VIRTUAL REALITY:

The Refiguring of

Space, Real, and Subject

Eric J. Forman

First Publication Date: 1995

Jesse Kalin and Molly Nesbit, advisors

The Philosophical Ramifications of Computer Technology

TABLE OF CONTENTS

INTRODUCTION

Virtual reality is the latest phase of the human effort to duplicate or create reality, and its technical framework — immersion through interface with computer-generated environments — might be the last. Human beings have been reaching towards the Real, towards some totalized unity, for most of their history. We are still getting over our prideful hope for total explicability of the cosmos and our cultural yearning for closure. VR represents the closest we have ever come to achieving the real, for it gives us a divine power to create worlds and beings and different physics. Our status as gods is a shaky one, however, for there are numerous complications we are just beginning to understand: epistemological as well as technical. "Virtual reality" is a term being tossed around frequently now, mostly for commercial exploitation, but its true potential has yet to be realized. What VR really entails is something to be excited about, but it is also something whose speed and unpreventable nature of arrival justifies serious examination now.

At its most basic, virtual reality is a computer-generated environment whose most important technological features are *immersion* and *interactivity*. The simulation is achieved by filling the visual field with a three-dimensional image that is constructed according to the cybernaut's virtual point of view. Every virtual object is an amalgam of geometric shapes, polygons, that the system renders up to thirty times a second, computing each one's color, light sources, shadows, and perspectival effects. The interface translates physical movements into virtual motion: as the head turns in real space, every polygon is recalculated to present a corresponding shift of perspective. If you move your hand, a virtual hand mimics that motion, and one can manipulate virtual objects as one would real ones. Already, the most powerful VR systems are capable of rendering photorealistically: visually, the computer-generated environment is indistinguishable from the actual world.

In examining the philosophical ramifications of virtual reality, I am entering a field of endless possibility, for, without exaggeration, VR involves a redefinition of human. I have chosen to remain rather broad in scope in order to impress how far virtuality will extend into our lives and concepts. The chapters cannot hope to cover anything fully, although specific argument and discussion is attempted as much as possible. Our world will become, and is already becoming, cyberspatial in dimension. The physical world is just one of many in our future, and our habitation of these new realms will transform notions as fundamental as reality, space, and self.

In the first chapter, THE (DIS)SOLUTION IS REALITY, I trace the human progression along the continuum of the human effort to *fully represent*, focusing on its explicit manifestation in the visual arts. As the real is increasingly simulated, our ability to distinguish between the two grows ever more complicated. VR is the ultimate simulacra; we must be aware of the dangers inherent in a potentially total alienation from the natural, or from each other. For, in the process of creating new universes, we still have not mastered simultaneous presence — although we will achieve a remarkable illusion of it. The end result is those universes existing over again for each cybernaut, in which he or she is the only "real" presence, surrounded by virtual projections: a paradoxical network of solipsism. VR's philosophically idealist structure is also the basis for its radical paradigm-shifting; because it exists only for the perceiving mind, we can create impossible realities as easily as any other.

New architectures arise in virtual space, liberated from the physical laws of the real world. In the second chapter, VIRTUAL SPACE: CYBORG SYMBIOSIS, I discuss how new structures of meaning around distance and time arise, and notions of internal and external are provocatively problematized. One aspect of the dualities dissolving around us is the cyborg fusion with our tools. We are moving ever closer to what I believe is an inevitable symbiosis with computer technology. Such a fusion is the logical development of our unique relationship with the world and the devices we produce to utilize it. Freud identified three great decentering moments in history: the Copernican realization that we are not the center of the universe; Darwin's proof against creationism that humans are themselves animals; and Freud's own theory of the subconscious that showed how we don't know ourselves. According to Bruce Mazlish, we are on the verge of the dissolution of a *fourth* discontinuity: that between man and machine.[1] I discuss how virtuality is one beginning of this synthesis, occurring through our omnisexual interfacing with virtual space, the realization of becoming continuous with our tools. If the first three "ego-smashing" moments were, in turn, cosmological, biological, and psychological blows to human pride, this fourth must be called *ontological*. "[T]his change in our metaphysical awareness," writes Mazlish, "this transcendence of the fourth discontinuity, is essential to our harmonious acceptance of an industrialized world."[2]

Virtual reality also brings us closer to the *telos* of communication: lossless signification, the perfect intercourse between subjects. In the third chapter, NEW DIMENSIONS IN TELE-COMMUNICATION, by examining the history of communication as a supercession of absence, we can place VR in a chronicle of progressive dematerialization of media. Cyberspace is purely phantasmic in this sense, and this aphysicality empowers an unprecedented connectivity between the imaginary and its projection to other minds. We are moving towards what Jaron Lanier calls "post-symbolic communication,"[3] the transcendence of our reliance on translating schema that inevitably lose some intended meaning. This is not a dissolution, but a bridging of the irrefutable gap of subjectivity. After millennia of efforts to harness and control the external environment, we are turning inward: the ultimate frontier, the colonization of

---

[1]Bruce Mazlish, "The Fourth Discontinuity," in *Technology and Culture*, ed. Melvin Kranzberg and William Davenport (New York: New American Library, 1972), pp. 216-232.

[2]Mazlish, p. 230.

[3]Jaron Lanier, Interview in *Whole Earth Review*, Fall 1989, pp. 108ff.

mind and self. In our imagined worlds, we can walk through, touch, and explore the mindscape:

> "We witness the mind using its speculative power in hopes of reading beyond itself, for turning ghostly paradigms into solidly realized places — terrains in which the whole man can act, interact, and ultimately grow."[4]

Finally, virtual reality is about a fundamental redefinition of identity, the subject of the last chapter, IDENTITY: THE CYBERSELF AS MANY. Cartesian duality is not quite dissolved, as many have written, but radically confused: in cyberspace, the mind is itself embodied. How we conceive of our selves in the space of this new mode of being will certainly change. Without a physical referent, we can realize ourselves in whatever way we could possible imagine. Are our identities inextricably linked to our bodies? The Internet is an explosive foreshadowing of multimodal cyberspace, and in that adolescence we can already see the possibilities of ontological play. What happens if we see the body as more of a limitation to self-expression than the quintessence of it? How will we evaluate external appearance in a space where it is fully mutable and liquid? What will it mean to be embodied as whatever we desire, be it enhanced versions of ourselves, differently gendered, or animal? I end by examining these, and other, questions more with an eye to show the prospects of a new paradigm than to posit any definitive answers. Virtual reality will transform the human, and practicing futurology with such a subject, as it is with any topic, is a safe, but futile, enterprise.

In the last three decades there has come a technological explosion that has literally revolutionized civilization. The computer began as a number-crunching device, and has progressively developed as a tool away from that mundanity of

---

[4]George Slusser and Eric Rabkin, "Intro: The Concept of Mindscape," in Slusser and Rabkin, eds., *Mindscape: The Geographies of Imagined Worlds*, (Carbondale, IL: Southern Illinois Univ. Press, 1989), p. x.

purpose. It has become much more than a device, rather now a medium with its own unique potentialities:

> "The technology of these transformative systems fulfills a profound human desire: to transcend the limitations of body, time and space; to escape language, to defeat metaphors of self and identity that alienate and isolate, that imprison mind in solipsistic systems. Our need is to fly, to reach out, to touch, connect — to expand our consciousness by a dissemination of our presence, to distribute self into a larger society of mind."[5]

In the postindustrial ontology of digital realms, the world is repostulated as information. At base, everything becomes a stream of binary bits — but while information is the only thing a computer deals with, to us that data will represent art, money, time, memory, appearance, sexuality, speech, and space. The way we conceive of each of those things will change, each in a different way, by immersion in virtual realities.

---

[5]Roy Ascott, editorial, "Connectivity: Art and Interactive Telecommunications", Special Issue of *Leonardo* 24, No. 2, 116 (1991).

The chronicle of the effort to create reality began long ago, its exact genesis being, of course, indefinite. Human beings have a long history of struggle with the limitations of mortality, grappling with death, the passage of time and imperfection. One manifestation of these exertions is our effort towards the ultimate, the divine, the immortal. We assert our own significance in what small way we can by making a mark upon the world, leaving some trace of our passage. Creating things, making an object that has function or aesthetic value, is one way of expressing some control over the environment. The act of creation not only shows our “mastery” over Nature but generates something whose lifespan can outlast our own. In this way, and in our attempt to tap into the divine power of creation, we are seeking a transcendence of self.

The majority of the history of art has been concerned with the attempt to recreate something already existing. The point at which we moved from straight imitation to producing images or objects that used existent forms only as points of departure is very difficult to draw. Throughout most of history, however, art has been concerned with an ascension towards the real. For millennia, humans attempted to fabricate reality, to produce images that could rival nature. A “striving after likeness to nature... has hitherto permeated the whole history of the visual arts,” wrote Rudolf Arnheim. “Among the strivings that make human beings create faithful images is the primitive desire to get material objects into one’s power by creating them afresh.”[6] Nature is thus accorded the greatest privilege, an obviously worshipful posture conflating the Natural with the divine. The urge or desire of Real-ism in images is paralleled in philosophy and religion as well: in all of those fields, there is a fundamental drive towards a totality, a mastery over our own inescapable condition of mortality. In art: reality; in

---

[6]Rudolf Arnheim, “The Complete Film”, in *Film Theory and Criticism*, 3rd ed., Gerald Mast and Marshall Cohen, eds. (New York: Oxford University Press, 1985), p. 28.

philosophy: truth; in religion: God. There seems to be a conflict between truth and God on the one hand, and reality, which is associated with the actual and thus often the mundane, on the other. Reality, however, is here conceived of in an ultimate sense, and the power to create reality is clearly a godly one. In philosophy, there is usually no higher truth than Reality, for Reality is what Is.

It is difficult to state with assurance what lies behind our fascination with artificial reality; Aristotle said that we simply take a cognitive pleasure from well-executed imitation. This does nothing to identify *why* we take so much pleasure from experiencing a convincing illusion or fiction. Part of it surely is involved with our relationship to nature and the extra-mortal — dynamics of power. There is also, perhaps, a fear present, not just of our own limitations, but of the groundwork of reality itself:

> "The reconfirmation of [the realist's] conviction in an eternal, known moral order by seeing things 'come out right' is clearly of a *derived* order... Existentially, the satisfaction of realist art almost seems to be created precisely in order to extinguish the lurking anxiety that the real world is nothing in the first place but a delusive fiction."[7]

Virtual reality is certainly the zenith of representation thus far in human history, and its essential structure **— immersion through interface with computer-generated environments —** may very likely be the most effective we will ever come up with. Even as our creative powers reach the height necessary to manufacture reality, we are discovering that what we thought it was is changing.

There are many ways of looking at the history of our desire to attain the Real, and any effort to delineate a comprehensive theory is a foolish one. We can, however, illuminate the place virtual reality holds in the progression of one specific enterprise: tangibly simulating reality. This human project has been enacted in manifold ways,

---

[7]William Earle, "Revolt against Realism in the Films," in *Film Theory and Criticism*, pp. 31-32.

most of which we could not hope to discuss fully here. It is clear, also, that this history contains different approaches to the same problem, some reproductive, some imitative, some originative. Every shift in method also brought along, or was the enactment of, a shifted conception of reality, or less grandly, our relation to it. We could start all the way back with the images in the caves at Lascaux, the earliest extant example of art on earth. This first instance of creative expression was a double assertion of ourselves on the world: people were forming nature into tools, and using those tools to create representations of nature. The object of simulation soon grew to encompass not just the natural entities we saw around us, but constructs which originated in ourselves. The act of simulation became the attempt to manufacture through experience or seeming *the impact of the real*.

Around the fifth century B.C., in the arena of Greek theater, humans began to present organized, much more comprehensive, simulations to each other. Here were organized events that displayed narrative and characters in a manner designed to seem, on some level, real. Public theater evolved from the direct, experiential, and emotional ceremonies of early Dionysian and Shivaite gatherings that were oriented around the cycles of death and life and the release of spiritual energy. As tribalism developed into societies of city-states, these "mystery" ceremonies were distilled for wider audiences, organized in accord with the Apollonian character of civilization. Thus, theater in its pure sense of divine possession and becoming other was displaced by drama, specifically tragedy, and the symbolization of those moments. The same movement that occurred with other communication media — namely, from experience to representation — happened early with the development of drama. A fundamental absence informed the theatrical event, as it did all other forms of *tele*-communication. The method of imitation central to Greek drama, *mimesis*, like other symbolic schema elaborated in the COMMUNICATION chapter, is essentially an encoded information stream. That information had a cultural purpose, and because the participant became instead the spectator, the crucial experience that was now only represented had to seem as real as possible.

Although the audience, no doubt, was conscious of the contrived nature of the spectacle, it was its realism that provided the climacterical enthrallment and impact. Aristotle recognized that the illusion of reality and the (largely contingent) vicarious involvement of the audience were valuable tools for inducement of a state of *catharsis* — emotional release and purification of the soul. In tribal societies, and persisting through the subsequent annexations of civilization, catharsis is the precondition of communication of life-lessons. It is mimesis, the enduring obsession of artistic artifact, that is the vital catalyst for producing that desired condition in the spectator-subject. In the twentieth-century, media had a more powerful imprinting effect than any before, largely due to more and more complete simulation. Unfortunately, the aim of catharsis is intellectual and emotional development only in the ideal; mimetic presentation, as we all know, can be an instrument for emptier or more subversive intent. (It is the crisis of America that capitalism rarely supports attention to content.)

The new imagistic powers of computers have graduated them from the status of tool to that of medium, and digital synthetic reality, by virtue of this, could be the most effective theater ever. It is, after all, the paragon of mimesis. Brenda Laurel has written about the connection between computers and cultural needs for processes that, often using mythology as a vehicle, communicate fundamental lessons. In her book, *Computers as Theatre*, she writes:

> "Quite simply, Greek drama was the way that Greek culture publicly thought and felt about the most important issues of humanity, including ethics, morality, government, and religion. To call drama 'entertainment' in this context is to miss most of the picture. The Greeks employed drama and theatre as *tools for thought*, in much the same ways that we envision employing them [with computers] in the not-too-distant future."[8]

---

[8]Brenda Laurel, *Computers as Theater* (Menlo Park, CA: Addison-Wesley, 1991).

The overlapping of entertainment and education has reemerged in the last decade as a potentially powerful application of microcomputer technology. Much was made in the 1980s of the fun in learning that personal computers could afford, but little of the software developed was wildly successful. With virtual reality, however, the power to engage the senses more fully than any technology ever has presents revolutionary possibilities for education. In order to fully stimulate, an educational process must combine abstract and concrete, general and particular, pictorial and symbolic. Where more meaningful lessons are concerned, pathos and the emotional are often essential. According to Laurel,

> "Drama presents a methodology for designing worlds that are predisposed to enable significant and arresting kinds of actions... If we can make such worlds interactive, where a user's choice and actions can flow through the dramatic lens, then we will enable an exercise of the imagination, intellect, and spirit that is of an entirely new order."[9]

Nine years after that was written, we have tangible examples of the technology that might fulfill Laurel's vision. It must be emphasized that the power of such hypothetical techno-dramatic disclosure derives from the mimetic qualities of virtuality. Simulation of reality creates the most effective site possible for involving and effecting an individual or community. From his reading of Marshall McLuhan, Alan Kay, the man partially responsible for the introduction of psychology into computer interface design, realized that "anyone who wishes to receive a message embedded in a medium must first have internalized the medium so it can be subtracted out to leave the message

[9]Brenda Laurel, "Interface as Mimesis," *User-Centered System Design: New Perspectives on Human-Computer Interaction*, D.A. Norman and S. Draper, eds. (Hillsdale, NJ: Lawrence Erlbaum Associates, 1986).

behind."[10] With Seymour Papert of MIT's Artificial Intelligence lab, Kay worked a lot with Jean Piaget's (and Jerome Bruner's) ideas of learning as exploration.[11]

> What McLuhan was saying is that if the personal computer is a truly new medium then the very use of it would actually change the thought patterns of an entire civilization... The intensely interactive and involving nature of the personal computer seemed an antiparticle that could annihilate the passive boredom invoked by television. But it also promised to surpass the book to bring about a new kind of renaissance by going beyond static representations to dynamic simulation. What kind of a thinker would you become if you grew up with an active simulator connected, not just to one point of view, but to all the points of view of the ages represented so they could be dynamically tried out and compared?[12]

Computer technology has been used for some time in the entertainment industry with the awareness that realism is a potent draw, with the result that videogames are now one of the biggest sectors of the information-communication economy.[13] Entertainment, and its exponentially increasing palpability and assaultiveness, is becoming so pervasive that many think it will have to be conflated with education in order for the latter to have any impact at all. We should be aware that, given the distribution of funding in the federal budget, the entertainment industry might be the controlling force in such a partnership. Nintendo, in 1990, gave MIT's Media Lab $3 million to support AI pioneer Seymour Papert's work with hands-on, computer-

---

[10]Alan Kay, "User Interface: A Personal View," *The Art of Human-Computer Interface Design*, Brenda Laurel, ed. (Menlo Park, CA: Addison-Wesley, 1990).

[11]Piaget and Bruner were the best known of a loose group of psychologists who modeled the human learning process on the metaphor of exploration: our minds scientifically (consciously or not) use our senses, initially on a trial-and-error basis, to experiment with everything in the world. Claude Levi-Strauss also talked about humans practicing *bricolage*, putting objects and/or concepts together in varied combinations. Seymour Papert has been working on using the computer as a medium to make these models explicit and tangible.

[12]Alan Kay, "User Interface: A Personal View," *The Art of Human-Computer Interface Design*.

[13]Howard Rheingold, *Virtual Reality* (New York: Summit Books, 1992), p. 288.

mediated educational tools, provided he turned over everything that might be marketable.[14] The explosion of digital entertainment, and the inevitable co-option of virtual reality for that purpose, will be addressed later in this chapter.

The effort towards increasing degrees of reality in imitation leaves an explicit trace through the visual arts. Western aesthetics, since Aristotle's *Poetics*, has mostly held — until recently — that art imitates nature. Although the sculpture of antiquity was certainly realistic in appearance, I prefer the development of painting as the more interesting backdrop for discussion of artificial realities for two reasons. One of these involves the two-dimensionality of painting: its endeavor to present the illusion of depth against that inherent resistance made for a richer play of simulation. Secondly, the simulative aspect of sculptural work was limited because the status of the sculpted object didn't involve a copresent, manufactured world. Painting, as opposed to sculpture (except, perhaps, in the scarce cases of large dioramas) could present a world to the viewer where objects were situated in an environment.

One of the most important historical inflection points in pictorial representation was the appearance of concentrated technical efforts at the onset of the fourteenth century to achieve more life-like effects with paint. The Florentine painter Giotto di Bondone is widely recognized as being the first to portray more expressive faces, heightened illusions of movement, and a compelling sense of space. Giotto, and later Leon Batiste Alberti and Filippo Brunelleschi, were all seminal in the history of the human ascension towards the real, Giotto for his emphasis of three-dimensionality on a two-dimensional surface, Alberti for his scientific investigation into vision,[15] and

[14]Karl Schoenberger, "Nintendo Investing in Research on Children," in *The Los Angeles Times*, May 16, 1990.

[15]Alberti, although best known for his treatises on architecture, also produced widely influential studies of painting. He realized vision was the key to grasping reality, and dedicated a lot of time to understanding its laws. Many painters began using systematic perspective techniques as a result of his writings.

Brunelleschi for his architectural use of perspective. After the 13th century, artists couldn't paint "flat" anymore, to use Clement Greenberg's language, and the strongest art became the most illusionist.

The Impressionists brought about a perceptual revolution in reaction to the long-standing idea of art's purpose as duplicative. Industrial experience has both destroyed reality and reinforced it, because we could manufacture ersatz substitutes for nature while simultaneously discovering more about what exists through science.[16] Although it observed nature with scientific interest, Impressionism challenged the mechanical worldview engendered by the camera's ability to reproduce reality. Art should create, anti-realists then claimed, be it an interpretation, a distortion, or an autonomous world.[17] Now that photography had taken depiction away from the exclusive province of painting, art self-consciously liberated itself from recording the physical world, opening up new realms of personal and aesthetic expression.

Our comfort with such ideas reached an extreme with modernist painting, whose theorists advocated an open admission of a painting's two-dimensionality. The art work, according to that movement, should not even try to present a "three"-dimensional image. The abstract art of Malevich, Kandinsky, Klee, Mondrian, and other early modernists prefigures virtual reality by explicitly turning away from representing known nature. In architecture, Piranesi's *Carceri* (Prisons) marks the beginning of discourse on the purposefully unbuildable. Ledoux, Lequeu, and Boullée all furthered this, asserting the space of the imaginary as being more important than concerns over

---

[16]Benjamin Woolley, *Virtual Worlds: A Journey in Hype and Hyperreality* (New York: Blackwell Press, 1993), p. 4.

