical model of how a person's ears actually hear for maximum fidelity. The signal is then pumped through an amplifier and out to the participant's ears via a pair of stereo headphones.

Movement through *Virtopia* is currently accomplished with a joystick or mouse, but could be expanded to include a

treadmill in order to provide a better metaphor for walking through the simulated landscape. All of these devices are linked to the main computer that drives the simulation. The platform on which *Virtopia* was originally developed was a SGI Crimson Reality Engine graphics workstation, which was able to maintain all the peripheral devices while generating high-resolution stereoscopic images at a frame rate close to that of motion pictures. (*Virtopia* has since been ported to additional computer platforms.)

The diversity of these seemingly unrelated tools necessitates the design of a powerful software system that can hold all the pieces together and allow the different components to interact and coordinate their respective activities. The difficulty of this communication between devices is compounded by a lack of accepted standards and protocols. Many of the peripheral devices were designed for use with personal computers, which often makes them incompatible with the graphics workstation used as the simulation manager. The extra effort involved is rewarded by the increased display speed and image quality afforded by the workstation.

Out of this organic tangle of cables and incompatible, jury-rigged devices flows a sensory experience that is novel and astounding. Engaged through both eye and ear, the participant enters an ar-

the people in the room could see what the participant was doing by means of two large video monitors. A *Virtopia* visitor would first enter the oasis-populated desert and could navigate to any one of its oases, which served as gateways to the various worlds. We also had the ability to "teleport" visitors to a world of their choice with a keyboard command, which we sometimes did in the interests of saving time or in response to a request to visit a specific world.

The most dramatic moment of the evening involved a young woman who had donned the HMD for a quick tour of the simulation. She promptly wandered into the Spider World, an environment consisting of a vast spider web set against a bloody sky complete with an enormous 30-ft spider (Fig. 2). The spider is actually composed of many polygons (much like a house of cards), a construction typical of real-time computer models. It lacks hair and other realistic spider characteristics. The rapid asynchronous movements of the spider's legs, however, combine with a smooth flow of motion of the body segments to create an overall effect that is more convincingly realistic than its parts. Given the interactive nature of the encounter (the spider reacts to the behavior of the participant: running quickly towards the spider, for example, may cause it to turn and run away), the experience can be fairly unsettling, as the woman soon discovered. She elicited an aggressive behavior from the arachnid that caused it to chase her until she was caught and surrounded by writhing spider limbs. The woman screamed, tore the display helmet from her head and ran from the room. Her departure initiated a flurry of requests from the waiting crowd not to visit the Spider World.

*Virtopia* attempts to engage the participant on a variety of emotional levels that are more complex and nuanced than the fear just described. The Endless Forest World, for example, consists of an abstract forest of massive symmetrical and richly textured trees (Fig. 3) populated by wraiths (Fig. 4). These female apparitions drift among the trunks in hypnotic patterns to the sound of a choral fugue. The wraiths may be approached, but will flit away before they can be touched. The sense of melancholy and loneliness this world tends to impart is subtle and somewhat hypnotic. Its rhythms lull the participant into a state of passive acceptance of the surroundings, despite the feeling of isolation they evoke. Visitors to this forest

tend to stay a relatively long time, far past the moment at which they have "seen everything there is to see." Many have even stated that it is their favorite of all the worlds. For those who decide to leave, a portal leading back to the main desert eventually appears. It is a rectangular door with a red, anemone-like texture: an incongruous object to be found in a forest, to be sure, but one that beckons by its very strangeness.