[17]Jonathan Crary shows us how misinformed this account is, for the Impressionists were also tapping into the same "objectivity" of sceintific processes like photography, one that is actually always *subjective*. [Jonathan Crary, *Techniques of the Observer* (Cambridge, Mass: MIT Press, 1990).]

utility or pragmatism.[18] VR, because it has no immutable laws, finally fulfills the vision of these architects by allowing the most fantastic and "impossible" architecture to be built and interacted with.

In the meantime, our relations to both reality and our constructs of reality were enriched and complicated by numerous other developments of technological and artistic nature. The most generally influential of these, one could argue, was Gutenberg's invention in 1437 of a new method of printing text mechanically. The COMMUNICATION chapter deals with various aspects of writing as idea transmission; here I am concerned with text as an effective method of creating virtual realities. The pervasive existence of literature and even journalism is testament to our need and pleasure in vital and involving fictions. Reading involves, to some degree, immersion in a fabricated environment, and in this sense its sudden availability marked a crucial point in humanity's experience with the nonreal. We enter into — and are entered by — good, involving books, or as Thomas Pavel has written: "once... fictionality is acknowledged, happenings inside the novel are vividly felt as possessing some sort of reality of their own."[19] Although it seems the very nature of literature contains such an idea, it wasn't strongly formulated until recent critical discourse did so. Literary theory, beginning most clearly in the 1970s, opened up possibilities of physically nonexistent realms having their own realities, realities which aren't necessarily of a lower order than the objective sort. This perspective is particularly close to virtual reality, for it is asymptotically close to modal realism. Carlos Fuentes writes in his introduction to *Don Quixote*: "reality is invaded by [fiction], loses its own defined frontiers, feels itself displaced, transfigured by *another* reality made of words and paper."[20] Fuentes'

---

[18]Marcos Novak, "Liquid Architectures in Cyberspace," in *Cyberspace: First Steps*, Michael Benedikt, ed. (Cambridge, Mass: MIT Press, 1991), pp. 245-246.

[19]Thomas Pavel, *Fictional Worlds* (Cambridge, Mass: Harvard Press, 1986), p. 11.

[20]Carlos Fuentes, "Introduction," in Miguel de Cervantes, *Don Quixote de la Mancha*, trans. Tobias Smollett (London: André Deutsch, 1986), p. xvi.

comment draws attention to *Don Quixote* as representing a definitive transition from medieval certainty to a world where all things are possible — Don Quixote explicitly asks the reader to believe in him.[21] In the modern world of wide open possibilities, actual and imaginary lose their dichotomization. Or, as Jean Baudrillard and J. G. Ballard argue, reality is becoming fiction, and it is the writer's capacity and task to invent both.[22]

Human beings are too visually oriented to be satisfied with text as the zenith of simulation, however, and as a result history shows a technological obsession with illusion from the nineteenth century on. In 1833, Wheatstone finished his breakthrough stereoscopic viewer, a device that fooled its user into thinking he saw a three-dimensional scene in front of him. Even at this early point, we can identify a divergence from previous means of depicting artificial realities (pointing us back to the theatrical tradition): increased use for entertainment purposes. Wheatstone's invention was highly successful as home amusement, and its popularity in that area led to a chain of improvements and other inventions.[23] The most compelling simulacra humanity could devise turned out to be the cinema, and it has remained so for the last one hundred years. The screening of images, not coincidentally, is also one of the biggest sources of entertainment in the world.

On December 28, 1895, one of the apocryphally accepted birthdates of motion pictures, the Lumière brothers projected a filmstrip called *L'Arrivée d'un train en gare*.[24] Something remarkable happened: spectators in the basement room of the Grand Café in Paris (the first movie theater) saw a train coming towards them and most of them

---

[21]Woolley, *Virtual Worlds*, p. 168.

[22]see Jean Baudrillard, *Simulations* (New York: Semiotext(e), 1983) and J. G. Ballard in *Re/Search #8/9* (San Francisco, CA: Re/Search Publications, 1978).

[23]Rheingold, *Virtual Reality*, pp. 64-65.

[24]Gerald Mast, *A Short History of the Movies* (New York: Macmillan, 1986), pp. 20-21.

shrieked and took cover. The moving image, this expressly demonstrated, was an incredibly convincing spectacle, two-dimensional or not. Film has been the dominant medium of simulation since then, and has evolved into a powerful and complex cultural force and mirror. Virtual reality technology has eclipsed film in simulative effectiveness, yet the discourse around film is still quite valuable to the oncoming paradigm. From its origins, the medium offered not just the power to reproduce existing objects, as photography did, but also to produce a kinetic, breathing "fictional reality." The paradox of that last phrase has been the topic of much writing in film criticism, and has emerged as a crucial issue of postmodernity. The term "virtual reality," of course, is another recasting of the same contradictory concepts, and what it entails is in many ways their culmination.

The film industry has been engaged in a continuous series of technical augmentations designed to keep audiences attracted; every one of them offered fuller simulation. First sound, then color, then 3-D, then Cinemascope, later, 70-mm, IMax, and Omnivision; all were designed to increase the thoroughness of film's illusion of reality. The success of these developments, but especially of the first group, was sometimes due solely to their newness, and the initial impact of their extra dimension of realism.[25] There is an important distinction between the two groups, for past a certain point, there wasn't much more in the way of surface effect or dimensionality that could be done. After Scope, the larger-format enhancements were pointing towards an effect which foreshadows a pivotal ingredient of virtual reality: immersion.

Back in 1955, a minor cinematographer and inventor named Morton Heilig had a grand vision for the direction of the film industry, which he believed was at a standstill. The most effective enhancements of sound, color, and wider screens were already

---

[25]3-D is a slightly different case than the others, for it came and went as a device for heightened realism; *The Third Dimension Murder* (1937) was the first 3D movie, but the real boom came after the 1952 film *Bwana Devil*. By 1954, Cinemascope's wide field of view had already replaced 3D as the focus of film evolution. [Mast, Film History, pp. 278-280.] Interestingly, 3-D is making a minor comeback in film via the VR-inspired headset use in Sony's new Manhattan IMax theater .

realized. Heilig recognized that the next plateau for motion pictures lay in the involvement the audience had with the images: in other words, interactivity. He had a key insight, which seems obvious to us now: when you watch a screen, it functions as a window into a reality, but when it expands and surrounds you then you're *part of it*. He published his plans for an "Experience Theater" in 1955 where he outlined these ideas, but no one was interested enough to fund him.[26] So he decided to build a prototype on his own, and set about assembling the "Sensorama Simulator," which he got patented in 1962. It used a stereoscopic filmstrip projected in a viewer that a seated viewer looked through, who, holding on to projecting handles, felt somewhat like he was riding a motorcycle. The Sensorama provided a complete virtual experience: sound, vibrations in the seat and handles, breezes, even smells pumped out through small grilles. The user/viewer (those terms were now blurred) took a ride down a Brooklyn street, a spin in a helicopter, a bicycle trip, and an encounter with a belly dancer (complete with perfume).[27]

Heilig had truly remarkable foresight; he had all the ideas for virtual reality decades before the rest of the world, even down to educational and industrial training possibilities. Unfortunately, he never got anywhere with his vision; funders backed out (a few got killed in freak accidents), his Sensorama couldn't withstand arcade abuse, proponents in influential positions got fired. His 1971 publication "Blueprint for a New Hollywood" was ignored, but it could have been the beginning of the VR industry.[28] (If he had some connection with the U.S. military, things might have turned out differently.) Because of Heilig's bad luck and the timing of his inspirations, virtual reality's material nucleus emerged, not from film, but from digital computers, despite the fact that movies were the leading industry of simulation.

---

[26]Rheingold, *Virtual Reality*, pp. 49-60.

[27]Leonard Lipton, "Now Step Into a Movie: Sensorama," in *Popular Photography*, July 1964, pp. 114-116.

[28]Rheingold, *Virtual Reality*, p. 60.

Just as art had redefined itself by moving away from representationalism, an analogous strand of thought came to film that held that it was futile for cinema to attempt to totally reproduce reality. Film came to be viewed as a medium that should produce its own unique space of existence, one that needn't have a direct relation to physical reality. Rudolf Arnheim, to name just one, held that the properties of actuality cinema cannot capture are precisely the basis for its artistic potential.[29] The issue was more complicated in some ways than it had been in the past: the majority of motion pictures relied on realistic effect for its impact, but on its fictional elements for appeal. The polar conceptual approaches of its earliest pioneers, the Lumière brothers and Méliès, illustrated perfectly the differing possibilities of film. The former favored a one-to-one portrayal of reality, a pure simulation of actual events. Méliès, on the other hand, found the potential of film to lie in the manipulation it afforded. His approach was more exclusively cinematic, emphasizing how the medium enabled the impossible to (appear to) happen.

It is the intersection of the realistic and formative tendencies that makes film so complex, for, as V. F. Perkins put it, "the cinema extends across the whole of the area between the two extremes... [A]ny attempt to isolate either in a 'pure' state becomes correspondingly inept."[30] One of the unique attributes of film that is neither formative nor quite realist is its ability to show different, normally inaccessible, views of objectively real events. Examples of this include such debatably nonrealistic techniques as slow motion, time elapse, and super close-ups. Just as realistic film can reveal more of reality than we could otherwise have seen, virtual reality promises a similar, but even more powerful, augmentation of our native senses and intellect. We can experience mathematical information recast in visual, kinetic terms, or "feel" molecular forces as

---

[29]Arnheim, "The Complete Film," pp. 26-30.

[30]V. F. Perkins, "Form and Discipline," in *Film Theory and Criticism*, p. 44.

they interplay with one another. This important area of virtual reality technology is discussed in the chapter on VIRTUAL SPACE.

Perkins, however, believed that film must retain a relation to the real world it depends on for effect. Here we find several useful points of departure to discuss how radical a development virtual reality is. Perkins writes that our belief in images is grounded "in the actual (if past) existence of the objects on the screen... [for c]learly, one cannot record something which has never existed."[31] Digital rendering technology completely nullifies this statement, for it is capable of producing images that need have no basis in anything actual, nor in any physical laws governing what is possible and what isn't. Given the requisite levels of resolution and a skilled 3D modeler, anything imaginable can be rendered and animated, *indistinguishable* from reality. In fact, with randomizing algorithms and texture mapping, the computer can produce objects that we *couldn't* imagine without it. Technically, Perkins' point about recording still holds, for the objects digitally manifested exist only virtually; their appearance is never a registering of something "actual," but rather a continual recreating. It is this perpetual recasting of all, or part, of a depicted environment as synthetic form that makes the idea of recording moot. As Perkins emphasizes, the central issue is that of belief, and VR can achieve startling credibility.

It is not just visual authenticity that provides the realism of virtual reality; much of its impression is due to its properties of interactive immersion. These affordances enact a profound shift from all other technological and artistic visual phenomenon. We are currently in the midst of a rapid growth in intermediate technologies (and conceptual schema) that incorporate ideas of interactivity. Full-scale virtual reality is not quite inexpensive enough yet to be mass marketed, although products with some connection to the industry are coming out with increasing frequency. The past few years, and perhaps the next twenty, will see a proliferation of entertainment technology

---

[31]V. F. Perkins, "Form and Discipline," pp. 48-49.

which constitutes an intersection of film, videogames, and VR. It is usually called "interactive media" or something equivalent, and it combines previous methods of representation with new ideas of viewer participation. This new genre is also looking ahead to future technology for its real blossoming, and as a result is prompting huge investments in research and development. The entertainment industry is aggressively defining one of the biggest and fastest growing areas of VR because it has the sheer financial weight to do so. Disney has its "Star Tours" simulator, Industrial Light and Magic makes a similar amusement environment called "SpaceRace," VR game-spaces like "Battletech" and W Industry's "Virtuality" are cropping up all over the place. All of these games/rides create a sense of presence in the depicted world, providing the feeling of immersion crucial to virtual experience. Some, like Disney's ride, are fairly passive, but the other games allow the players to control their own characters or vehicles in a virtual space inhabited by other players. The business is getting so big that Hughes Aircraft has formed a partnership with LucasArts Entertainment to apply all of its flight simulation technology to the creation of entertainment systems.[32] A company that makes real airplanes is diverting itself to make computer simulations of real airplanes for mostly teenage boys to play (and spend money) in: Baudrillard couldn't invent a better example of the postmodern condition. Sega built its own multimedia production studio to release its *Jurassic Park* game at the same time as the movie, and added CD-ROM drives to its home systems. MCA has a grand plan (directed by Alex Singer, former TV and film director) for a "voomie" theater that will have two full participants, an emcee, and 36 spectators/partial participants.[33] Sony Theaters have just opened something called "InterFilm," which appears to be a film the audience can interact with through joysticks in each seat (I saw an advertisement for it in *The New*

---

[32]Ken Pimental and Kevin Teixeira, *Virtual Reality: Through the New Looking Glass* (New York: Tab Books, 1993), p. 215.

[33]Pimental and Teixeira, *Virtual Reality: Through the New Looking Glass*, pp. 221-223.

York Times in the last week of April of this year). Cinema and simulation are converging finally, just as Morton Heilig urged almost 25 years ago. The advantages of full immersion and control a head-mounted display offer, however, might make these developments short lived. It remains to be seen if what seems to be an optimally individual technology can be adapted to retain some sense of community. Movie theaters already have a curious tension between a desired collective viewing experience and the intrinsically asocial absorption in the screen. True virtual reality entertainment will synthesize all of these aims, for each player-participant will have individual viewpoint and control while projectivally existing in the same space with other players.

The movement from the role of participant to that of spectator brought about by the growing public sphere and the disembodiment of communication technologies, is effectively reversed by virtual reality. On an abstract level, the estrangement from experience informs much of the alienation contemporary society suffers from. This type of alienation is the focus of recent writing by thinkers like Jean Baudrillard, who find postmodern society to be ever more distant from genuine existence. Earlier thinkers like Heidegger also were concerned over what could be called alienation: in Heidegger's language, Man's downfall into inauthentic being. Karl Marx identified alienation as occurring on four levels: man from his own products, from the activity that produces those products, from the natural world he lives in, and from other men.

Technology could be, and often is, implicated with all of these variously named dividing movements. Twentieth-century media and urban life produce multiple sorts of alienation: prosthetic interaction through phones or with surrogate machines produces alienation from other people; we encapsulate ourselves in cars, offices, boundaried homes; we buy imitation foods and fabrics for "convenience." The development of simulative technology, in its quest for the most realistic effects, has brought with it an increased detachment of the subject. As simulations improve technically, the general alienation from the natural world they contribute to becomes more widespread. Some of this is due simply to the saturation of spectacle the modern individual is exposed to. Yet there is also a packaging of reality, a consumer-culture conception of simulation as entertainment. Entertainment is something the bourgeois could afford because of the leisure time spawned by the Industrial Age, and imitation in its various forms was popular amusement. Simulations such as those offered by theater or film, but also entertainment in general, was a luxury commodity, although its ubiquity soon called this into question insofar as luxury connotes exclusivity or rarity. Activity classified as leisure, exacerbated by the massification of its forms, as Thorstein Veblen has shown, is accompanied by an association with passivity.[34] The passive audience, however, although displaying considerable tolerance for formula and trope, also demands ever more stimulation. Capitalism, in part through its immobilization of the consumer (both physical and spiritual), must also yield to the demand for the new it creates, and the ensuing exponential speed of habituation.

Virtual reality is the latest technological feat inspired by our heightened expectations. (There are, naturally, many other factors involved in driving VR technology, see APPENDIX.) Interactivity is more than another level of simulacra; it involves the spectator transcending his passive role and thus redefining the status of external and internal, subject and object. The new cybersubject is inserted into the virtual spectacle, which is transformed into environment by his discursive presence. Although virtual reality creates the spectacular like nothing else before it, at the same time it seems to be a definitively progressive step from the current glut of passivity engendered by modern media. For the first time, perhaps, since he was a participant in tribal ritual, the subject is immersed on the level of direct experience. (VR is also discussed in the COMMUNICATION chapter as potentially dealienating through the new sociality it creates, seen in embryonic form on the Internet.) The experience, moreover,

---

[34]Thorstein Veblen, *TheTheory of the Leisure Class: An Economic Study of Institutions* (New York: Modern Library, 1934).

is centered exclusively around him, as opposed to intermediate massified forms like sporting events that assume crucial entertaining, pedagogic, or mythologic roles. Before interactive media, all film could do was "offer enough of reality to make the spectator disregard what is missing... [but t]he primitive magic which creates belief in the real presence of the object shown soon loses its power."[35] It is the organization and articulation of virtual realities around the cybersubject that transcends what Perkins called the "inevitably short-lived" illusions of cinema's augmentations. "[T]he only sort of belief which we can regard as truly complete [is when] the audience was made to react to the image as it would to the event."[36] The immersive aspects of VR systems further relativize the belief Perkins speaks of. Virtual reality is event, not just image. We don't need to believe in the actual presence of objects, nor in their ever having existed; the only thing that matters is their reality relative to us. This reality, of course, is stripped of traditional requirements for existence; actuality loses it privileged meaning.

Virtual reality could also be said to produce an even *more* profound alienation from experience because in it we are surrounded by total artifice. Most philosophical concern over a movement away from authentic experience has equated experience with the natural, and thus with the Real. As an ultimate simulacra, VR both fulfills the worst fear of such concern and also problematizes the very foundations of the questioning itself. For if the reality we experience in cyberspace is in every way convincing, is it defensible to maintain a hierarchy of Real? This taps into a lengthy and much-traversed field of interrogation, and ends up hinging on personal metaphysics. One section of this field is the debate between realism and idealism. The central issue there is over which is more fundamental between materiality and mind. The realist position would be to declare the physical world as superior to the virtual even if there was no sensible or

---

[35]V. F. Perkins, "Form and Discipline," p. 47.

[36]V. F. Perkins, "Form and Discipline," p. 47.

phenomenal difference between the two. The existential idealist, although not necessarily denying a primacy to the offline world, might claim that virtual realities have as much reality as any other.

Even if realism is correct in identifying material objects as having existence without mind, this asserts nothing because the very structure of the reality question is attacked by virtuality. A Derridean deconstruction is appropriate, for asking which is more real imposes a metaphysical, totalizing value of Truth on the real. The question is not, is there a primordial reality to objects in the offline world, or even if there subsists a higher Truth in them — but rather, does it matter? What are our criteria for the importance of the Real? In posing the earlier questions, we are assuming the posture of the most naive and/or hopeful metaphysicians. To put it in Presocratic terms, we are engaged in a meaningless search for an *arché*, that, even if found (and modernity seems to tell us this is impossible), would make no difference. If we take any empirical criteria for reality, such as those of observability, causal efficacy, and fulfillment of expectations, we find that virtual reality satisfies them all. A physicist might argue that there are no natural laws informing the behavior of virtual objects, that all of their properties are purely phantasmic. This proves something only if we accept materialistic metaphysics; again, if we postulate a virtual system that immerses completely and seamlessly, it wouldn't matter that there was no higher authority to its laws. VR can provide an empirical reality as strong as the one we've been used to, but a condition of absolutely undetectable simulation is not necessary for this argument; as long as cyberpresence is convincing, the virtual world has its own reality. As Dr. William Bricken, co-founder of Autodesk's virtual reality program, has said: "Psychology is the physics of VR... Realism is not necessary."[37] The essential point of all of this is that we must remove the totalizing assumption that new realities must conform to the standards of an older model. As much of the theory alluded to in this chapter has asserted, reality is no

[37]Quoted in Pimental and Teixeira, *Virtual Reality: Through the New Looking Glass*, p. 160.

longer unitary, but multiplicitous — and now VR can concretize those alternate realms for the first time.

The apparent actuality of high-resolution virtual worlds illustrates how the quality of realism does not derive from a metaphysical unity, but rather is created by the perceiving mind. Material objects have no more existence than virtual objects do (one could say); it makes sense to speak of them only in their relation to being apprehended. Ultimate reality, simulation shows us, does not lie in objects themselves, for they do not exist in-and-of-themselves. Like Borges' Tlön, VR is a world of non-objects, whose reality is perceived but exists only as each individual wants them to. "The world for them is not a concourse of objects in space; it is a heterogeneous series of independent acts... mental processes which do not develop in space but successively in time."[38] Virtual reality seems to contain things and space and cause and effect, but these subsist only by the "independent acts" of perception. Those acts are what bestow reality on simulation programs.

Immaterialist idealism is thus evoked by virtual reality, although perhaps more as an exercise than anything else. The philosophies of Berkeley and Arthur Collier, for example, both deny the existence of a material world. Virtuality embodies this viewpoint, for all of its structures are entirely aphysical. Believing in the materiality of virtual objects is, in point of fact, a self-delusion. All that we perceive does indeed have *percipi* as its *esse*, as Berkeley put it; moreover, all objects are exactly as we apprehend them to be. There is no indirect or mediate knowledge of reality as materialists believe — all sensation in virtual reality is constructed as such. Virtual objects are assembled entirely for the perceiving consciousness, and thus have no essence or truer reality which can be only imperfectly grasped.

---

[38]Jorge Luis Borges, "Tlön, Uqbar, Orbis Tertius," in *Labyrinths* (New York: New Directions Publishing Corporation, 1964), p. 8.

Because the structure of our interpretative understanding is built into the construction of virtual worlds, this puts us in a position to problematize dualistic epistemologies. Kant's view that world-knowledge is impossible without the activity of consciousness synthesizing sensations under the rubric of the categories presents no immediate conflict. This belief, however, presupposes an unknowable material reality that the mind tries to interpret, and on the surface virtual worlds have no such reality. VR is purely phenomenal; its objects are conceived and constructed as phenomena, and then apprehended as such. Or, alternately, there are only noumena in virtual reality, for one's perceptions are of objects-in-themselves, exactly as they are. It would be hasty to end there, however, for the nonexistence of a physical structure in cyberspace is not the same as a total absence of existence apart from consciousness. Insofar as it is undeniable that we have created the simulated objects in virtual systems, they have some existence before being perceived. Separate from the cybernaut's mind, those objects are at base streams of 1s and 0s, although it is hard to say what meaning that has without an intelligence to define it. With this in mind, Kantian phenomenology could be reinstated, for one could describe the foundational datastream as the equivalent of noumenal reality. The crucial difference, of course, is that whereas in the real world we assume noumena to have as much, or more often, greater reality than our phenomenal experience, in virtual reality, the so-called noumenal level has no such privilege. More pointedly, on the level of data, there *are* no objects or things, thus making it problematic to say that anything corresponding to what we perceive subsists in-itself on a pre-cognizance level. Virtual objects can be discussed in a common-sense way as having autonomous existence, but the mind is clearly essential, and thus primary. This brings us closer again to a nonabsolute, objective idealism, that is, asserting consciousness as fundamental without holding that there is *nothing* other than mind.

A curious Platonism inheres in the relationship between virtual entities and the actual things they simulate. The objects in physical reality are the equivalent of the

Forms, while the virtual objects are the sensible shadows of those. Assuming the virtual entity is attempting to approximate something actual, we can say that the simulated version does not have the same fullness (reality) as the original. But for Plato, the Forms are more real because they are apprehended by the intellect, do not exist in time, and cannot come into existence or cease to exist as temporal things do. All of these attributes, however, belong to *virtual* objects. Thus, in a strange reversal of Platonist metaphysics, virtual entities are qualitatively closer to Forms than actual ones. There is one exception or caveat to positing the virtual as Platonically ideal: the virtual can come into existence, for it is created. However, although the virtual can also be erased, the digital is inherently deathless. Not only will it exist forever, but if a virtual object is destroyed a copy of its data can enable a perfect reincarnation. In addition, virtual reality allows us to construct objects without imperfections, in fact, makes mathematical perfection more normative than unnatural. Geometric forms (and all others) exist as pure number in a virtual system, and barring viruses and system crashes, are immortal and without decay. All of virtuality can thus be thought of as Platonically ideal yet paradoxically possessing many of the irregularities of sensible reality. To use Plato's favorite ideal object, the sphere, as the basis of a metaphor: The metaphorical obstacle between man and apprehension of the Forms he has virtually present to him is the pixel. As long as there is a visual unit distinguishable in a curvature, there can be no seamless perfection, spherical or otherwise. The computer holds the pure, mathematical formula for the object, yet our display systems, the sensible level, are not sophisticated enough to give us enlightened access.

Other metaphysical structures such as space and time are not present as such anywhere in binary data; those ordering concepts are necessarily imposed by consciousness to make our perceptions coherent. Kant's categories of the transcendental self apply are rather explicitly illustrated in virtual reality. Even if certain behavior patterns based on time are programmed in to virtual objects, that is reducible to more or less arbitrary binary data like everything else in the system. There is nothing absolutely present about Time in a series of 1s and 0s (an argument against this is dealt with below). Given these points, virtual reality might illuminate something about the real world philosophically. Constructed, or simulated, reality shows us how the mind can bring categorical concepts to bear on our perceptions of a world-structure that was built without those concepts. In other words, even though we never build any such essentially existing fabric, we perceive and act as if it is present. This lends support to a refutation of totalizing metaphysics in the real world, for we could analogously be imposing non-existent structures on physical reality. It would be valid to argue against this that Kantian categories are essentially present in virtual reality because it is built by people who cannot do anything without their "space-time glasses" on. Despite this, it is not certain that space and time exist inherently in VR, for those concepts, as just mentioned, are only data and are therefore in essence meaningless. Furthermore, spatiality and temporality both are completely liquid in virtual reality, that is, are able to be manipulated, reformed, or removed. The definition of metaphysical concepts does not usually include the ability of mortals to play with them.

There are significant differences between space and time in their existence, or non-existence, in the virtual mode. Time does not seem as mutable as space in VR because it is a structure that is usually thought to be impossible to escape. Space, on the other hand, is utterly not present in virtual reality, at least in terms of the perceptual illusion of phantasmic cyberspace. Although time transcends even virtual realities (i.e. time passes no matter what the virtual clocks say), it doesn't have an existence in VR equivalent to its traditional one. Motion can be speeded up or slowed down, or even reversed. Events which have "already happened" can happen again, with the same or different outcomes. Experiences can be replayed with all of the sensation of the original occurrence. This would seem to depend on everything being recordable, in which case, the fact that the events took place in the past can not change. Although this is true, the passage of time is then only meaningful in terms of memory or perception, but not for objective "reality." There are no real objects to be changed; anything that is different as the result of an event is not irrevocably so. Nothing gets older in virtual reality, not even people. We must not overlook the possibility that VR systems will be configured in such a way as to make events and object-transforming repercussions irreversible. Furthermore, our minds are altered by our experiences, whether those experiences are virtual or not. Insofar as change of any kind has some notion of time inherent to it, temporality cannot be transcended in virtual reality, but it can be mutated.

The ideas of another seminal idealist philosopher, Gottfried Leibniz, form several interesting parallels with the metaphysics of virtual reality. Leibniz' monadology defines the universe as being composed of independent, immaterial entities that exist as pure will. Monads are essentially active, yet have exclusively mental lives and never come in direct contact with each other. The subject in virtual reality is monadic in that it is without physicality and exists only as perception. Leibniz' monads "see," as does the cybernaut, a continuous procession of representations rather than so-called things themselves. No substances other than monads really exist; likewise, in virtual space, the only real entities are the consciousnesses that inhabit it. Just as with monads, virtual selves never meet physically, never actually touch each other's bodies. Monads and cybersubjects both see the world from a perspective different from that of other monads or cybersubjects, yet the differences in perception have nothing to do with physical position. What the unit (monad or cybernaut) sees is determined by its appetitive impulses, which shift the focus of the stream of representational experience. The unit lives out its detached, individual existence while still interacting with the representations of other units. Michael Heim writes that Leibniz' God, "we could say, is the Central System Operator (sysop), who harmonizes all the finite monadic units.... Thanks to the Central System Monad, each individual monad lives out its separate life according to the dictates of its own willful nature while still harmonizing with all the other monads on line."[39] Although I appreciate his analogy, I disagree with Heim on two points. The first of these is largely inconsequential, concerning the obvious differences between a system operator and Heim's hypothetical Central System Monad: no system operator knows everything about all users, and there will never be just one sysop in cyberspace. The more important contention I want to make concerns Heim's presupposition of a unified network that all monads would comprise. It is central to Leibniz' system that every unit represents the same world, albeit from a different point of view. Virtual reality, however, will not be one all-encompassing network that every entity will be connected to (although there might be a metanet of sorts subsisting in the web of lesser networks). Multiple worlds are possible and inevitable in VR, inhabited by many, few, or none. Some virtual universes will be inaccessible by most units. There can be no one "virtual reality" that is the only world, let alone the best of all possible worlds.

The reflection of the entire universe in each unit is one of the more famous characteristics of Leibniz' monadology. Each microcosm contains the macrocosm, or rather, each mirrors the whole cosmos from its own point of view. This structure is rather interestingly literalized with virtual reality systems. In a shared simulated environment, each subject sees the world through his or her computer-headset system. The data of the entire world can exist in every subject's system, represented differently in each one. The world data is manifested according to each cybernaut's point of view, yet all share the same space, not physically, but psychically. The system user, like the monad, doesn't need to be able to actually see the other units (or have windows, in Leibniz' language) for all actions and existences are mirrored in the virtual incarnations present to the user/monad. As I just mentioned, all of this does not mean all of virtual space will be reflected (digitally compressed) in each user, for there will be numerous worlds.

---

[39]Michael Heim, *The Metaphysics of Virtual Reality* (New York: Oxford University Press, 1993), p. 99.

An additional, more esoteric, connection between Leibniz and virtual reality lies in his tripartite categorization of monads. The three types he distinguishes are bare, animal, and rational. This point concerns the first, and in some ways, lowest of those: bare monads, which have perceptions like all other monads, but only unconscious ones. What we call physical objects, like rocks or chairs, are examples of bare monads. It is difficult to imagine what Leibniz was thinking of when he claimed that such things have perceptions. One approach to illustrating a way of looking at this claim is to imagine a virtual world that contains some nonsentient objects. In virtual reality, we can assume any vantage point we choose, including that of a chair. We could see from the virtual geographical spot the chair occupies, as well as review all events that ever took place in that space from the chair's perspective, condensing or editing the timeline if we wished. Thus we would assume the spatial and temporal standpoint of that object. This does not, of course, let us know anything about what it's like to be a chair, or any other bare monad. But inhabiting its perceptual locus, though it has no consciousness to process anything, does provide a (admittedly crude) game-device for imagining how it might still have perceptions. Everything has a point of view in virtual reality.

Virtual reality, I think, leads us philosophically to a phenomenalist view that is ends up being reducible, in more ways than one, to solipsism. In any computer-generated world, the environment view is rendered according to one dimensionally-specified point of view. What is cognitively resolved as motion by the user is actually a continual re-drawing, a literal refiguration, of the virtual world. Transferring from one dataspace to another, or between multimedia modes, is accomplished by the system restructuring all relevant information around the subject. Thus, the environment is perpetually brought *to* the observer/participant. The subject does not move, but a series of numbers representing the world's relationship to the subject fluctuates as certain physical actions are translated by the system. All space is rendered for one subject; he or she is surrounded by worlds whose visuality and tangibility exists solely for that subject. As I have just shown, virtual reality can thus be seen as inherently idealistic, existing only as a perceived phenomenon. This is problematized, however, by the existence of a network or metamatrix which holds the properties of its components — and records changes enacted by others — whether the user is jacked in or not. Still, virtual worlds have no existence physically, subsisting entirely in the illusion the user constructs for him or herself. Without the subject, virtual reality is a meaningless binary stream that a computer arbitrarily translates. We could interpret the seated user with a head-mounted display (HMD) on as the ultimate image of solipsistic self-absorption.[40]

There is no question, I think, that visual media like film, television, and video games are endangering the distinction between real and fictional. The rise in violence in America is not coincidentally linked with the meteoric multiplication and intensification in screen violence, although the relationship is causally reciprocal. The television is so insidious because it presents obviously fictional sitcoms, so-called reality (news), and hybrids such as commercials and docu-fiction shows like *Cops*, all in the same frame. It seems we are especially vulnerable because imagistic culture is so entertaining. Humans born in the video age, who are exposed to screen images from birth on, have both a shakier demarcation of real and, on the other hand, a more demanding appetite for the realism of special effects. Humans naturally believe what they see, unless otherwise learned. Yet we aren't convinced as easily as we used to be.

Computer-generated realities have repercussions on a general scale for the reliability of images. Now that computer manipulation is potentially invisible, the alteration of otherwise "realistic" images has a much greater deceptive power. This is especially true because there will not be spaces as clearly defined as the cinematic for the presentation of realistic fiction. The magnetism and seductive qualities of film show

---

[40]Woolley, *Virtual Worlds*, p. 9.

how we can lose ourselves in a constructed reality, but that reality is a provincial one. There is a bleeding over, of course, and that fact should alert us to the potentialities of VR. Our culture already displays mind-numbing acceptance of any image, especially television, and is mostly ignorant of the manipulation all images undergo, being concerned only with the final product. Even the film audience, who is conscious of the medium, is not always of the means behind the image, and thus still has a distorted view of the reality, or irreality, of what is on the screen. What happens when the context of spectacle is not one of construct or artifice?

The human race will develop an increased skepticism to visual images as a result of exposure to computer-shaping, but to what extent is impossible to predict. It is obvious that we look at images with a more critical eye than we did 100 years ago in the Grand Café basement; the question is how far our instinctual acceptance of the visual (but really of reality as a set of environmental stimuli) will be scaled back by an evolution of consciousness. According to Paul Saffo, research fellow at The Institute for the Future in Menlo Park, CA:

> "By decade's end, we will look back at 1992 and wonder how a video of police beating a citizen could move Los Angeles to riot. The age of camcorder innocence will evaporate as teenage morphers routinely manipulate the most prosaic of images into vivid, convincing fictions. We will no longer trust our eyes when observing video-mediated reality."[41]

If new ontologies of real are created by virtual environments, is the (old) Real thus demoted? There is a distinction between not assigning as much meaning to traditional reality, and not assigning as much importance to it. I am discussing the latter here, and by it I mean that actuality, that is, the offline physical realm, might come to have no more status than any cyberspace. This does not mean we will lose respect

---

[41]Paul Saffo, "Hot New Medium: Text," in *Wired* 1.2, May/June 1992, p. 48.

for the spatiotemporal conditions of offline reality; any collision with a moving vehicle would reinforce that effectively. But non-programmed surroundings and the immutability of distance or time will merely be aspects provincial to the realm of actual. If the bulk of our social interactions, our entertainment, our finances, our learning, and our art all take place in virtual realities, those will become the most important. With this said, I should add that I don't think humans will begin to exist solely in the virtual. (If teledildonics is perfected, however....)

We must ask: can virtual reality ever seem *totally* real? Have we realized what André Bazin called the myth of total cinema, which has indeed "prompted the appearance of the mechanical arts that characterize today's world"?[42] Blaise Cendrar once outlined a hypothetical, cinematic scenario of two scenes of Mont Blanc: one real, the other studio. He maintained the real one contains certain "emanations" which give the film a soul; these intangibles resist duplication. We are in a position to refute this, although a definitive proof would always be elusive. The question remains: How real can we get?

[42]André Bazin, "The Myth of Total Cinema," in *Film Theory and Criticism*, pp. 21-25.

The terms “virtual reality” and “cyberspace” are often conflated; the distinction that should be articulated, I think, is that whereas cyberspace serves as a wide-ranging metaphor for the aphysical realm of information, VR indicates a simulated environment that is made present to the senses. Virtual reality attempts to make concrete what is only abstract in cyberspace: all of virtual reality is cyberspatial, but the reverse is not necessarily true. Both terms indicate nonspaces of pure information, but VR manifests data as visual images and sound — palpable environment. The critical feature of a virtual reality is its interactivity: a cyberspace one can move through, explore, manipulate.

Cyberspace, in its most general sense, “grew” as data began to speed around the globe, first along telephone lines, and then along its own dedicated lines or satellite beams. The idea of “growing” intentionally leaves indistinct the existence of cyberspace before it had arisen as an idea. It seems to have existed before conceived of as such, its genesis being in the first transmission of meaning along physical pathways that had only arbitrary relation to the message’s content. One might say that smoke signals transmit meaning over great distance, so in that sense the message (not the puffs of smoke), while traveling, is some cyberspatial realm. To some extent this is true, however, the meaning-carriers in smoke signals are able to be physically placed, whereas bits of data, for all intents and purposes, have no tangibility. Moreover, entities in cyberspace can interact with other entities, travel to other places via pathways their originators never know, and can mutate and reproduce in unknowable ways.

When the computer enabled other data-entities to inhabit the ethereal space of information transfer, our conception, or awareness, of it, grew. Cyberspace, however, does not adhere to antiquated Cartesian definitions of “space.” Virtual space has no physical geography (although it would later develop a geography of some kind), so the metaphors we assigned it were — and are — often limiting and occasionally misleading. The telegraph and telephone, through their near-instantaneous transmission of electrical current, made distance an almost moot factor. The communication tools which appeared along with microcomputer advances — cellular phones, pagers, and, more recently, Newtons and other PDA's (Personal Digital Assistants) — brought the relevance of geographical location further into question. Phone conversations and bank transactions, we might say, both "take place" in some realm within microprocessors and/or cables. (The development of these technologies of interchange is discussed in the next chapter on *TELE*-COMMUNICATION.) But to think in those terms is not to evolve out of old paradigms. Its not that the bits of sound or data have no physicality, they do; however, their *meaning* as voices or transactions or images, does not. Now, with faster and more powerful PCs and high bandwidth cable networks, human postindustrial societies are moving deeper into what Michael Benedikt calls the "permanently ephemeral."[43] Telecommunications technology has drastically reduced the assertions of those ancient adversaries of mortal beings, Space and Time, and virtual reality is continuing that millennia-old project. Cyberspace is not only defined by the unlocatability (unknowability) of a physical place of interchange, but by this division between meaning and its carriers. Meaning must, and does, have its own realm, and this realm is completely without analog in a physical conception of the universe. This description, of course, could be accused of itself being dualistic, although I would posit (in line with what many others have suggested) that cyberspace is in fact some kind of tertiary realm, an intersection or overlapping of tangible and immaterial that is neither.

[43]Michael Benedikt, Introduction, *Cyberspace: First Steps* (Cambridge: MIT Press, 1991), p. 11.

Allucquère Roseanne Stone has written that she finds it odd that virtual space is most frequently visualized as Cartesian.[44] This fact is not just technological conservatism; it makes perfect sense, in the birth of a new paradigm, to utilize our most intuitive methods of absorbing information. Humans have always experienced space as being three-dimensional, with incredibly sophisticated tools of navigation and depth perception. Using a Cartesian visual vocabulary takes advantage of these hard-wired abilities. There is no question, however, that the tendency to delineate new paradigms in terms of old is at play here. As we get used to the absence of physical laws in simulated environments, our virtual realities will probably become less "real," that is, less constrained by our assumptions as to what is possible. This is the premise of VR, after all, making the nonreal, the fantastic, or the impossible seem actual so that it has the impact and manipulability of the real. It seems unlikely, however, that we may ever find it beneficial to totally dispose of Cartesian structure as a visual metaphor to help locate us in what will become increasingly complex spaces. Along the way, we will discover what is useful to retain of that metaphor and what is liberating about its arbitrariness.

Despite our emancipation in virtual space from Newtonian regulations, there are many instances where it is desirable to retain them. Any simulation that is designed to improve real-world performance, such as a flight-simulator or a satellite repair training scenario, obviously aims to be as realistic as possible, *especially* in terms of complicating limitations. Other areas of simulation also depend on their fidelity to the physical world for their effectiveness. Recently scientific studies have confirmed the success of "virtual therapy" on acrophobic patients, a new approach to traditional exposure-desensitization methods.[45] Participants in one study, donning a head-mounted display,

---

[44]Allucquère Roseanne Stone, "Will the Real Body Please Stand Up?: Boundary Stories about Virtual Cultures" in *Cyberspace: First Steps*, p. 104.

[45]Mark Hodges, "Facing Real Fears in Virtual Worlds," *Technology Review*, May/June 1995, pp. 16-17.

rode a virtual glass elevator in a multistory hotel to ever-higher heights. Physiological symptoms such as rapid heart rate, sweaty palms, and shaky knees gradually decreased. The experiment culminated in 90 percent of the subjects conquering their fear in the real world by riding fifteen floors in an open, glass elevator. Virtual realities like this one, or similar scenarios of high balconies or canyon bridges, also are effective because they are *not* real. One wouldn't want to fall and be killed in the course of therapy. Awareness of the absence of real physical danger is just enough to encourage subjects even while the degree of realism is sufficient to trigger phobic response.

Space in virtual reality is very different from real space in many ways besides not being physically actual. The laws that bind the real world simply don't apply; not only can fantastical and prohibitively expensive architecture be constructed, but the very physics of cyberspace is programmable. Impossible structures will be commonplace, except that their impracticability will cease to important or noticeable — it would only be so in the context of the real world. Perhaps if an ordinary street scene was rendered, a huge building supported by copper wires would stand out as unnatural and extraordinary. Yet more likely we will habituate ourselves to the freedom of virtuality with remarkable, if not unsettling, quickness. Cyberspace architecture will not be constrained by limits of ground, horizon, boundary, or even three-dimensionality. Structures don't have to resemble anything our physical world has ever seen, although, as mentioned above, similarities will prove facilitating. Virtual reality is an *n*-dimensional space, where doors can open to fields, and tree branches become film houses. Space will be defined entirely by navigation, orientation, but not by distance. Or rather, distance will take on a new meaning, one that will signify quantity of information, the amount of data one must move through to reach a desired point. In this way, distance — space — will collapse into time, for all travel will only be inessential insofar as it involves maneuvering through a topology of information. "Getting somewhere," as an undesired expenditure, will be a passage of time with the illusion of spatial dimensionality. Once specific nodes have been located, the series of links necessary to reach it will be programmed and travel to those points will be virtually instantaneous.