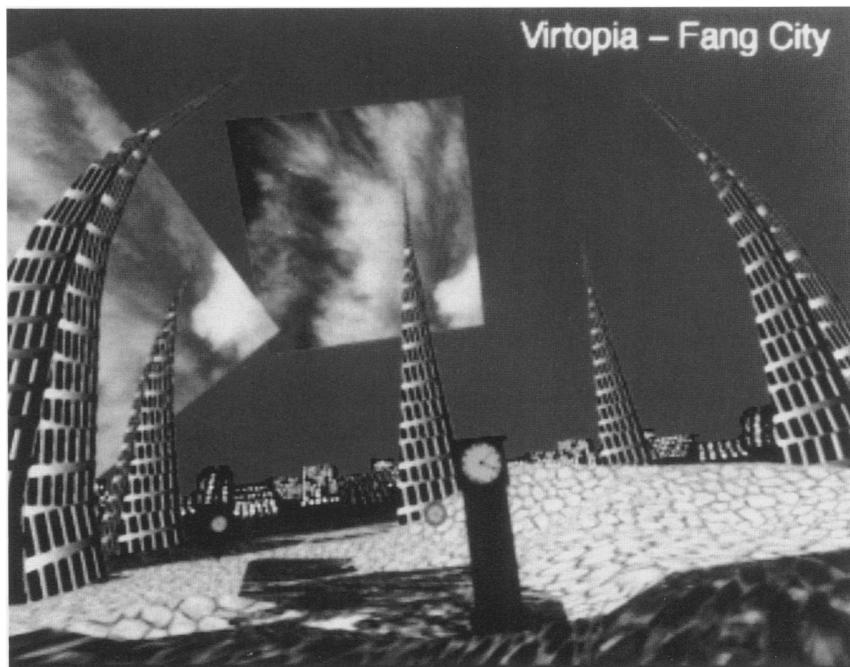
The Wacky Desert adopts yet another approach to engage the participant. Visitors to this world are enthralled and confused by the myriad of brilliantly colored stars and planets that pitch and tumble above (and even through) the surrounding landscape of iridescent dunes. The colors of the sky shift to the pulse of spiraling galaxies and the heavenly bodies resonate with sounds that roll in from all directions. The viewer is liberated from the physical constraints of gravity and logic and is allowed to fly into the rich harmony of textures, shapes and sounds, making this another popular world for participants. Eventually, a blue pool appears in this landscape, providing reentry to the main desert.

Fang City is a world of cycles designed to elicit feelings of existential angst and introspection (Fig. 5). The scene is initially one of pastoral serenity: the participant stands near a tranquil lake in a clearing. Several bats flap peacefully overhead to the accompaniment of crickets and trickling water. Soon, how-

ever, the landscape begins to shift and the sky darkens. The scene metamorphoses into an urban nightmare. Enormous pointed buildings tear out from the earth to loom overhead and disturbing anthropomorphic clocks of all shapes and sizes wander aimlessly while they sound out the time. The sound of clanging clocks soon becomes overwhelming. Dark clouds swirl overhead and a jagged city skyline replaces the ring of trees that had circled the horizon. The main feeling reported by many people is one of being trapped. In time, however, the buildings recede, the sounds quiet down, and the scene returns to its original idyllic state to begin the cycle again. At this point the visitor can find an unlikely way out of this world: an enormous eyeball appears over the fields of flowers. Flying into this eye transports one immediately back into the main desert.

The Conversation Room presents an essentially empty space haunted by the memory of a crowd of people talking (Color Plate B No. 1). In the room's center is a table on which a scrapbook sits. Each of the four walls is aurally textured with an abstracted animated conversation. As a visitor approaches any of the animated walls, a fragment of a conversation disassociates itself from the general hum. Approaching the scrapbook on the table causes the pages to turn slowly; each page contains photos and postcards. As the pages turn, other conversa-

Fig. 5. *Virtopia*, virtual-reality installation, 1993. The urban part of the cycle in Fang City, which starts out as an idyllic, pastoral world and quickly changes to become a threatening city with tooth-shaped buildings rising out of the ground and endlessly clanging clocks.



tion fragments become clear. The isolated conversation fragments all deal with transitions and changes in life over which we have no control. For example, when approaching one wall, a visitor might hear a voice saying: "It's a feeling like you've been standing on the edge of a cliff and someone suddenly retracts it. You feel yourself falling. . ." or perhaps a voice that reverberates with a persistent echo, saying "I don't know, I don't know how to think about all this." The photos in the scrapbook also speak. At a page of images of babies, one overhears: "But they are your babies. You want them to grow up. . . Just think if they didn't!" On a page with pictures from a first Holy Communion, one hears: "It was the holiest of times. I didn't know then it was the holiest of times, but it was. I felt so holy then." This environment has varying effects on those who are immersed in it, based on their own life experiences.

Within yet another world, one appears to be suspended high above a cluster of exotic mountain peaks. A large school of skeletal fish swim by and the "sky" overhead boils and churns. A periodic sound of bubbles completes the effect of being under water. A dark castle sits atop the largest mountain peak. If the participant enters the central tower, the world grows silent as an enormous clam turns and slowly opens to reveal a massive, disembodied head. The head glowers, taunts the visitor and reacts menacingly to any exploration of the room. There is a series of disks bearing colorful images set into the floor, and approaching each one elicits a different reaction from the head. When the last disk is touched, the head shrieks and its eyes bulge out before it finally explodes in spectacular fashion.

*Virtopia* is designed to evolve continually and incorporate more experiences. To date, we have designed approximately 15 worlds for *Virtopia* and implemented seven of them. Several new experiences are awaiting implementation. Descriptions of two of these future worlds follow.

The Iron Maiden world places the participant at the center of a spherical space about twice the person's height. Thrust through the sphere are huge and dangerous-looking projectiles re-

sembling giant rusty nails. They are so numerous as to prevent one from moving anywhere. No real pain or even pressure results from contact with these points, but sounds make it clear that one is bumping into them. The sound creates a psychological barrier, discouraging movement beyond these shapes. The participant can, however, press past these nails, through the sphere itself and on to the outside world. At the moment of escape, the world turns bright red and the sounds become cacophonous. Once the participant makes it through to the outside world, the cacophony changes abruptly to gentle sounds: wind blowing, the tinkle of wind chimes and soft choral music can be heard in various parts of this space, which is delicately colored, like clouds of rainbows. From time to time, ethereal beings or creatures fly through the space. One of them will lead the visitor back to the desert world. The Iron Maiden world can be experienced as a birth metaphor or a death experience, depending on how one is predisposed. Some visitors may not even attempt to press past the spikes to find what lies beyond.

A brightly colored child's room is part of the Toy Box World. Several toys are scattered on the floor, and outside the windows is a sunny daytime environment with a bright blue sky. The toys come to life as they are approached: tops spin, robots walk, xylophones play. The participant can easily become fascinated by these toys and try first one, then another. At some point, the participant will notice that the scene outside the window has changed. The blue skies have been replaced by the faces of starving children pressed up against the window.

The actual reactions of visitors to this last world and to many others cannot be foreseen. Part of our experimentation in designing *Virtopia* involves observing the types of effects these various worlds have on people. Are our natural human reactions as strong within virtual worlds? Can we evoke a full range of emotions from joy to sadness and nostalgia to angst? Many more participants will have to experience *Virtopia* before we can answer these questions, but our initial feedback is promising.

## CONCLUSION

Virtual-environment technology has come a long way in the last several years. Advances in computing technology and software, along with new ways to configure and display these systems, have made it possible to create a new generation of immersive environments. Improvements in technology, however, will always lag behind our expectations of how good things *could* be. This does not mean that we cannot create interesting and aesthetic environments with what is available now. We propose that, if artists and designers make thoughtful use of imagery, sound, story and meaningful interaction in order to engage the participant on an emotional level, virtual environments can produce the moving and rewarding experience to which the technology aspires.

## References and Notes

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12. C.S. Lewis, *The Magician's Nephew*, book six in *The Chronicles of Narnia* (New York: Macmillan, 1970).

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