The term travel should be supplanted, perhaps, by "transference," but even that term connotes geographic movement of the subject. The very notion of travel must be refigured, for in virtual space, "the subject ceases to exist and, as Paul Virilio puts it, becomes motion."[46] The self in virtuality is entirely action and at the same time continual stasis. Inasmuch as the cybernaut's physical body is located in one space, and does not leave that space (although there might motion of limbs and head), the subject is objectively static. The notion of the subject as stationary locus goes much further, however, and is bound up with the solipsism inherent in an individual VR system discussed in the previous chapter. While the offline self is discrete and goes nowhere, the subject in virtual space *is* the environment and vice versa. In other words, the cyberspatial self is information just as its surroundings are. World-data is constantly being realized in the perceiving consciousness, even while subject information is being integrated back into the world model. "In an ecstatic exaggeration of Merleau-Ponty's phenomenological model, world and body comprise a continually modifying feedback loop"[47]: perpetual dataflow.

The most incontrovertible aspects of daily existence on earth such as gravity, weight, mass, and friction have only arbitrary value in virtual spaces. All of these forces can be postulated as different forms of resistance; in contrast to real world physics, cyberspace is perfectly liquid in essence. Just as distance in simulation is reformulated as time, so are these other forms of physical resistance. Time is the only applicable obstacle to movement, for it is the only external interference to the activity of mind.

---

[46]Francine Dagenais, "Perfect Bodies," in *Virtual Seminar on the Bioapparatus*, Catherine Richards and Nell Tenhaff, eds. (Banff, Canada: The Banff Center for the Arts, 1991), p. 43.

[47]Scott Bukatman, *Terminal Identity: The Virtual Subject in Post-Modern Science Fiction* (Durham, North Carolina: Duke University Press, 1993), p. 187.

Space in the virtual realm is reducible to thought and perception; all appearance and events take place only for the jacked-in consciousness. "The environment in which we now probe feels more like water because every thought is like an immersion. We are traversing a complex system, accumulating layers of information at electronic speed — discovering internal landfalls to aid us in our search for the critical path."[48]

Because no natural restrictions apply to virtual worlds, certain laws and barriers will be artificially imposed by system designers, for the human mind has evolved for existence in Euclidean space. Meredith Bricken, a VR research scientist previously with The Research Lab at Autodesk, described how a project there gave users a six degree of freedom trackball to control their movement in a virtual office. The trackball had very quick response time and no laws of gravity or resistance programmed to effect the subject's movements. Bricken commented on how the system "afford[ed] more maneuverability than the human body is accustomed to... In first testing the trackball, we tumbled into perspectives we could barely interpret and careened through the walls and floor... The simultaneous changes in pitch, roll, and yaw as well as direction in 3-space was confusing; people are not used to moving without the guiding constraints of ground and gravity."[49] This clearly illustrates the usefulness of applying components of old paradigms to the new, but Bricken also writes how quickly users adapted to other virtual systems that enabled flying and instant change of perspective.[50] The lesson that

---

[48]Bruce Berland, "Reversing the Lens System: The DAX Group in 1991," *Connectivity: Art and Interactive Telecommunications*, Special Issue of *Leonardo* 24, No. 2, 1991, p. 116.

[49]Meredith Bricken, "Virtual Worlds" in *Cyberspace: First Steps*, pp. 373-374.

[50]Two virtual worlds, Virtual Seattle and Octopus's Garden, were designed at the Human Interface Technology Lab (HITL) as "introductory adventures in cyberspace." In Virtual Seattle, people could fly around a model of the city or jack in to the perspective of a moving ferry; in Octopus's Garden one swam around an undersea plateau and could choose to see through an ROV, the octopus, a school of fish, or a starfish. Some of the entities in Octopus's Garden were controlled by the computer, others by system operators. "Although few of the participants had experienced the technology before, individual learning time was remarkable [sic] short.... After two or three minutes, most people demonstrated a clear understanding of the capabilities and constraints of these worlds." [Bricken, "Virtual Worlds," p. 377.]

some resistances or limitations are facilitating is one that applies to other technological issues besides subject perspective. Large hypertext webs, for example, are another emergent Information Age entity whose power lies in its liquid form and potential immensity of connectedness. These attributes, however, can be so overwhelming that the user is effectively paralyzed, or at least bogged down by an overload of possibilities. There is such a thing as too much freedom in virtual information spaces; efficiency and ease of stabilization must be balanced with navigational hypermaneuverability and the wealth a massive network affords.

Another little-discussed question of virtual reality is that of tactility, and relates to the issue of what real-world dimensions are carried over into cyberspace. The lack of tangibility, physical weight and force is one of the biggest obstacles on the path to complete virtuality. As with many other areas of human operation dealt with by VR researchers, touch was discovered to be an unbelievably complex event. Our skin has thousands of nerve terminals per square inch, every one of which sends information to our brain up to 500 times per second.[51] Texture is such a subtle phenomenon whose physical mechanics are so complex that some believe we will never achieve full simulation of it. VR development now is mostly concentrating on grosser instances of touch, getting some mechanical resistance to correspond with manipulating a virtual object. Feeling something, for most of us, is the last threshold of perceived reality (since "I'll believe it when I see it" should have fallen by the wayside in the last century). It is hard to disbelieve something if you can heft it in your hand or feel it hit your chest. Integrating tactile feedback into a virtual world will probably take longer to do convincingly than any other aspect of VR.

The ultimate goal in VR haptic research is to combine gestural transduction (input) and tactile feedback (output) in one lightweight glove. One of the large problems of tactile simulation is that conveying really solid feelings, like hitting a table,

---

[51]Rheingold, p. 319.

requires machinery that could be potentially dangerous. "If you slam your hand down on a virtual table, the device needs multiple horsepower motors to make it feel like you've hit a tabletop," says Henry Sowizral, head of a VR research project at Boeing Computer Services. "Well, multiple horsepower is enough to break your arm if someone has written the program wrong."[52] It is unlikely that any company will want to be liable for that kind of damage, and so VR systems could very well evolve with little tactility. In addition, it is improbable that anyone will want to account for the possibility of desired danger in simulation. In other words, there are areas where virtual reality will be deliberately developed *not* to be like reality. The difficulties of tactility are significant for several reasons, not the least of which is that touch is a crucial element of our interaction with the world. Both economic factors and some belief in "improving on" reality will probably keep any forces stronger than mild out of virtual experience. This would render all virtual realities pseudo-ethereal, if not entirely phantasmic.

During the birth of this new technology, few people are conscious of the lack of texture and solidity in the simulation. Entire environments, if not every one of them, will be utterly pain-free zones. Will this further degrade our perception of realism in systems where space is already permeable? Running into walls, dropping objects on yourself or other people, cutting your own body: all of these actions will probably produce no feelings. Will this essential distancing from behavior (according to our old paradigms) subtly alienate us from our virtual environs? There are positive repercussions imaginable: hypernavigation will be encouraged by the absence of any physical danger. Unlike the real world, the worst that could happen while engaged in full-speed exploration is getting lost. What happens once we become accustomed to certain virtual conditions? This could have repercussions on how we deal with the

[52]W. Wayt Gibbs, "Virtual Reality Check," in *Scientific American*, December 1994, p. 40.

offline world, which might seem more and more harsh to the cybernaut reluctantly disengaging from the interface.

I believe the immersive instinct or tendency in simulation will cause most people to adapt their behavior to a world without pain with very little questioning. The brain's desire for coherence is illustrated by the filmic experience, manifested as the phenomenon of persistence of vision and our establishing continuity over elliptical edits. Watching anyone play a videogame illustrates how quickly the proprioceptive system conforms to an artificial interface and set of laws (significantly, this is more true for those under the age of 30). The incredible adaptability of the human brain is a valuable attribute but also a reason we should be cautious. Virtual reality will be a powerful entrancer for the perceptive system, and there is the danger of people unthinkingly assuming its tactile laws are the "way things are." As with film, we will learn to read the codes of VR quickly, and once read they are deeply imprinted. Consider how transportation technology has transformed our notions of geography and distance, and how our relativizing skills have deteriorated as a result. A difference of an hour on a plane is hundreds of miles — which can span time zones, climates, and even cultures. McLuhan's global village is an accurate metaphor in this light; as the world shrinks to a village, we are losing touch with its physical reality. Potentially even more threatening is the possibility that, as society puts more trust in VR, systems will gradually increase their capability for exerting force. There are many reasons people might want the extra realism, for entertainment, for scientific visualization, for the augmented navigational skills any extra harnessing of sensory data can offer. If habituation is extensive enough, we might discount or forget about the potential danger haptic hardware presents. Malicious hacker scenarios, I'm sure, don't need to be narrated.

There are many virtual spaces that fall between neat definitions of real and imagined. As I mentioned in the REALITY chapter, a burgeoning field of VR is dedicated to exploring the ways in which our natural senses can be augmented by data visualization. Back in the 1960s, Douglas Engelbart, the leader of the influential Augmentation Research Center (ARC), had the idea that computers should function as mind-amplification devices, used in conjunction with human contextual and intuitive powers. The idea central to Engelbart was that computers should be as visual as possible, since this is how humans take in and process inconceivable amounts of information.[53] ARC was funded by the military's Advanced Research Projects Agency (ARPA), who also hired Ivan Sutherland, another man who was to become hugely influential in the development of computer technology.[54] Although his work was funded and designed for the U. S. military, Sutherland was a visionary who saw users eventually forming some manner of symbiosis with computers. In 1965 (!) he wrote:

> "A display connected to a digital computer gives us a chance to gain familiarity with concepts not realizable in the physical world. It is a looking glass into a mathematical wonderland... [and] should serve as many senses as possible."[55]

Because computer graphics allow us to translate data into any number of different phenomena, and then animate those models, we can discover relationships we never knew existed. Computers allow us to utilize our most powerful capabilities,

---

[53]Much of personal computing, and the prototypes of virtual reality components, comes from work done at ARC. Engelbart's lab invented the mouse, which wasn't commercially available until the 1980s, back in the '60s. Hypertext, windows, video integration, conferencing, and online processing were also all essentially invented at ARC.

[54]Sutherland, regarded by some as the "grandfather of VR," designed a program called Sketchpad in 1962, "the first great conversational human/computer interface [and] also the first great direct manipulation one." In 1965, he created the first head-mounted display (HMD), as of right now a central part of almost every VR system. [Susan Brennan, "Conversation as Direct Manipulation," *The Art of Human-Computer Interface Design*, Brenda Laurel, ed.] See APPENDIX for more.

[55]Ivan Sutherland, "The Ultimate Display," *Proceedings of the IFIP Congress*, 1965, pp. 506-508.

pattern recognition and contextual evaluations, in areas that are normally too abstract or complex to grasp. Some successful applications of VR include molecular docking structures that users could intuitively interact with to figure out optimal configurations. The system fed computer-generated 3D models to users who interacted kinaesthetically with them, having the illusion of physically sliding the molecules around until a proper fit was felt.[56] Mathematics is filled with similar stories of how computer visualization make dimensional or temporal relationships and curvatures salient that had been so subtle or complex as to escape notice. Techniques of mathematical modeling have caused the development of new sciences of chaos; the popularized image of fractal graphics is testament to their aesthetic, as well as scientific, value. "An extended, but valid, reconception of the 'real'" results:[57] "this new medium," writes two mathematicians, "is allowing us to see connections and meanings which were hidden until now."[58] Financial visualization is currently a growing field of VR for a similar reason: comprehension of data so massive it is otherwise unmanageable. User can fly around the datasea, zoom in to see further subcategories, which are mutating polygons imprinted with their corresponding information tags or corporate logos. These examples illustrate how virtual reality can contain spaces of metaphorized information that by utilizing disparate grammars bring out unexpected associations. By being

---

[56]This early VR system, developed at the University of North Carolina, was used effectively in 1986. It used a large robotic arm to simulate the resistance of molecular forces on the user's encased arm. A journalist (Howard Rheingold) reported: "Knowing next to nothing about the chemistry symbolized by the colored clouds floating in virtual space and the tinkertoy bonds that I could feel in my arm bones, I was able to find... the alignment necessary for docking." [Rheingold, pp. 26-29.]

[57]Bukatman, *Terminal Identity*, p. 109.

[58]H.-O. Peitgen and H. Richter, eds., *The Beauty of Fractals* (Berlin and New York: Springer-Verlag, 1986), p. 3.

engaged visually and haptically in three dimensions, we can explore and play with information, revealing deeper structures to physical reality.[59]

Not all of virtual space must inhere entirely within the computer system. One of the larger funding spots for VR at the moment is the field of "reality augmentation," primarily in medical imaging and engineering/ repair. These systems overlay virtual displays on real-world vision, displaying hidden structures and relevant information. A surgery-planning prototype at UNC uses a head-mounted display to show rendered images of the patient's body, with all layers of skin, muscle, and tissue selectively visible, translucent, or invisible.[60] At Boeing Aircraft, mechanics can use a VR system that superimposes data and diagrams as well as virtual renditions of obstructed parts over the actual visual field.[61] The space displayed in these examples is not exactly cyberspace as we have defined it. Physical reality is not itself enhanced, but our percept of it is; we introduce comic-book superpowers into our phenomenological interplay with the actual. Virtual reality is not just an ontological space we enter into — it can extend out of its boundaries, like the cinematic trope of the fictional character crossing into the real world. This is a cyborg event in the most explicit way, for we are augmenting ourselves with apparatus effectively synthesized with our bodies. Cyborgization occurs as we form a human-technological symbiosis, which with virtual reality can occur inside or outside the system. Internality and externality lose their sharp delineation: reality becomes virtual becomes reality.

The evolution of technology logically pointed towards a time when humans could inhabit virtual space as our messages had done first. In effect, virtual reality technology involves making *ourselves* into messages, so that, in a neat updating and

---

[59]This is a cyberized step beyond Piaget and Levi-Strauss' ideas of learning as exploration referred to in THE (DIS)SOLUTION IS REALITY (see n. 6).

[60]Rheingold, pp. 31-34.

[61]Pimental and Teixera, *Virtual Reality: Through the New Looking Glass*, pp. 179-181.

extension of McLuhan's famous phrase, the (previous) medium becomes the message, which then becomes a new medium capable of transmitting messages from either paradigm. In cyberspace, as I have already shown, we are the environment as much as simply in it; it is contained within us, we are all of it.

> "[T]he body loses its self-definition, forcing a restructuring of the notion of environment, its internalization thereby eliminating heretofore distinctions of within and without. The body is caught in the ambiguity of wholeness/loneliness. The body as receptor as motion becomes the medium itself. The medium is the body."[62]

One aspect of cyborg theory is predicated on a line of thought extending from this: the notion of humans becoming something not-human in the transference of parts of us — and now, all of us — into a nonspatial, digital realm.[63] I would argue this process could be seen, perhaps only analogized, in the early technology of telephone conversations and later various electronic transactions.

The distinction between organism (person) and carrier (voice) in those interchanges was more than a simple reproduction, it was a splitting-off of being. By being transmitted through communication technology and interacting with other projections, the carrier took on a life of its own, if you will. There was something more than mere "projection" happening; it is not an inaccurate term, but it still carries the connotation of emptiness for the voice. Although to what extent one assigns presence might depend on particular prejudices of semantics, our voices have some existence separate from us in so far as they bring about a new, distinct space which we ourselves do not inhabit. The segment or projection of being, still dependent on its host organism for its intent and on its destination organism(s) for its re-translation into meaning,

---

[62] Francine Dagenais, "Perfect Bodies," p. 43.

[63] See especially Donna Haraway, "A Cyborg Manifesto: Science, Technology and Socialist-Feminism in the 1980s," *Simians, Cyborgs, and Women* (New York: Routledge, 1989), pp. 149-181 and Ollivier Dyens, "The Emotion of Cyberspace: Art and Cyber-ecology," in *Leonardo*, Vol. 27, No. 4, 1994, pp. 327-333.

makes us into cyborg entities. Part of our consciousness becomes translated into a totally non-human form, be it digital or otherwise, and so we become, in part, a symbiosis of organic and technological. This process is perhaps better described as a foreshadowing of cyborg existence; the development of VR is making this much more explicit. In virtual reality, the self is a cybersubject, technologically ontologized and immaterially (digitally) constituted. Space, in virtual systems, is equivalent to body, is equivalent to object. Under the great equalizer of digitality, the self is not just imbricated with technology, it is technology: we become data.

Humans will become cyborgs through two quite distinct paths, which this discussion brings about the articulation of. The first possibility — or inevitability — is a physical integration of non-human (but not necessarily non-organic) material into the human. This development is the more obvious one which has dominated the collective imaginary of science-fiction literature and cinema. The Terminators and RoboCops of those genres represent "ever more emphatically armored" bodies asserting their solidity in masculine, mechanical, and "trustworthy" forms.[64] The other means by which humans will become cyborg entities could be described as cognitive (as opposed to physical). A cognitive-perceptual shift occurs when we interact with any technology which affects our perception, which all tools of remote communication do, as well as all of information technology. This has also been described, rather jargonistically, as the "postclassical (software-interfaced) transorganic data-based cyborg or personality construct."[65]

Cyborg theory, led by Donna Haraway, has addressed the duality of human inter-relation with technology, a duality just articulated as biological versus cognitive. However, the latter theater of transformation (evolution, mutation) can cause biological

---

[64]Bukatman, pp. 305-306.

[65]David Tomas, "Old Rituals for New Spaces: *Rites de Passage* and William Gibson's Cultural Model of Cyberspace," in *Cyberspace: First Steps*, p. 32.

changes as well. By conceiving of, and manipulating, information through the medium of technology — specifically the computer and its unique cyberspatialization of meaning-constructs — our percepts inevitably mutate. Our consciousness is altered, to whatever degree, infected by the memescape of the technology's method of rendering "world." Cognitive science has shown us that consciousness is mostly, if not entirely, the result of the neurological configuration of the brain. When our modes of perception change, our brains *physically change*. In this light, a cyborg subject in which the melding of human and technology takes place purely in the cognitive realm — no implants, no prosthetics — is still biophysically altered. Richard Dawkins, in his influential book *The Selfish Gene*, defines memes as "living structures, not just metaphorically but technically. When you plant a fertile meme in my mind you literally parasitize my brain... [any meme] is actually realized physically, millions of times over, as a structure in the nervous systems of individual men the world over."[66]

Cyberspace is an incredibly fertile breeding and distributing ground for memes. Besides being so in the more traditional sense of disseminating ideas put forth by individuals, cyberspace is itself a memescape. By virtue of being an environment, with new systems of representation, acquisition, spatiality, and identity, computer generated worlds effect powerful changes in everyone who inhabits them. Virtual reality will provide the most visceral and enveloping instance of any cyberspace, although the two terms are not all that distinct. Although purely abstract cyberspace can carry strong and influential ideas, VR, as defined at the opening of this chapter, is the visually and immersion oriented presentation of such nonspace, and thus far more effectual to the human. Through technological modes of being like virtual reality "the imaginary of the machine," as Ollivier Dyens has put it, "extend[s] its cognitive geography into us."[67]

---

[66]Richard Dawkins, *The Selfish Gene* (Oxford: Oxford Univ. Press, 1976), p. 192.

[67]Ollivier Dyens, "The Emotion of Cyberspace: Art and Cyber-ecology," *Leonardo*, p. 328.

As opposed to the classical, media culture vision of cyborg construction, our terminal synthesis with/into virtual space is a feminized act of cyborgization. We dissolve into digital space, which envelops us as well as gives form to us. The techno-humanoid cyborg of the Robocop kind can be seen as a perpetuation of the "industrial age metaphor of externally forceful masculine machinery, expressing nostalgia for a time of masculine superiority," resisting the feminization of electronic technology.[68] Consider the evil protagonist in *Terminator 2*: the liquid, morphing, androgynous (read: female) T-1000. Yet cyberspace is not simply feminine; it involves a combination of gender-associated metaphors that gives hope for an alternate future other than a patriarchal technopoly. Early programming languages had a distinctly masculine appeal in their extreme logicality and arcane command structure, as is borne out by the disproportionately male user/hacker population.[69] Yet the iconographic interface of the Macintosh began to feminize the technology, making it more intuitive, more visual, and, through its mouse-caressing navigational system, even more sensuous.[70] Virtual reality is potentially a field for Haraway's "cyborg politics": technological symbiosis as a progressive alternative to simple masculine command-based control.

As stated earlier, we can somewhat tenuously identify the onset of cyborgization as occurring with the invention of the telephone. That was but a tiny seed; virtual

---

[68]Claudia Springer, "Muscular Circuitry: The Invincible Armored Cyborg in Cinema," *Genders*, in press, cited in Bukatman, p. 306.

[69]Between 1983 and 1986 the percentage of doctoral degrees in computer science was in the range of 10 - 12 percent. As of 1989, women held only 6.5 percent of the faculty positions in computer science and computer engineering departments (in a survey of 158 Ph.D.-granting institutions); a third of these departments had no female faculty members at all. [Thomas Naps and Douglas Nance, *Introduction to Computer Science: Programming, Problem Solving, and Data Structures* (St. Paul: West Publishing, 1992), p. 323.]

[70]Although it is not very progressive to preserve these distinctions, I believe it is significant that it was a woman, Susan Kare, who developed the distinctive GUI (graphical user interface) of the Macintosh. Kare approached the job as an art piece that had to be functional as well as friendly. She is considered to be "the mother of the famous Macintosh trash can." [Ron Wolf, "Artist a Go-Between for Users, Computers," *The Chicago Tribune*, June 10, 1990.]

reality will enact a techno-organic recreation of ourselves. Human evolution, since Darwin, was thought for a long time to occur through wholly natural processes of adaptability and selection. It is apparent now that technology has emerged as a powerful, and unprecedented, new factor in evolution. What humans create, the un-natural, in turn creates us. We make ourselves. But that is too simple, for technology has the unique property of possessing agency without being alive (so far — this is also getting hazier). As a cultural force, it shapes human thought and interaction in many ways that are unforeseen by its creators. In the past century or so, this has been due in large part to the simple irreducibility of a macrocosmic dynamic. Technology, until recently, could be seen as *other*, a conception easily analogized as object/tool. Computers are bringing about a revolution because how the digital can manifest itself dissolves this dualistic boundary. In an ironic, almost poetic, twist, the realm of the binary disintegrates a comfortable (binary) opposition.

The profound moment of the first tool captured brilliantly by Kubrik in *2001* also marks the moment when human evolution deviated from Darwinistic, "natural" selection. Since then, our tools have been extensions of ourselves (which could be used as an argument for repostulating Darwinism), but still conceived as distinct. The separation is problematized, however, because how we think determines what tools we develop a need for, and our tools, in turn, influence how we think. With an old, mechanical tool such as a hammer (indeed, Kubrik's spinning bone was nothing else), it seems fairly straightforward to see it as an external object used to augment our natural strength. (Although we should remember the expression that tells us that when one holds a hammer, the whole world looks like a nail.) A tool in an intermediate, if you will, stage of technology, an electro-mechanical device like the telephone, is more complicated: we extend out of *it*, without our actual presence. We are internalized by the machine, but incompletely so. On the other end of the connection, what's left of us buzzes out with a tinny voice. The tools of our current age, which the computer is the exemplar of, are still extensions of us because we utilize them — they are discrete objects sitting on our desks or laps that we can turn off. But it grows increasingly difficult to disengage from them, not just because of their seductiveness, but because they continue to operate in the background. E-mail accumulates while the power is off on your laptop. Clock cycles elapse, files can be transferred, faxes sent, anti-viral programs run, all while the computer seems to be asleep in its corner. Most importantly, the interface of the personal computer presents a shift: we extend into it, adjusting to its abstractions, its metaphors, its geographies.

Is this what the birth of cyberspace meant, the inversive moment when tools ceased to be mere extensions of ourselves? The progression of computer technology maps the human effort to penetrate the machine, and eventually to unionize with it. Acutely aware of this, John Walker, the cofounder and president of Autodesk, divides computer history by its level of interactivity, not by its hardware.[71] The first generation of computers is dated around the late 1940's, when programs were conveyed through huge plugboards. Walker identifies a "barrier" in each generation which is removed by the next; the barrier of the first generation was the front panel.[72] In the 50's, programmers used punchcards and batch processing which greatly speeded up "communication" with the system, but was still very awkward. Each programmer had to wait for weeks, sometimes, to get a set of cards run through, and if anything went wrong, there was no system of feedback to quickly isolate the problem. It wasn't until the third generation, by virtue of the invention in the 60's of timesharing, that programmers could directly interface with systems through keyboards and screens. The terminal, however, was still a significant barrier. The fourth generation was defined by its pull-down menus, a big improvement in passing commands to the computer.

---

[71]Autodesk is a major software company that specializes in Computer-Assisted Design programs for architectural firms. Autodesk, under Walker's direction, has carried out a major foray into virtual reality technology.

[72]Pimental and Teixeira, *Virtual Reality: Through the New Looking Glass*, p. 56.

Walker identifies the resulting menu hierarchy as the barrier of this generation, which the fifth generation refined using breakthroughs of visual iconography and point-and-click mouse control. This generation is the one the world's users are still mostly in, close in many ways to the final barrier — the screen itself. Walker sees us now enmeshed in development of the sixth generation, which will entail a major paradigm shift by removing the screen and allowing us to enter "into" the computer.

This history advances the clear metaphor of the human penetrating the machine; what is not as often realized is the simultaneous penetration of us by the technology. Now, with virtual reality, we symbiotically encounter the machine; we inhabit and merge with the matrix. Walker's sixth generation is cyberspace, and it represents a union of human and (now more than) tool. While using our newest technology, we cannot be separated from it; we are projections of each other. The internalization hinted at in the telephone is fully realized, and beyond: as I argued above, cyberspatial existence is both penetration (masculine) and absorption (feminine). "[T]his knotting creates... an understanding of the world created by an organic *and* a technological deciphering and modeling of information."[73] The computer, although we created it, is much more than an object now, it is an entity, or even more expansive and influential: a space, a nascent model of *being*. A thoroughly postmodern imbrication is taking place: dualisms of human and device, environment and object, mind and body, male and female, are all placed in question. Virtual space is an architecture endowed with the kinesis of mind, wherein we can simulate the actual as well as actualize the imaginary, forever problematizing the ultimate duality of non/existence.

[73]Dyens, "The Emotion of Cyberspace...," p. 327.

NEW DIMENSIONS IN *TELE*-COMMUNICATION

It seems likely that within twenty years communicating interpersonally through your computer will not be uncommon. Your "computer," of course, will be some sort of hybridization of what we now term our PC's, televisions, VCR's, phones, and faxes. Although computer-mediated communication in the form of E-mail and Internet conferences is common already, most of that interchange is textual. Telephone conversations still offer (most of us) something closer, more personal, than electronic interchanges, but the latter's textual nature is merely a temporary condition necessitated by limited bandwidth. In the near future, virtual reality systems will likely contain/be (that distinction is no longer applicable) the (cyber)space in which humans communicate over distance, as well as relocate even more of the interchanges we currently still carry out in person. In cyberspace, even as it stands today, new structures of meaning are arising — some consciously, others by unmeditated consensus — which call our notions of identity, space, and (to a lesser extent as of now) temporal progression into question.

In the first part of this chapter, by outlining an abbreviated history of *tele*-communication (in the Greek sense of *tele* as remote, at a distance), I hope to illustrate the place of virtual reality in the continuum of efforts to *fully represent*. This human endeavor has been, most explicitly, a technological project, but — on a larger scale — it has also been a philosophical and spiritual one. The philosopher of science Karl Popper's ideas will be used as a backdrop for discussing how VR will be the partial culmination of one ideal of communication: presenting concepts without recourse to a foreign vocabulary, without the consequent degradation or perversion of intended meaning. What is happening on the Internet is just a foreshadowing of what is to come: soon images, tomorrow embodied selves — multiplicate, protean entities together in virtual space. Meetings of every sort will take place in VR, many of them of a character never seen before. The realm of communication in the 21st century will expand to encompass the visual and informational, and will carry the exchange of ideas of diverse natures: personal, corporate, intellectual, artistic. Will virtual realities become common locations for everyday tele-interaction? What applications exist today that display revolutionary possibilities for communication? The last part of this chapter will address these questions, examining in the process what corporate visions and agendas are being brought to bear on the emerging theater of the technosocial.

Devices such as the phone, fax, and modem are the most recent step in the enactment of our desire to increase the expressiveness of our means of communicating with each other over distance. When the history of communication technology is articulated, I believe virtual reality can be seen as a logical, and progressive, development in human history. But to outline the history of *tele*-communication, in the more general sense which that manipulation of the word engenders, we need to go back to humankind's first efforts to represent absent entities. Some of those entities might have been not present because of geographical distance; in communication this was the case with both the originator and content of a message. Equally important, if not more so, were those entities that were absent by virtue of being abstract. Both cases, that is, things wanting expression that were either physically remote or immaterial, drove humans to develop symbolic representation.

The first known instance of writing by *homo sapiens* dates from 6000 B.C.; systematic writing started appearing about 3500 B.C., almost 35,000 years after complex language came into being.[74] The act of writing, continuing a movement which began with language itself, condensed meaning into small symbols. Sumerian cuneiform, probably the earliest form of writing, in its first two thousand years was used almost exclusively to record data such as inventories and calendars, or for mnemonic purposes.

---

[74]Timothy Ferris, *Coming of Age in the Milky Way* (New York: Morrow, 1988), pp. 413-427.

As far as we know, in its early stages, writing did not try to describe or evoke so much as transcribe, or at most, refer. Attempts at reproducing or simulating experience, which virtual reality is in many ways the culmination of, developed, but slowly at first. Babylonian and Assyrian writing circa 3000 B.C., adapted from the Sumerians, used between three and six hundred cuneiform symbols for words, and less frequently, syllables. Most of the symbols at this point were already fairly arbitrary, although the fact that some descended from pictographs was visible here and there. In Egypt, by the time of the first dynasty (dated 3110 - 2884 B. C.), heiroglyphics were generally considered perfected. 604 symbols were used that could each have up to three purposes (although rarely all three): ideogrammatic (e.g. a picture of a man meant "man"); phonogrammatic (e.g. a picture of an owl represented the sign "m," because the spoken word for "owl" had "m" as its principal (heard) consonant); and determinative, an unpronounced symbol after an ambiguous sign to clarify its meaning (e.g. an eye to indicate that the preceding word has to do with seeing). Systems arose which exclusively used phonograms to spell out words, the basis of all alphabets today. This development made explicit, from a historical point of view, the estrangement from the signified that written signifiers underwent; today, all writing is comprised of symbols which appear to have no relation to meaning. (This is debatable, perhaps, in non-phonemic — that is, non-alphabetic — languages such as Chinese, whose characters each stand for an individual word or concept.) In the digital age, electronic media facilitate the reintegration of more directly signifying content (images, music) into text; multimedia desktop publishing and hypertext, in my opinion, deserves the hype.

After the appearance of language, humans had the means to repeat (and spread) intentions, desires, and points of view. But it was the invention of writing that made possible the transmission of ideas across time and distance for the first time.[75]

---

[75]We should not discount the meme-spread that oral traditions accomplished; constructs that were identified with or were strongly conveyed became communal. Myth developed before writing, and became a carrier for a wide variety of cultural information.

Beginning with that epochal development, I believe it is possible to identify an attempt to master the transmission of meaning by compacting it, reducing its essence through encoding. After all, any attempt at representation must not aim for total reproduction; even if not impossible, it would take so much time that the act of communication would be rendered useless. The nature of symbolization points to the gradual dematerialization of media which characterizes the evolution of communication technology. This dematerialization involves the steady reduction of physical factors, or obstacles, in the transmission of information over distance or time. Half a dozen millennia ago, the ephemeralization of media was just beginning, but it becomes clearer and clearer as history unfolds from that point. This movement is one that at the same time reifies meanings; cultural constructs like mythologies (stories) or scientific theories, for example, could be recorded and disseminated, and thus reinforced, on an unprecedented scale.[76]

When writing began, the ability to inscribe thought and information provoked an expansion of cultural ideas, mythologies, and structures, what Karl Popper termed *World 3*. It is worthwhile here to use his thought to structure our historical discussion.[77] Popper described the world as being an amalgam of three sub-worlds, each distinct but interconnected.[78] *World 1* consists of objective, material things and their concomitant physical properties. *World 2* is the subjective "space" of consciousness, populated by every individual's mental constructs: dreams, imaginings, memories, etc. *World 3* contains public, sometimes institutional, structures, the consensual products of communities of living, thinking beings. The *World 3* structures which interest us here, and which constitute the majority, although they are real — that is, they objectively exist

---

[76]Benedikt, Introduction, *Cyberspace: First Steps*, p. 11.

[77]Michael Benedikt discusses cyberspace using Popper's ideas in his Introduction to *Cyberspace: First Steps*, pp. 1-26.

[78]Karl Popper, *Objective Knowledge: An Evolutionary Approach* (Oxford Univ. Press, 1972, rev. 1979), pp. 106-152.

— have no physical presence. Many *World 3* structures are purely informational: language, art, science, religion, social organizations. These frameworks feed back into *Worlds 1* and *2*, and all three worlds influence each other's evolution.

More than simple growth of *World 3* structures occurred with the spread of writing; a new era was born. A consistency and permanence inhered in those structures which had not been there previously. Millennia later, with the invention of the printing press and the resulting spread of literacy, immense portions of *World 3* could be, and were, recorded. Text packed in signification, was now easily reproducible, and could be transported anywhere fairly easily. As McLuhan has pointed out, the printing press democratized idea production and distribution (previously, for the most part, only noblemen and religious scholars knew how to read or write) and also made it impossible to locate in single places — and thus, control — *World 3* inscription centers.[79] Writing, especially post-Gutenberg, was the invention that advanced the articulation of ideas and enabled greater analysis and feedback, the cornerstones of intellectual growth. The general progress of human knowledge, Popper believed, can be seen as a conversion of myth (which Popper characterized "pseudo-sciences" as, e.g. Marxist historical theory or psychoanalysis) into science by its subjection to critical examination. Virtual reality, we will see, is the next step in the technology of idea interchange, one that will allow communication of previously unrepresentable ideas (through scientific/mathematical visualization) as well as enable richer critical dialogues on many topics — interchanges that may not contain any text at all.

Although printed matter could get to almost any city in the world by the 16th century, time was still a significant factor that could not be circumvented. Short distances could be covered without too much delay by semaphores, smoke signals, and light-flashing, but these were limited systems. The invention of the telegraph in 1844

---

[79]Marshall McLuhan, *Gutenberg Galaxy: The Making of Typographic Man* (Toronto: Univ. of Toronto Press, 1962).

solved some of these problems; it was the first system for distant communication whose range extended beyond the human senses. Thirty-some years later came one of the most influential inventions in the history of communication: the telephone. The technology in the devices patented by Alexander Graham Bell in 1876 and 1877 is still the basis for the modern phone.[80] The telephone continued the historical path of *tele*-communication, that is, it marked another transition from physical information transport to a form of relay with less resistance or delay. Each eclipsed technology had inertia and friction working against it to a greater degree; the telephone (and telegraph), by using electrical transmission over wires instead of ink, paper, and binding, and ships to carry it all around, diminished the constraints of time and space considerably.[81]

The telephone was a seminal invention for several reasons, the most relevant here being what I posit as the emergence of the basic requisites of cyberspace as we define it today. One understanding along these lines is arrived at by conceiving of some immaterial, unknowable place where information exchange occurs. Our current phone conversations, by this reading, take place in some virtual locale. The conception of a nonphysical realm which those conversations inhabit is much more recent than telephones themselves. It wasn't until the Information Age rolled in on its juggernaut, the computer, that the possibility of a "nonspace"[82] of this kind could even arise. (Although certainly ideas of spaces of the imagination had been around for a long time.) One might surmise, actually, being closer to this conception upon the introduction of the telephone at the end of the 19th century, when the full wonder and strangeness of

---

[80]Barbara Chernow and George Vallasi, eds., *The Concise Columbia Encyclopedia, Second Edition* (New York: Columbia University Press, 1989), pp. 814-815.

[81]Interestingly enough, before the 1930s and 40s people didn't realize the telephone could be used for matters that weren't "serious." At first, the telephone was thought of as a "voice-telegraph"; apparently, the step of dematerialization was so great it took a while to see the extent to which the traditional impediments to remote correspondence had been overcome. [Benedikt, Intro., p. 9.]

[82]Both this term and "cyberspace" were injected into theoretical circles and, to a lesser extent, pop culture by William Gibson's book *Neuromancer* (New York: Ace Books, 1984).

voices disembodied would come across. Before the technology was taken for granted, people must have wondered *where* the voices came from, and what their relation, if any, was to their unknowably situated speakers. The voice, as a carrier of consciousness, was being projected over vast distances; in this sense, not only did cyberspace *become*, as it were, but so did the first cyberspatial entities; in this case, the truncated being that our voice, through representing, became.

Information continued to be condensed through the severance of media's physical correspondence to their messages. In 1935, the first commercial tape recorder demonstrated the ability to *store* material electromagnetically, using microscopic particles to contain reams of information. At approximately the same time, wire-less broadcasting began to inundate the world. Radio and television could send lots of data in almost no time, with very little energy expenditure. The very air was soon full of information; McLuhan has written about electronic media surrounding us, invisible, literally permeating everything.[83] In this light, cyberspace can be thought of since then as existing, not nowhere, but everywhere.

Technology of all sorts progressed rapidly after the first third of the twentieth century. World Wars I and II provided the impetus for much of this development; civilian based technologies, in general, were (and are) stimulated in waves by military research trickling down. Video technology and computer hardware, both driven by electronic component miniaturization, crossed a price threshold at the same time. This convergence is one of the driving forces behind the incredibly rapid technological upgrades we've experienced in the last few decades. One of the results of the digital explosion is a combining of old media with new, which, in Popper's model, is the norm for the objects of *World 3* expression. The history of those objects so far has seen repeated displacement of earlier technologies which causes their applications to evolve. In other words, although some technologies become outmoded, most are not replaced

[83]Marshall McLuhan, *Understanding Media* (New York: New American Library, 1964).

but refigured, usually becoming more specialized. Print-based media have been combining with electronic media — hypertext, “multimedia,” satellite transmission of digital data that becomes the content of newspapers — in ways which produce unprecedented hybrids and mutations of text. Writing is not going to disappear because of an increased power over images, just as word processing has not killed the book. Many companies have tried, and still are trying, to produce electronic books. No one has figured out a way to surpass the aesthetic pleasure of the page; so far, a screen is not sensual enough. The advantages of a digital body of text are significant — an enormous amount of paper and space saved; the ability to find every occurrence of a particular metaphor in Dante in less than a minute; the power to embed instant links between distant passages, to name some hackneyed examples. As with any new power, some of us are anxious to utilize it whenever possible. Refinement of a technology’s application takes some time; sometimes one might benefit from a digital version of a book, but certainly not all the time. Similarly, virtual reality systems will not entirely replace human interaction, science-fiction paranoia to the contrary. Simple telephonic systems might linger, since the public is extremely habituated to them; it is foolish to try to predict one way or the other. If history is any indication, VR will transform the realm of communication, but not to the exclusion of all previous forms. Rather, those forms will develop more refined niches, remaining more appropriate for certain needs.

The broad movement outlined here is one from the actuality and wholeness of process or concept to symbolic, concentrated forms of expression. This progression, however, can be seen as delimited by our available technological means. As this discussion points out, these means have been improving steadily, but the linear dematerialization of media can only go so far. Books, paintings, theaters, videotapes, floppy disks — all are objects, information patterns which are the physical analogs or manifestations of *World 3* structures (according to Popper). As such they are imperfect representations of the ideas which exist immaterially in *World 3*. If we accept this near-Platonic hierarchy (and, as anyone who has tried to convey a vision visually or in writing can attest, it is not a far-fetched conception), we can trace a historical progression of reaching towards fuller realizations of *World 3* concepts. Most would agree that there has been a positive movement in our facility with language, or in the unfolding of art and film history. Media that dominate today, however, are still limited because the complexity and chaotic order of our minds is extremely difficult to condense or symbolize. By representing symbolically, which any medium must do if there is a concept behind it, the resulting object is only a portal to its true meaning or intent.[84]

As humans have struggled to reproduce more and more of experience, the forms of our media have become increasingly distant from it. As Jaron Lanier has articulated this tension, "information is alienated experience."[85] Socrates issued a similar warning 2500 years ago, although for him (or Plato) the issue was focused on how writing can impoverish the memory of experience. This distancing became more complex when notation outgrew record-keeping and mnemonic uses, that is, when writing became literature. Dating the origin of fiction would be a convenient capsulation of the historical moment at which symbolic schema began to be used to represent the irreal, but it is not an easy task. That time is hard to pinpoint for reasons other than archaeological, how one defines "fiction" being the most obvious source of variance. Some consider Cervantes' *Don Quixote* to be the fountainhead,[86] others find it in Dante. More common, perhaps, are those who define the Homeric epics as the genesis of fictive writing. Joyce Carol Oates claims that Egyptian papyri dating from 4000 - 3000 B.C.

---

[84]This issue is intriguingly hazy with art, especially modernist works with their emphasis on being purely themselves, "meaning-less."

[85]Jaron Lanier in "Life in the DataCloud: Scratching Your Eyes Back In — John Barlow Interviews Jaron Lanier," *Mondo 2000*, Summer 1990, p. 44.

[86]John Perry Barlow, "Being In Nothingness," in *Mondo 2000*, Summer 1990, p. 42.

containing a work called *Tales of the Magicians* are the first known literary documents.[87] As I mentioned near the beginning of our historical sketch, until this point, whenever it may have been, writing was not used to evoke the imaginary. It is conceivable that for some time humans didn't consider the symbolic encoding of experience a tenable enterprise. Fiction, one could argue, represented both an increased confidence in our ability with written language and a large step in the scope of our ambition as to what was reproducible. Virtual reality, of course, is the furthest we have dared yet. We are attempting now to reproduce not just ideas or images, but spaces, people, motion — reality itself.

There is an intriguing loop in the progress of communication enacted by virtual reality, one that circles back to preliterate experience. Our methods of representation have become advanced enough that the need to symbolically encode information is being surpassed. Once communication takes place in virtual realities, that is, once communication is not merely conveyed by technology but occurs within it — in a space created by the technology — the paucity of expressive possibility in our current modes of communication will become clear. Wittgenstein wrote on how linguistic propositions are always separated from reality; in his view, any attempt to talk about things or facts is senseless, ultimately, for we can't say what can only be *shown*. Might virtual reality bring us closer to *showing*?

The ultimate in communication is for another person to be "in our heads," seeing the unique mental constructs which exist only in our brains. Even today, but especially when available technology improves, virtual reality will eliminate much of the distance between our minds and our means of expressing our minds. One will be able to construct, literally, anything, and have other people interact with it the way you do. Instead of trying to evoke a world, a certain perspective, the way something looks, or

---

[87]Joyce Carol Oates, Introduction, *The Oxford Book of American Short Stories*, Joyce Carol Oates, ed. (New York: Oxford University Press, 1992), pp. 8-9.

directions for navigating a flow of information, VR will allow one to have and provide a far more direct interface to the desired content. In this new medium, one might create a small world of creatures, movement, numbers, music, floating whispering heads... and let others explore, talk to the world or its inhabitants, even have things respond. Cyberspace is the newest stage of *World 3* evolution, in which materiality (that of the objects which, it is hoped, convey meaning) is done away with[88] even while that same quality is bestowed, by simulation, on our concepts. The postliterate era of computer-generated immersive environments thus suggests a possible transcendence of the need for (often ambiguous and unstable) linguistic interchange to communicate.

Let us not get carried away, however; many writers have gushed about the power to instantly make real our imagination, or similar fantasies of direct communion. "Our minds" writes Nicole Stenger,

> "were softly leaking rainbows of colored imagination, soon to be joined by innumerable rainbows that would embrace the earth and change the climate of the human psyche. ... On the other side of our datagloves, we become creatures of colored light in motion, pulsing with golden particles. Forget about Andy Warhol's petty promise of fame for fifteen minutes. We will all become angels, and for eternity! ... In this cubic fortress of pixels that is cyberspace, we will be, as in dreams, everything: the Dragon, the Princess, and the Sword."[89]

Not all of this is hyperbole; the way we think *will* change, and in virtual reality, we will be able to adopt the point of view of any character or object, even, in an environment/narrative. The connection between our imagination and what we can make experiential will become more direct with VR technology, and this will be a

---

[88]Benedikt, Intro., p. 4.

[89]Nicole Stenger, "Mind Is a Leaking Rainbow" in *Cyberspace: First Steps*, pp. 50, 52.

profound step towards "lossless" communication.[90] It is a mistake, however, to conceive of a time when VR will bring about the exact realization of *World 3* structures. Virtual reality will make our personal worlds inhabitable by others, but those worlds won't correspond *exactly* with our thought. VR will not ever allow another person to have the exact perspective or background we have. That must wait until neural implants and the like; even then, it seems unimaginable that there won't be some gap. Some translation must take place; no matter how sophisticated the system, we must instruct it somehow to present what our minds picture. To speak otherwise is to foresee a future in which there is no distinction between mind and space/object. Such a vision is indeed religious, as well as philosophically ecstatic: in essence, pure thought. Although I don't foresee neurotechnology achieving this any time soon, I do believe virtual reality is a pale instantiation of that yearning. To be immaterial, to move everywhere in a world instantaneously, as well as to construct one's own worlds, where one is essentially omnipotent — all of this points towards becoming, in an almost crooked way, our definition of God.

If we look to a time when communication occurs through, or in, some virtual space, the potential questions are numerous. Which questions are pertinent depends largely on what exactly we are picturing when we imagine the future. As telecommunications, cable networks, and personal computers converge, telephone interchange will continue to seem the same, although it will travel through the same fiber optics as all other data. Since their invention, telephones have become more and more feature-laden, certainly easier to use, but still convey the exact amount of identity and intent as they always have: a disembodied voice. Soon enough, live transmission of

---

[90] "Lossless" is a term I borrowed from digital compression technology, referring to zero visible degradation of resolution. Its opposite in that context, believe it or not, is "lossy." My use of the term is not related to its usual context; the word seems to sum up some, perhaps crude, ideal of communication: total representation, getting everything across one wants to without gaps or ambiguities.

images along phone lines will enable people to see each other while talking, perhaps on the same terminal one's computer system uses. This science-fiction informed vision of videophones and the like has been, in the last century, the most familiar manifestation of our collective desire for improved remote communication. Artifacts of cultural imagination of that sort *will* come into being; actually the technology for a videophone device has been around for some time. Of course, to what extent people actually want this or any other imagified commodity could be debated at length. In our society there is a sort of collective presumption or expectation of progress, whose automatic nature is imprinted by late capitalist mechanisms. This makes it especially interesting to look at the case of video images supplementing telephony, which will provide some indicators useful for investigating if the world wants or needs virtual reality communication systems.

The reasons the public didn't respond to videophone concepts are difficult to isolate, but we can make a few conjectures. One mundane explanation is that simple fear or caution in the buying public was caused by poor information saturation. One reason the videophone fizzled at first, certainly, was due to the crudeness of the technology — low resolution images, transmission lags, camera position confining the user's posture, etc. Another pragmatic factor was the scarceness of similarly equipped people to communicate with. There are some deeper considerations: perhaps it is indicative of how ingrained life with existing tele-communication methods has become, causing even the American public to be uneasy about a whole new sphere of exposure. There is the probability that most people enjoy restricting the other party's access to voice only. More than a few writers have pointed out the undesirability of somebody being able to see you in the "privacy" of your own home. Many of us feel that the world is invasive enough already. Communications media are supposed to increase our power to reach out into the world, to extend ourselves; commercial factors have made the media increase the world's ability to enter our space. Television, for example, is easily seen as a media channel penetrating and infiltrating the sanctity of the home. Again we are reminded of McLuhan's writing, specifically his discussion of electronic media permeating our environment with its transmission waves, becoming an omnipresent medium like air.

In imagining future communications in virtual realities we should not ignore how the telephone has contributed to the alienation of modern and postmodern societies. VR is not exempt from such a worry, although we can hope for a paradigm that increases meaningful communication and understanding. One factor in favor of this optimism, from a sociohistoric point of view, is that virtual reality might bring back elements (such as bodies, visuality, and full personalities) whose absence made the telephone such a useful device for commercial purposes. To put it another way, VR lends truth to the slickly false advertising slogan "Reach Out and Touch Someone."

VR as a communication medium will definitely impact culture, more so, I believe, than even the telephone has. Whether virtual reality is a medium that people will want to use for day-to-day, "casual," conversations — in other words, replacing the telephone — is something many executives are trying to figure out. With virtuality, the video eye will not extend into your real, physical environment; the linear progression of invasiveness in media technology will taper off. One can retain the often advantageous feelings of anonymity and security that the technological limitations of telephones got us used to, while still gaining the tremendous boost to the expressive possibilities of remote communication which visuality affords. It seems the public is a little more receptive now than even five years ago to incorporating a visual element into telecommunications, probably because new marketing schemes avoid suggesting the telephone will be replaced. (This is a perfect example of the specialization of media which can occur after the initial confusion and blundering over-application.) Most American corporate R&D focuses on augmenting old technologies rather than recognizing the need for truly new concepts. It is a mistake to imagine future technology as merely an extension of current tools and methods, although there is always a transition period where just that occurs.

Right now we are in the final stages of a technical transition that has important ramifications. A massive increase in computing speed and bandwidth is bringing almost all video into the digital domain. It is possible to digitize a live feed, send it anywhere in the world virtually instantaneously as binary data, and have it reconverted to an image at the receiving end. The importance of this is not immediately obvious, mostly because the companies behind the technology don't know what they should advertise. One critical result: by being digital, any representation of you can be seamlessly altered or substituted for. The next chapter, IDENTITY, addresses at length the questions, excitements, and concerns this brings up, as well the broad range of repercussions, both cultural and philosophical, it might have.

Eventually, telecommunication companies will allow the public at large to realize that along with our faces (which present the most obvious and captivating possibility), any sort of other information can be shuttled over to whomever one is talking to. This information could be a photograph, moving video, an alternate projection of ourselves, or a self-contained simulation. Imminent developments in communication technology, such as videophone devices, will be fairly consequential, enacting some significant changes in how we interact, as well as what in what modes we choose to interact. These shifts, however, are slight relative to what virtual reality might mean for how humans communicate.

Several approaches are now being tested by megacorporations all over the world. Some of them use the familiar videophone concept as point of departure, but instead of using a realtime video transmission of a fixed area, most likely designed to be filled by the person's face (maybe head and shoulders) these approaches are shifting parts of interchange into virtual reality. American companies, for the most part, are not the ones who are dedicated to investigating VR as a communication medium. Most of the companies who have made a commitment to visionary research and development are in Japan.

In marked contrast to the United States, the Japanese have made a big national commitment to virtual reality research and development since 1988. Japan has a Ministry of International Trade and Industry (MITI) made up of all the big leaders in Japanese government, industry, and academia. Virtual reality is integrated into Japan's official industrial policy, whereas the US doesn't even have an industrial policy.

The Advanced Telecommunications Research Institute International (ATR), created in 1986, has evolved into the world's richest VR laboratory. Their goal is to build the mass-media cyberspace communication systems for the 21st century. Nippon Telephone and Telegraph, the largest communication company in Japan, is ATR's biggest shareholder. ATR is not just a Japanese organization, it has international sharing in its charter: over 140 communications and computer companies contribute money and people, although the majority of shareholders and researchers are Japanese. In 1991, ATR's budget was $50 million a year; two of their four labs focused on televirtual communication. They have labs devoted to intelligent communication systems, interpreting telephony, human sensory perception mechanisms, optical and radio communications, and advanced telecommunication devices. "Communication with realistic sensations" is the motto of their VR effort, which is partly focused on conveying modes of expression that don't go across telephones like posture, gesture, facial expressions, and gaze direction. They've developed a $10,000 gaze tracker (eye-tracking is usually done with infrared or other optical means, although sometimes with biosensors (dermal electrodes) mounted on the muscles around the eyes) and a $1 million wall-sized video projector which sharpens detail at the center of the user's gaze, mimicking how human vision works. The VR lab is working on gestural input and scene interpretation to remove goggles and gloves from users. The lab wants to build an intelligent communication terminal that responds according to how you direct your attention, picking up from the ideas of American VR pioneer Myron Krueger and the work at MIT's Media Lab (see APPENDIX). Most of the VR work at ATR is aimed at virtual meeting spaces, using immersive 3D video displays (the Japanese are hoping VR can be developed that doesn't require headgear), eye-tracking, and gesture-sensing (again, they prefer to do without input gloves). Their scientists are using computer-modeled masks with facial characteristics and head movement data going over phone lines. This means that a communication system could come about that would represent oneself through a computer puppet, so to speak. The computer-generated image would probably have a few user-configurable options at first, with more to come, and would mimic all of your real movements. This would allow your physical self to remain thoroughly privatized, while still conveying the nuance of facial expressions. Just as suggested above, in this type of system what you appeared as would not have to have any correspondence to what you really look like.

Fujitsu is another Japanese company that is very serious about virtual reality research.[91] Fujitsu beat IBM at mainframe technology, which is an indicator of their clout; Japan is the only country where IBM does not have the top market share. Their 1988 net sales: $15.2 billion. They have a division solely devoted to VR now; they're building their own HMDs, graphic chips, and 3D modeling software. Fujitsu is the ultimate vertical megacorporation; they do it all, at every level, from core microcircuits to satellites. Fujitsu is mainly targeting CAD, entertainment, and education as the commercial areas of VR. Fujitsu Laboratories has two centers; one studies telecommunications, space, information processing, and personal systems; the other works on electron devices, electronic systems and materials. Their corporate mantra: "What Mankind Can Dream, Technology Can Achieve." Fujitsu breaks AR (artificial reality) into three levels: device (gloves, eyephones, datasuits, eye-tracking, gesture-sensing equipment), system (computer graphics, speech and gesture recognition

---

[91] All information about Fujitsu's VR effort from Rheingold, pp. 291-298, 306-310.

software, world modeling, and user capabilities), and “art and application” (remote operation of tools, communication systems, and training simulators as well as entertainment applications centered on artificial, first-person dramas users will participate in). They see “scenario control” systems operating in the background of VR setups which will contain world laws and behaviors. “Knowledge agents,” run by neural networks, will help users locate and manage the information flow. Because of its sheer size and distributing power, Fujitsu will probably be a great influence on how modes of communication evolve. Their entertainment products, however, seem to be higher priority, which means that technology will be adapted for use in communication systems.

One company, at least, in the U.S. is very involved in thoughtful design of the future of communication. Jaron Lanier, the founder of the highly successful VPL Research, is actively pursuing a vision of what he has termed “post-symbolic communication.” Lanier’s vision is of people exchanging total simulations, i.e. virtual worlds, for each other to explore and learn from — post-symbolic communication. Virtual reality, for Lanier, promises to make *Worlds 3* and *2* (to continue with Popper’s terminology) take on *World 1*-like characteristics, the most profound of which are materiality and inhabitability.

In 1989, Lanier presented his Reality Built for Two (RB2) system at a Pacific Bell technology convention. RB2, the demo of which contained a virtual environment called “Day Care World,” was designed to illustrate how two people in the same virtual space could exchange and demonstrate ideas in an unprecedented manner. While in Day Care World, which was a simplified model of a center for pre-school kids, one could fly around, pick up blocks, turn on lights and fans, or choose to see from an adult’s or child’s perspective. The other person appeared as a cartoony solid. Walls could be resized, light sources moved, ceilings raised, all by pointing and gesturing. The demo was wildly successful: even with its crudity — resolution and update-time that seems archaic today — users felt the potential of interchanging ideas in a vocabulary innate in those ideas. Words, for example, are not well-suited to describe architectural details, which is why blueprints exist, as additional symbolic vocabularies to work with. Three-dimensional models are even better at giving an approximation for a design whose meaning is attempted to be conveyed. Models are extremely time-consuming to make, unfortunately, and clients don't have to vocabulary to understand and discuss blueprints. Virtual reality allows a user to inhabit a simulation of any space or building, walk around in it, experience its proportions, lighting, materials, and so on. The system can be configured much like VPL's RB2, where one could move around elements at will and see and experience the result instantaneously. Free, costless, experimentation is possible, in other words, a capability that is sure to have as much artistic value as practical worth.

Architectural visualization became a commercial product when Autodesk and VPL entered the virtual reality industry in 1989. Shortly before, the VR team at UNC took the blueprints of a new, as yet unbuilt, building they were to move to and converted it into world-object data. By having a computer render the scene based on an HMD-wearing user's head position, they were able to "walk" through a virtual 3D model of the building before it was constructed. While doing so, they found one hallway to be uncomfortably narrow. When they brought this to the architects' attention, they were met with polite scorn, but the UNC researchers persuaded the architects to use their VR system. The plans ended up being modified, and today you can walk through that slightly wider hallway to the offices where the simulation of itself sits. Other small but significant VR uses have been spreading in the architecture community since then, like navigating a building as if one were in a wheelchair before building begins.

The Port of Seattle project also illustrates some of the potentials of virtual reality environments. There are plans to redesign the Port because as one of the world's major seaports, it is becoming more important as a stepstone to and from the Pacific Rim. Long-term plans for such a massive site involve billions of dollars and important people from all over the globe. Trying out ideas in VR not only saves a tremendous amount of money, it also facilitates communication between architects and clients, and allows people who speak different languages to have a far more synchronized concept of what's happening in the design process. In one virtual meeting, several executives of different nationalities, representing different interests, along with two of the chief architects, walked around together (without their customary interpreters), gesturing approval or concern. The architects were able to quickly demonstrate alternate designs with the same realism as the originals, and all in a manner that could not be misunderstood. Though elementary, this was post-symbolic communication, and it is the reason architectural visualization is one of the major areas of virtual reality research and development.

The next plateau that virtual reality represents is far more than just another quantitative step in the technology of image presentation. The sense of presence enabled in virtual spaces can be seen as actively working against some of the technologically (or otherwise) induced alienation discussed previously. Allucquère Stone has written that modern cities thwart social spaces and interaction because they are structured more around the needs of economic interests than around facilitating cohabitation and harmony in the urban context. We are beginning to seek a sense of community that the geographical and cultural realities of modern urbanity have damaged or obstructed. Although sometimes blamed as alienating forces, "[t]echnologies can be seen simultaneously as causes of, and responses to, social crisis."[92] Stone believes that Internet communities, and their eventual development into embodied virtual systems, are innovative cultural solutions to the need for social

[92]Allucquère Roseanne Stone, "Virtual Systems," in *Zone 6: Incorporations*, Jonathan Crary and Sanford Kwinter, eds. (New York: Urzone, Inc., 1992), p. 620, quote p. 613.

interaction. The reintroduction — and redefinitions — of sociality engendered by virtual reality may prefigure a "variety of complex and ingenious strategies for survival in... the urban wasteland."[93]

Thinking of the next step in telecommunication as a few other features presented along with the sound of one's voice is rather shortsighted; there will be other factors which will disclose a sharper distinction from our current paradigm of voice-only telephony or text-only letters/faxes. The computer mediating interpersonal communication will result in more than a simple facial video image, more even than a moving, expressive body being broadcast. Virtual reality will do more than make technology simulate proximity and presence, which has been by and large the project of *tele*-communications so far. We are at the culmination of that history, whereby the very purpose of *tele*-communication is collapsed. For VR puts us in a position to rethink not just what is able to be transmitted over distance, but the very possibilities of communication itself. It will provide us with abilities, cyborg abilities, that enable interchange on a higher level than we have ever experienced.

---

[93]Stone, "Virtual Systems," p. 620.

If cyberspace existed before digitalized navigation, it becomes much more rich and complex now that we have evolved (in, it should be noted, a tremendously short time) to the point where we are able to project incarnations of ourselves in much more complete form. Remodeling current modes of communication into virtual modes will have significant consequences for how we think of subject and body, and the relation between the two. One of the ways virtual reality technology engenders revolutionary possibilities of human interaction is the unprecedentedly mutable nature of a subject's image or representation. Given that one's image will be transmitted as data, *there is no reason why that image has to be you*. Communication in virtual reality might involve alternate projections of yourself, or hybrid personae with your facial expressions mapped onto a computer-generated body. Not only could you have your computer alter your appearance, you could also have anybody else's image transmitted along with your words. Or an object, or an animal; Howard Rheingold, the author of one of the definitive technical books about VR, never tires of describing how he danced with another person who appeared to be a twelve-foot tall purple lobster in a system demo.[94] Now, in our current conception of phone conversation, this seems somewhat fantastical, and most companies aren't aiming to develop these possibilities for "everyday" personal communication. Telephonic conversation, however, is the primary instance of technology-mediated interaction only today; the future, as the Internet demonstrates, might see many other modes of communication come into being. In some of these modes it might be useful to appear as yourself, in others perhaps a manipulated version of you or an altogether dissimilar persona. In virtual reality, your real-world identity has no place or power unless you wish it to (this is not to say your desires and fears are suddenly dissipated).

---

[94]Rheingold, *Virtual Reality*, p. 170.

Cyberspace can be seen in its early adolescence on the Internet, where on-line discourse and personal exchange, the newest form of *tele*-communication, has created entirely virtual communities. At this stage in its technology, most interaction on the Internet is text-based; despite this transiency, it is worth discussing the ways in which traditional communication has some of its underlying assumptions removed by electronic discourse, if only to foreshadow what virtual reality might engender. The textual nature of Internet conferences creates a framework that has its own unique personal dynamics, not all of which are peculiar to a non-visual environment. Foremost among these is the referentlessness of every presence on the Net; not only does everybody exist without any physical appearance, but identity information of any kind, being fully plastic, affirms very little about someone's "real" self. Examining text-based electronic communities, the predecessors of virtual reality, will reveal hints of a potentially radical paradigm shift in the ontology of identity, and because Net-life exists now, it provides a much needed empirical basis for theorizing.

Throughout most of history, human beings have grounded identity and self in the body. The physical body was (and, for the most part, still is) conceived of as at least the carrier of one's self, if not an inseparable component of self on its own. Mind or intellect is often equated with self, insofar as intentionality, beliefs, fears, etc. are presumably all generated by the mind. One of the major debates in the history of philosophy, of course, centers around the distinction between mind and body. Even if we regard the mind or thought as the one indubitable presence, as Descartes did, everyday existence requires acceptance of the body as at least a housing for self. One commonsense view of the world takes the body to be a physical structure which the self not only inhabits but is also comprised of in some way. The average person has a hard time thinking of their self, on a familiar level, being distinct or disconnected from their body. It was not so long ago, in fact, that culture (catalyzed, specifically, by American youth culture in the 1960s) recognized and celebrated that part of who we are is our body, breaking from a lingering Victorian code of repression.

In fact, it was the Victorian era that marked one of the clearer steps in the divorcing of body from subject that virtual reality completes. The industrial proliferation of the homogenous working unit (a body for which subjectivity, in the eyes of the machine, is superfluous) contributed to that divorce, as did the development of communication technologies which removed the body from social intercourse. Strictly speaking, it was really the birth of *tele*-communications that began the breakdown of the coupling between thought and the physical presence of its originating entity. We can clearly see in the instance of the telephone how that device projected identity into a space the body did not inhabit. Technology of that sort, as well as the production of text, provokes a tension over the site of identity, resulting in a decentering of interchange and a fragmentation of society. Still, even at the onset of the twenty-first century, many of us regard the body as the definite locus of identity. Our thoughts seem to originate from whatever space our bodies occupy; our brains are indubitably located in our heads. Although the telephone has introduced a prosthetics of presence into daily life, the level of simulacra it achieves is not enough to alter our fundamental conceptions of ourselves. Virtual systems, however, problematize in a very immediate way the conception of identity as being inseparable from a corporeal self. Virtual reality is a mode of near-total immersion within which our physical existence is essentially irrelevant, and consequently makes it possible that identity will come to be conceived of as totally unconnected to the body.

Any such refiguring is largely contingent on frequency of engagement with new technological modes of being, in this case, participation in people-oriented virtual environments. I think it unlikely that we will all cease to interact in the real world and come to exist entirely within simulated space. It does seem probable, however, that as the technology becomes more sophisticated and more wide-spread we will exist as virtual projections a higher and higher percentage of the time. The notion of identity or identities that are part of us yet not associated with our bodies will necessarily be impressed on us. This possibility of existence will supplement, not supersede, the conception of self-grounded-in-body which has dominated for millennia. Were they to co-exist, conflict seems inevitable between such seemingly disparate formulations. How can we ground our identity in our physical body while at the same time situating it in a virtual body or bodies? There must be a tension, but not one of mutual exclusion; our physical selves will lose their hierarchical prominence over our "other" selves, becoming instead simply another facet of what we consider ourselves to be. The key shift is from an implicit primacy of the physically-grounded self to a framework within which the physical body as interacting organism is only one focal point of identity. For years, people on the Net who have developed strong on-line personalities refer to their "RL" ("real-life") identities, identities which are treated as not only distinct but often secondary "others." Many users, of course, never reveal anything about their off-line personae. Within virtual environments, one's simulated identity or identities will be the important one; if communication with a certain person occurs only in virtual reality, that person's "actual" identity will have much less importance than the identity of his or her virtual projections. Even in the physical, off-line world, the so-called real self will evolve into just one fragment of identity that stands on equal ground with virtual selves.

As the proliferation of virtual selves complicates the identification of a primary site of self, pagers, cellular phones, and soon-to-be-popular portable satellite links are making it increasingly difficult to privatize location. Insofar as technology in the first case is making the subject unlocatable and invisible and in the second case situates and makes evident the subject, these movements seem to be contrary. Consider, however, that the electronic devices listed are not concerned with physical location, but rather just the *ability to locate*. It is the "connectedness" of the individual, not his or her actual position that matters. The individual is posited as a node, a spot on a network which considers geography irrelevant. Even with a plethora of digital bearings on where you are, your body and its whereabouts are completely removed from the sphere of interaction. You become virtual, even without connecting to a VR system; your "real," physical self is more, not less, disconnected by locating devices. Again, although the actual self is connected by networking technologies, its physical position is unknown to those communicating with it. When you call someone with a beeper, you locate them in one sense, yet you still have no idea where they are.

The explosion of the Digital Age transformed the information landscape so quickly that we are often alienated by the new environments we created. This was largely a consequence of the vagaries of technological development; now that the initial flurry of computerization has calmed, a lot of companies are putting money and resources into interface design. Technology is never a one-sided game; some developments can be posited as attempts to locate, and stabilize, ourselves in an overwhelming flood of information. Immersive simulation — VR — will provide the ultimate interface, one in which we can interact with the dataflow as fully enabled human beings. Along these lines, virtual reality can be seen as an enabling and dealienating re-introduction of self and presence into the networks of technology and electronically mediated interaction.

As the network makes our physical self less and less important, people and institutions (what the network is mostly comprised of) will do so simultaneously. The demotion of the physical self does not just occur within the network; social interchange, whether it be for pleasure, business, or artistic purposes, is a huge part of daily life. If a large segment of that sociality is displaced into the virtual, the importance of the offline body as socially-conscious will shift proportionately. If you conducted all communication over the phone while on vacation, you are more likely to lie around in sweatpants than to put on a suit or make-up. For all of history, humans have ordered their lives and interactions around physical selves and physical surroundings. Virtual reality, as in many ways the endpoint of the demotion of materiality, takes away the physical body as a presence which signifies in any way. In cyberspace, suddenly a historically substantial portion of what it means to be human is rendered irrelevant. What happens when the cues humans have always used to evaluate each other are almost all thrown into question? In the offline world, when we first meet someone, the vast majority of our judgements on all aspects of that person's character are informed by his or her appearance. Virtual appearance has nothing to do with real appearance — although of course they might correspond. What is important is the sudden unreliability of all visual information that virtual reality introduces. Even the quality and timbre of a person's voice, if the system we're imagining has that capability of reproduction, is fully manipulable.[95] Many of our first assumptions about people are based on gender, ways of dressing, and attractiveness. What will happen to sexual dynamics if everybody can enhance or completely alter their appearances? On the Internet, it is not uncommon for users to assume other genders or sexualities. This role-playing, if you want to call it that, is undetectable as a machination, although one's conduct can certainly provide hints. A physically handicapped senior citizen could be seen as a healthy twenty-five-year-old graduate student. An Asian teenager might present himself with the visage of a white, adult celebrity. The ramifications are manifold. Take this tale of the Internet, one whose framework is not at all uncommon in virtual spaces:

> "This story is about a totally disabled older woman who could still push the keys of a computer with her headstick. The personality she wore on the net was huge, though, and her disability was invisible and irrelevant. Her standard greeting was an expansive "HI!!!!!" She was sympathetic and intelligent, and in the intimate electronic companionships that can develop during online conferencing between people who may

[95]A cyborg device of this kind has been available for years: telephones that digitally alter the pitch of your voice. The advertisements trumpeted the usefulness for a woman living alone to sound like a man.

> never physically meet, her women friends shared their deepest troubles, and she offered them advice that helped make significant changes in their lives."[96]

So far, it sounds like a positive but slightly hackneyed example of computer-mediated interaction affording a handicapped person freedom from discrimination or prejudice. The woman's wisdom and caring were unlocked by the absence of identity cues which normally might have been prohibitive. But the story continues...

> "After several years, something happened that badly shook the conference's participants. We learned that she was only an online persona; that in her offline life she was a middle-aged male psychiatrist. How had this come about? Logging on to the conference for the first time, he had accidentally begun a discussion with a woman who mistook him for another woman... 'I hadn't known that women talked among themselves that way,' [he said later]. 'There was so much vulnerability, so much more depth and complexity. Men's conversations on the nets were much more guarded and superficial, even among intimates. It was fascinating, and I wanted more.'"

The man's (?) real-life identity went undetected for years,

> "until one of her devoted admirers, bent on finally meeting her in person, tracked her down. The news of their meeting and the discovery of the woman's offline male persona traveled quickly through the conference. Reactions varied from humorous resignation to blind rage. Those most deeply affected were the women who had shared their innermost feelings with her. 'I felt raped,' one said. 'I felt that my deepest secrets had been violated.' Several went so far as to repudiate the gains they had made in their personal and emotional lives, which they felt to be predicated on deceit and trickery."

Because of being new and all textual, electronic discourse stands easily as a distinct category of interaction which, with its provincial laws, "netiquette," and playful acronyms, retains its own special character. Most germane to this discussion is the arbitrary relation between offline and online personae engendered by cyberspace. As

---

[96]All quoted text from Allucquère Roseanne Stone, "Virtual Systems," p. 612.

mentioned before, in the case of the Internet, its textual nature meant no physical appearances existed to provide identity information. Textuality is appropriate, for the unexpected behavior on the Net in the story just told was nothing more than fictive writing. It is only in the context of truth, and the trust that flowed from that flawed assumption, that people felt transgressed. The system operators were not surprised in the least — “they had long ago taken for granted” the groundlessness of online identity.

The real severance, however, exists by virtue of the computer as medium. As with most mediums, the networked computer *a*) translates the message, first, solely by carrying it (erasing the context, temporal or otherwise, it originated in) and second, often further to facilitate transmission (in the computer’s case, into binary data), and *b*) is of restrictive bandwidth, i.e. doesn’t transfer the entire presence of the original message/subject. Virtual reality will contain many conference-type interactions similar to those on the Internet, except that the experience will be multimodal. Visual and aural effects will greatly enhance a sense of presence for the user, yet will not actually transplant any more of the subject into cyberspace. The movement from text-based environments to VR systems that engage most of the senses could work in opposite ways on our assumptions about identity. If people engaging in solely textual interchanges make strong assumptions about identity, won’t embodied presences be even more affecting? Maybe, but it is equally possible that our imagination is engaged more by what text *doesn’t* afford, and so visual images will make us less likely to construct base personae for those we interact with. The existence of virtual bodies, in other words, might call our attention immediately to the mutable nature of those bodies. Text by itself does not make explicit the tacit construction of identity, as opposed to choice of facial and body image, which obviously does so more strongly.

When real-life physical identity is severed from virtual selves, it seems certain that we will gradually demote physical appearance in the hierarchy of identity information. Virtual appearance will be recognized as standing in arbitrary relation to a person's "real" (better, "offline") self; virtual selves will eventually be judged by what seems to be more meaningful criteria: content of speech or thought, creativity of concepts, etc. Our relatively recent political and moral ideals of total lack of identity prejudice, it seems, will be closer to actuality. Won't we have to question all of the assumptions and decisions we make based on appearance — gender, race, attractiveness? Those signifiers don't signify much at all if they are entirely malleable constructs. Moreover, virtual reality will not just enable freedom of choice between categories, but will also introduce new categories. More precisely, non-categories: one could, fairly easily, appear as some sort of pan-racial, androgynous being. Not to mention all sorts of nonhuman objects, living out the personifications on which popular animated movies have thrived.[97] Yet there is much that is problematic about generalizing the designifying of certain identity cues. By assigning a progressive value to the elimination of gender and race, for example, we postulate a transcendence of those attributes. It remains to be seen how much of our behavior, or optimistically, our open-mindedness, in virtual spaces translates back to the real world. In addition, such attributes are not just affects which happen to foment prejudiced assumptions. They are very much part of the fabric of every self that lives, and a total deconstruction of their meaning could be harmful if we disallow *any* significance. There are further complications: qualities such as gender and race have impact in large part — if not entirely — by virtue of a social field of interplay. Michael Serres, among others, has asserted that the individual, like culture, is a continuously constructed product of

[97] For example, Lumière, the anthropomorphicized candlestick in Disney's *Beauty and the Beast*; these types of characters have always been popular, perhaps because they embody personality without the threatening significance of the human. Consider also the fascination with talking animals, such as those in C.S. Lewis' *Narnia Chronicles*. For the child, I believe, a fundamental benevolence and safety inheres in the (Good) animated object or animal. If virtual reality habituates us to nonhuman entities with complex, multilayered, impure human agendas, that innocence might disappear.

intersecting social spaces.[98] Our identities, and the treatment we get from others, is often defined by difference, and oppression and mistreatment occur through social relations. Larger political fields are important because of how they effect individuals. If technology creates a space of interaction where fundamental aspects of identity lose their significance, that loss might occur, not just in the realm of social treatment, but in the individual him or herself.

The extent to which we are conscious of the arbitrary nature of appearance in VR, and thus how much of identity is an imposed construct, revolves around the transparency of the technology. Virtual reality systems will probably be developed, as most technology is, with invisibility as an overarching *telos*. If the process of selecting one's appearance is complex and belabored, it is more likely that the subject will be aware of the fabrications of others. Conversely, if the process is so intuitive as to be almost automatic, it will be easier to forget how much each person chooses details that may mislead. This binary opposition is far too simple, however, for if the potentialities of personal appearance are magnified along with the ease of instantiating them, the issue must be reformed, for superficial aspects might become more meaningful. One of the reasons physical impressions are taken to be shallow relative to a person's full character is that what can be conveyed through appearance alone is limited. What if we suddenly have far greater power to construct our bodies, choosing from infinite menus of shapes, animals, video images, sounds, artworks, geometries? How much more of who we are could we communicate if our virtual selves became a series of mutating, morphing relationships? Appearance might begin to mean more, not less, in virtual spaces. How much we are aware of the assumptions we make based on visual cues would then cease to be such a critical issue. Gleaning a lot of information from visual cues in virtual reality could lose the pejorative cast we usually assign it. In physical

[98]Michael Serres, "Language and Space: From Oedipus to Zola," in *Hermes: Literature, Science, Philosophy*, Josue V. Harai and David F. Bell, eds., (Baltimore: The John Hopkins University Press, 1983), pp. 39-53.

reality, we might be so aware of the paucity of expressive possibilities that we will draw less meaning from appearance than we currently do. If we are optimistic, we can see a future where truer aspects of identity are shown than physical reality allows us to. The internal is externalized by the subject's dissolution into digital space; a transparent technology will enable the clearest connection between self and its constructed manifestation.

In some sense, our conception of identity must become rarefied: stripped from it are physicality, spatial location, singularity, even temporal position. As mentioned before, such a development, if the emergent sense of identity is a purely psychological one, that is, behaviorally and intellectually based, is at least *potentially* enlightening. The body, however, as a site and indicator of identity, has always provided us with cues into which we pack meaning , and there is a certain advantage to that. As with any symbolic interchange, there is a compromise made: a time-efficient condensing of signification results in a less full representation. Prejudiced suppositions and mistaken first impressions are obvious examples of the shortcomings of time-saving assumptions based on appearance. But we cannot take the time to explore the mind and character of everybody with whom we come into contact. In addition, we often function in society as role-specific units whose appearances are deliberately to be read as facilitating codes.

The more obvious examples of this, such as policemen and medical personnel, don't really exist as such in cyberspace. Those who have roles analogous to official entities, such as obscenity filters or debugging specialists, might retain special identifying characteristics in virtual space. I think it more likely that the elimination of physical space as a potential source of conflict will result in the absence of need for visual codes of authority. Police cars and ambulances need to be obviously marked so that civilian vehicles will yield right of way. In cyberspace, authority entities will most likely be invisible, if not AI-driven. They will be programmed to enjoy processing-time benefits by system designers, and so will have no need to make themselves conspicuous for purposes of civilian obedience. Certain service-providing entities, whether public or private, technical advice or security protocols, will continue to need clear identification. On large Internet providers like CompuServe and America Online, services are advertised and performed as collective agencies, not as specific individuals. Iconographic codes or ingrained, universal symbols are often used to signify the function of those entities. Almost nobody who is part of the system's administrative side presents themselves as individuals. (At the same time, the democratizing effects of E-mail often allow the public at large to communicate more personally than ever with those prominent members of society who used to be the most inaccessible: celebrities and politicians.) We could have virtual worlds populated exclusively by citizens, so to speak, although most likely commercial elements will insinuate themselves into every nook. Still, the potential absence of any visible "authorized" entities is an intriguing one, which so far on the Internet has resulted in an anarchical web of cooperation that many find exciting and encouraging.

The VR systems available to the public might not enable absolute freedom to be whatever we choose. Howard Rheingold's claim that with virtual reality "we are on the brink of having the power of creating any experience we desire"[99] is naive because of both technical limitations and corporate/capitalist structuring influence. The potential for fascistic restriction is present in virtual reality, although I believe that the more advanced the technology becomes, the less this is probable. There is no question some aspect of VR will become mainstream, and given the history of commercial products, it is wise to temper any utopian leanings. What if consumer-level systems only offer limited menus of "personal body choices"? In Lucasfilm's Habitat, for example, an early prototype of a virtual community, participants were represented by cartoon characters whose only differences were hair color. The limited choices in Habitat's

[99]Rheingold, p. 386.

system were mostly due to hardware and software shortcomings, but it is easy to see how end-user choice might be sacrificed for technical reasons.[100] Furthermore, companies will probably simplify the options available to the consumer because complexity (i.e. any requirement for thought) doesn't usually sell well. Systems in their early stages might only offer a few choices to their users, but there is reason to be optimistic: the precedent of the computer industry is that as ease of use improves (interface being a barometer of technological progress) the end-user becomes more enabled to bypass schematic dictates. Hopefully, the ideals of individual empowerment that infused the birth of personal computing will be perpetuated somehow within the corporate conglomerates.[101]

The mutation and evolution of identity involves multiplicity as fundamentally as it does disembodiment and virtual reembodiment. Our long-standing centering of the self in the body is not just a question of location; it is also closely tied to a *single awareness* of identity. Because the body is so clearly in only one place at one time, as well as being concretely unitary, the self as inhabitor of it is also easily postulated as singular. Moreover, as Allucquère Roseanne Stone has pointed out, society conditions us to behave as having one true identity, attached to a single physical body.[102] This is largely due to political and legal agendas: individuals must be discrete, identifiable units in order to be taxed, assigned fault, and (if one tends towards Orwellian fears) controlled. Society is more comfortable with "a political, epistemological and biological

---

[100]Chip Morningstar and F. Randall Farmer, "The Lessons of Lucasfilm's Habitat," in *Cyberspace: First Steps*, pp. 273-301.

[101]The PC has been progressively more empowering for the individual by both its reduction of exclusivity due to sheer expense and its elimination of dependence on third-party monopolies. Desktop publishing, video editing, and electronic music are the more obvious examples.

[102]Stone, "Virtual Systems," pp. 609-621.

unit that is not only measurable and quantifiable but also understood as being essentially in place."[103]

The undercurrents of an ontic unease with indeterminacy and plurality are found in the idea of simplification and reduction as an indicator of and technique towards comprehensive understanding. This originated, perhaps, with the medieval philosopher Occam, bloomed during the Enlightenment, and flourished as modernity took hold. The modern individual was and is (since, although theory has outstripped modernism, most people have not) ill-equipped to admit to schizophrenia, whether it is culturally-induced or not. There has been an uncomfortability with the notion that there is no unitary self, that one's identity is neither consistent nor able to be precisely delineated. Technology, especially as a condition of prostheses, decenters and fragments the self; engagement with the hypermodern device both brings out and introduces further schizophrenia in the individual. This was shown previously as occurring with the disembodiment of the telephone, and now with virtual reality: one's location becomes uncertain. Where is the self? Is part of it in the telephone receiver that it seems to be floating out from? Is it in the cyberspace of a VR system, where it exists more fully than the cybernaut's essentially blindfolded and disengaged body does? Other modern phenomena try to reassure by defining: standardized tests, personality profiles, even house numbers on numbered streets. Much of the tendency towards singularity can be quite constrictive, and as the Internet demonstrates very well, there are those who are reacting directly against it. As much as people have idealized stability and control of self and environment, there seems to be a collective desire to rebel against the repression of alternate identities that persists from the 1940s and 50s, and beyond. Technology, specifically virtual reality, can be a vehicle for freeing the self from imposed codes of identity-specific behavior. Ubiquity breeds social acceptance:

---

[103]Stone, p. 614.

although the idea is nothing new on the boundaries of culture, we are discovering in the light of day that it is a relief not to be yourself.

In many ways, the fragmentation of self which virtual reality enacts is a continuation of the colonization of interior life that began with critical psychology. The beginning of a popular non-singular conception of identity can be spotted as far back as Freud insofar as his ideas of the subconscious articulated sides of each of us which we are not aware of. Freud himself viewed his work as producing an "ego-smashing" moment,[104] the third in history after the Copernican revolution and Darwinism; each represented the resolution of a discontinuity in how we placed ourselves in the cosmos.[105] Freud's unconscious was a blow to a metaphysics of (self-) awareness, and prefigured recent theory about the decentering of identity. His work showed us that there are other sides to our own identities which may not be present to us, that there were facets to us which seemed to not belong. In the first confusion of such a realization, one might indeed feel like there are parts of your identity which are not you or not the you that you know, and thus that some sort of pluralism was being revealed. Such a view is mostly informed, however, by the long-standing privileging of a single locus of awareness. However, Freud's division of Id, Ego, and Superego is essentially a splitting of the individual, not a multiplication of it. In the nineteenth and most of the twentieth centuries, convolution of identity was not a welcome phenomenon; multiple identities in one individual was regarded as unhealthy. Psychiatry developed as a science of personality, with driving metaphors of illness (pathology) and purging. Gradually, postindustrial modes of being and scientific and intellectual investigation of self destigmatized multiplicity, although did not resolve it. Freudian analysis, while

---

[104]Bruce Mazlish, "The Fourth Discontinuity," in *Technology and Culture*, ed. Melvin Kranzberg and William Davenport (New York: New American Library, 1972), p. 218.

[105]Ernest Jones, *The Life and Works of Sigmund Freud* (3 vols.; New York, 1953-1957), II, pp. 224-226. Freud's remarks are from the 18th lecture of his *General Introduction to Psychoanalysis*, delivered 1915-17. Cited in Mazlish, p. 216.

very much a fitting tool for the rationalizing, unifying instincts of modernism, already pointed to the crisis of complexity which postmodernism addresses.

The shifting fields and fundamental incompletability of knowledge revealed by postmodernity brought notions of multiplicity to the fore. Virtual reality makes explicit, or concretizes, the ever-shifting, socially constructed nature of identity that contemporary thinkers write of. Julia Kristeva, according to Iris Young, relies on a psychoanalytic notion of unconscious to assert that subjectivity is heterogeneous and decentered.[106] Kristeva suggests that consciousness, meaning, and intention are only possible because the subject-in-process slips and surpasses its intentions and meanings. What one says and does has a multiplicity of meanings, ambiguities, plays, and these are not always coherent. The subject is not a unity: any individual is a play of differences that cannot be comprehended. The subject is thus a heterogeneous process that cannot make itself transparent, and therefore is unable to grasp itself as a singularity.[107]

If postmodern theory of this sort announces that our bodies and identities are not ontologically present to themselves, cyberspace further illustrates just how much the self can be socially and technologically mediated. The prosthetic presence of a virtual entity removes the body as a site of agency, producing a free-floating self whose location is nonexistent. (Inside virtual space, of course, location is simulated, giving it meaning within the virtual framework.) The self manifests in protean forms, each of which is free to violate the values and behaviors of the others. Each is also free of the history (and its ramifications) acquired by any identity which is embodied more than once.

---

[106]Iris Marion Young, "The Ideal of Community and the Politics of Difference," in *Feminism/ Postmodernism* (New York: Routledge, 1990), ed. Linda Nicholson, pp. 310-311.

[107]Julia Kristeva, "Le sujet en procès," "L'expérience et la pratique," "Matière, sense, dialectique," *Polygogue* (Paris: Editions du Seuil, 1977), pp. 55-136, 263-86.

> "When the essential components of human experience are denatured, they are not merely revealed as constructions. The human subject who stands as the putative source of experience is also deconstructed and reconstructed in ways that fundamentally alter what it means to be human. The postmodern anticipates and implies the posthuman."[108]

It remains to be seen how our fundamental conception of ourselves will change as a result of the ability to variously embody disparate personae. The monolithic conception of self which is so ingrained in us by biological reality will be sustained as long as there is an off-line body whose movements are being mapped into the virtual sphere. Yet as far as the system is concerned, the body is indeed "meat" as so often hyperbolically described in cyberpunk literature.[109] That term is exaggerated, of course, because the removal of the body in virtual space does not mean corporeal existence in the physical world will cease to be important. Despite this, what we take subjectivity to mean is significantly disturbed because of the control the virtual world exercises over the physical body's sensory apparatus. Subjectivity involves point of view, implicitly stable in its geography (although not, of course, in its particularities) and strongly unitary by the assumptions of social interplay. In VR, by contrast, one can dislocate the subject at will, even if by the relatively simple act of shifting your perspective from one part of an environment to another. More provocatively, one could switch to the point of view of any other entity instantaneously, even seeing your own virtual body as the other does. Temporality is also destabilized; the plasticity of experience in virtual reality allows replay of already-enacted interchange with the possibility of inhabiting any other subjective space. In this way, memory — which has always informed the singularity of subject — is substantially transformed. We used to be able to affirm the consistency of our own self by the continuous presence that memory is constructed

---

[108]Katherine Hayles, *Chaos Bound: Orderly Disorder in Contemporary Literature and Science*. (Ithaca, NY: Cornell Univ. Press, 1990), p. 266.

[109]Most notably in Gibson's influential *Neuromancer*.

around. If we can relive moments with a clarity equal to their first enactment, this by itself redefines memory. If our memories don't privilege our original point of view, or *any* point of view, this seriously undermines a perceived continuity of subject. What will it mean for the philosophical discourse on identity if we exist in a realm where our "bodies" are entirely unstable, where the location and topology of selves is subject to instant change?

There has been philosophical rumination on the construction of subject for some time, primarily focused on the logical difficulties entailed in upholding a continuous self despite its constant flux. We all operate around the persistence of identity even though such persistence is utterly intangible. Although Locke and Hume both questioned deeply the validity of the body as a criterion for personal identity, they came to no satisfactory conclusions. Hume believed one's thoughts, feelings, and imaginings are crucial to the self, and sought for "the bond that unites" all such ever-changing mental activity. Finding none, and rejecting a doctrine of "spiritual substance," he gave way to complete skepticism about identity. Locke, after rejecting the body as a criterion on the basis of bodily-transfer puzzles, tried to assert memory as the single necessary and sufficient criterion. This fails because memory is often unreliable and, as Terence Penelhum shows, its verification presupposes a concept of personal identity. Penelhum, however, reposits the body as a valid criterion, claiming that Locke's body-swapping stories are pointless, for if they were true, all of our concepts would be different: "the bodily criterion can always be used, for the body is present whenever the person is."[110] Virtual reality obviously refutes this argument, for not only can bodies be switched at will, but the body is never present where the person is. If "the person" is considered to be in cyberspace, that is; this is precisely the dilemma of self facing us.

---

[110]Terence Penelhum, "Personal Identity, Memory, and Survival," *Journal of Philosophy*, Vol. 56, 1959, pp. 882-903.

That the intractability of identity has been philosophically worrying for so long comes from the very source of the word, the Latin *idem*, meaning the same. The consciousness that apprehends perception and experience is *never* the same for those activities alter our ideas and standpoints. The unavoidable flow of time makes the biological self perpetually changing as well; we are constantly being cellularly reconstructed.

If, in the virtual, we exist multiplicitously, what conflict will this produce with our evolved instinct to center thought and perception in a single self? Because virtual reality is a space where subject is no longer grounded in anything, it seems we must cease to impose a static and monolithic conception on identity. Again, unless we think in an exaggerated futurescape of bodiless electronic data-beings, we must not lose sight of the existence outside virtuality of a stable entity through which experience is organized. This entity is the mind, and the self it constitutes will not dissolve in the near future. Our perceived singularity of self, be it an invention consciousness uses to maintain order or not, would seem to underlie even the fragmentation of postmodern existence. The mind's divorce from the body will free it to inhabit alternate subjectivities, but those others which can now form part of the self can not be utterly distinct, for only another mind can offer that.

Virtual reality enacts contradictory influences on Cartesian dualism, simultaneously actualizing a mind/body split and collapsing binary distinctions. In cyberspace, mind becomes a body; virtual bodies are avatars of the directive mind. The physicality of the brain, which cognitive science is investigating, is reified by virtual reality research seeking to explore how the mind constructs perception and experience. At the same time, the phenomenology of virtual experience "overthrows the sensorial and organic architecture of the human body."[111] Technology and poststructuralist

---

[111]Tomas, "Old Rituals for New Spaces: *Rites de Passage* and William Gibson's Cultural Model of Cyberspace," p. 32.

thought are problematizing the dualities which have dominated Western thought — binary oppositions that are consequences, ironically, of a metaphysical desire for totality. Derrida writes of how Western conceptualization exhibits a logic of identity, the urge to formulate a unity or whole. An immense number of dichotomies have been created by this metaphysics of presence: subject/object, mind/body, culture/nature, etc. According to Derrida, the logic of identity also attempts to posit the subject as a self-identical unity. Descartes began the tradition of conceiving a unity of consciousness, a transcendentalism that Derrida shows is doomed. Any claim to totality retains its essence and purity only by relation to what is extrinsic to it; as Hegel showed earlier, any concept imbricates itself with what it claims to exclude. Deconstruction rejects Hegelian dialectic, however, because it ends up forming an ultimate synthesis out of the oppositions generated by metaphysical logic.[112] The fuzziness of the locus of identity engendered by virtual reality clearly problematizes the Cartesian subjectivity which informs the modern metaphysics of presence yet also makes coherent a full existence of mind without body.

> "A grand paradox is in operation here: even as we are finally abandoning the Cartesian notion of a division of mind and body, we are embarking on an adventure of creating a world that is the precise embodiment of that division. For, it is quite clear that our reality outside cyberspace is the metaphysical plane of cyberspace, that to the body in cyberspace we are the mind, the preexisting soul. By a strange reversal of our cultural expectations, however, it is the body in cyberspace that is immortal, while the animating soul, housed in a body outside cyberspace, faces mortality."[113]

---

[112]Jacques Derrida, *Of Grammatology* (Baltimore: John Hopkins University Press, 1976). Parts of summary paraphrased from I. Young, "The Ideal of Community and the Politics of Difference," p. 303.

[113]Marcos Novak, "Liquid Architectures in Cyberspace," in *Cyberspace: First Steps*, p. 241.

I follow Maurice Merleau-Ponty in asserting that the unitary truth of the Cartesian *cogito* is not adequate to ground the experience of the human.[114] Virtual reality, I have tried to show, is the potential field for surpassing that obsolete model. It is a bit ambitious, however, to celebrate the multiple subjectivity which virtual reality allows us to enframe without first examining what presuppositions inform such ideas. Seeing the enthusiasm with which Internet users interact as alter egos and even present themselves as radically different personalities, together with a vague sense of historical repression of such exploration, suggests to the observer that it is healthy to fragment the unitary subject. Is there a teleology here, one that posits the enactment of multiplicity as more natural? Virtual reality goes beyond mere agreement with the postmodern recognition of multiplicity in the self, for that deals with our (re)conceptions of subject as it has existed throughout history. Furthering the deconstruction of identity implies a new metaphysics within postmodern theory, part of whose aim, ostensibly, is to destroy such behavior. The critical excitement over virtual reality and cyberspace, including my own, gives away the presumption that there is progress in the actualizing of theory we find in new technological modes of being.

By extension, ceasing to place demands of singularity and ultimate explainability on ourselves, and indeed the cosmos, is taken to be the product of a more refined understanding. Certainly there are factual bases to these beliefs: Gauss's demonstration of shapes that could not be described using Euclidean geometry and Gödel's proof that mathematics could not be a self-sustaining system both deflated the hope for some pure science.[115] The hope for reduction and comprehensive understanding manifested itself on levels from the individual to the cosmic, from the idea of a single self to that of the universe as a single machine. These conceptions have been firmly in place since

---

[114]Maurice Merleau-Ponty, *Phenomenology of Perception*, trans. Colin Smith (London: Routledge & Kegan Paul, 1962), p. 147. Cited in Bukatman, p. 250.

[115]Woolley, *Virtual Worlds*, pp. 61, 64.

Newton gave us his idealized mechanics, compounded along the way by thinkers like the mathematician Pierre Laplace, who spoke of a perfect knowledge of the universe. More recently, Einstein has shown that the purity of Newtonian physics was something of a naive hope; the principles of relativity meant absolute knowledge was impossible because the position of the observer is always relative to the thing observed. His model of the universe was not utterly relativistic, however, for it still assumed immutable laws of motion, causality, and time. Quantum physics then showed us that the observer fundamentally determines events, that there is no absolute causation. Uncertainty, indeterminism, nonlinearity, acausality: all the trappings of postmodernism.[116]

Yet now we have the new science of chaos, and I think a partial reinstatement of the classical hope for the explainability of the universe. Chaos theory reveals, belying its name, that there is a deep structure to seemingly random phenomena, that what we thought was unpredictable is actually computable. This would seem to indicate that although many natural states in the world — clouds, identity structures, fruit fly populations, large-scale social or political dynamics — are all highly unstable on the level we experience them, there is in fact a simplicity to their behavior. Interestingly, it is the computer that brings order (in terms of what it makes present to our understanding) to chaotic systems. Fractal graphics made the order of chaotic systems visible, empowering us to see more comprehensively than we ever could with our unaided minds. Against, or perhaps supplementary to, the idea of virtual reality enacting a more authentic (postmodern) mode of being, i.e. multiple and decentered, I would suggest that virtuality might enable us to understand the single self better. The ability to literally be anything we want could be a powerful tool towards understanding more of those sides normally not present to us, the Freudian unconscious. Virtual systems, analogously making the normally unseeable viewable, can reveal things that the unstable self moves towards, the strange attractors of human behavior. The

---

[116]Bukatman, pp. 173-174.

computer is a tool whose (transformative) power we are just discovering; with it we might perceive something more fundamental about the self — perhaps, as in mathematically turbulent systems, a deep order, an evolutionary (cosmic?) meaning behind the confusion of postmodernity. Just as the computer as a visualizing (visionary) tool helps us see patterns operating in chaotic behavior, its embodying of our multiple and decentered identities might enable us to discover more about the self that each one of us is so complexly.

The very fabric of civilization is altered by virtual reality, and along with it, the structure of the human self mutates. VR is a cultural product, a step in the evolution of communication, the ascendancy towards the real, and the exploration of the self. While a VR system, the most sophisticated technology ever made, is potentially, even breathtakingly, empowering, it is still subject to many limitations. Vivian Sobchack writes that the "new age mutant ninja hacker" wants to merge with technology, but with subjectivity intact and essentially unchanged. "This electronic solipsism clearly derives from the compelling but ... naive prognostications of McLuhan... and [doesn't] acknowledge the political reality of power and its operations."[117] Is virtual reality a liberation from the body, and thus a political liberation as well? Theoretically, I believe the answer is yes. In practice, however, we must examine the demographics of who has access to computer systems and the education to utilize them. The same elite has the privilege of new modes of empowerment, and thus the same underclass will be perpetuated. While keeping this in mind, we must also strive to retain the transformative powers and benefits of virtual reality in the face of inevitable corporate co-option. Although capitalist agendas will, of course, pervert all utopian possibilities, VR is still a field of tremendous hope for the evolution of the human.

It is also important to realize, in the flush of new capabilities, that individuals in current VR systems are only a few steps above a disembodied voice in translating the full significations of human presence. As technology stands today, and most likely for the next decade, inhabiting virtual space as a moving, speaking, responsive entity is still a limited projection of what it is to be a human being. Despite this, the step from a mere floating voice to a full body (no matter its appearance) that can see, recognize, and interact by speech, text, image, or gesture with other virtual bodies is a large one. I

[117]Vivian Sobchack, "New Age Mutant Ninja Hackers," *Artforum*, April 1991, pp. 24-26.

believe society will be genuinely revolutionized by this exploding industry, but it is still a long way from the unrealistic portraits portrayed in the media.

Alvy Ray Smith has estimated that our visual experience of reality is the equivalent of 80 million polygons resolved at 30 frames per second. This computes to a mammoth 2.4 billion polygons per second of real-time rendering, far beyond the power of any computer we know. (This is just for the visual component: sound, motion calculations, and data updating from other presences all also require massive processing time.) Silicon Graphics makes some of the most powerful microcomputers in the world: the RealityEngine^2 was released in 1994 and renders 2 million polygons per second. The University of North Carolina, however, has surpassed that by linking together the entire UNC network as one computer. UNC called this massively parallel computing architecture "Pixel-Planes," and it has gone through five generations since its inception. Massively parallel systems break up a single task and all work on it simultaneously; a normal computer, no matter how fast, can only do one instruction at a time. With Pixel-Planes, this limitation is removed and each pixel in a world-model can have its own processor working simultaneously. PixelFlow, the next generation at UNC after Pixel-Planes 5, is expected to be able to compute 30 million polygons per second.[118] The potential of computing power is appreciated even more when we consider that early, room-sized, computers performed a few hundred instructions per second, while today, most desktop computers can do about 4 million instructions per second (MIPS). Intel's Micro 2000 plan predicts it will build a chip by that year that will process 2 *billion* IPS.[119] Although even PixelFlow is only 1/80 of what is needed for visual "reality," we can see that the notion is not impossible.

The optic is not the only aspect of reality, however, and there are other significant technical limitations to seamless virtuality. One of these is the requirement for physical

---

[118]W. Wayt Gibbs, "Virtual Reality Check," *Scientific American*, December 1994, pp. 40-42.

[119]Kenneth M. Sheldon, "Micro 2000," *Byte*, 16 (4) April 1991, p. 132.

hardware — at present a full body interface is distinctly noticeable, if not uncomfortable. Head-mounted displays are heavy and wires or tracking devices get in the way or fail. For another thing, HMD resolution is still very coarse; the most expensive system in the world is roughly the equivalent of a computer monitor. Users get motion sickness and "sopite syndrome" — chronic fatigue, drowsiness, lethargy, and irritability — from body motion not matching up to virtual cues. This type of (non-)motion sickness happens because tracking systems are clumsy and interference prone, and software is still slow to get full sensor data. There's a significant lag problem from the delay in position-sensing exacerbated by the delay in processing signals from a glove and head tracker, plus the delay of computing world-model polygons. An average system has a total delay of about 200 milliseconds; anything over 50 is irritating and interferes with realism. The most difficult frontier may be that of tactility and haptic feedback. Force feedback systems are potentially injurious and texture is poorly understood and difficult to artificially emulate. As discussed in the VIRTUAL SPACE chapter, tactile simulation is such a complex affair that many believe we will never achieve true realism with it. Lastly, for many decades at least, the most fundamental obstacle will be that of computational power.

We must keep in mind that the *telos* of the technics of simulation should not become the only issue. Exact duplication of traditional reality is not necessary for virtual worlds to be realistic enough to involve and transform the human. A theoretical perspective shows us that other realities are already present, and that we must deprivilege our old, unitary Real. Cyberspace is a displacement or re-placement of our current reality, but equally a realm of the imaginary whose existence transforms the meaning the real holds for us. The statement that it is pointless to identify a transcendent universal reality is no different than an empiricist refutation of metaphysics: its value lies, not in that negation nor in a reigning-in of philosophical rumination, but in relativizing our concept of reality. In the personalist universe of virtual reality, space, existence, solidity — truth — is made at will. People will inhabit these new worlds with varying degrees of awareness and confusion, and they *will be affected*. Virtual reality, no matter its ontological status, is real. It will problematize countless dualities involving not only the real, but mind, space, organism, gender, and self. It will force us to rethink the rigidity of our distinctions, for cyberspace is a liquid environment that flows over us, that we float in. It will absorb and reflect us, like the ocean of Lem and Tarkovsky's *Solaris*, as we are, as we hope to be, and as we never imagined ourselves to become.

Computers as Mind-Amplifiers

Much of personal computing, and the prototypes of virtual reality components, comes from work done in the 1960's at the Augmentation Research Center (ARC) at Stanford Research Institute, led by Douglas Engelbart. Engelbart saw back in the 50's that computers were good at doing the computational tasks humans had trouble with, but that machines should be used not to replace human function, but to free people to focus on higher level problems which computers can not do. He was inspired by Vannevar Bush's (President Roosevelt's Science Advisor) seminal 1945 article, "As We May Think," which outlined a vision of a user navigating through an information space created by a computer. The idea central to Engelbart was that computers should function as mind-amplification devices, used in conjunction with human contextual and intuitive powers. Engelbart knew computers should be as visual as possible, since this is how humans take in and process inconceivable amounts of information, but in the 1950 there were no TV's and only a dozen computers in the United States. Nobody paid him much mind, so he went to work for Stanford Research Institute in early 1957, the year that something happened that finally (after seven more years, actually) got the ponderous and fickle eye of bureaucracy turned on him. October of '57 was when the Russians launched Sputnik, and when the United States realized it was not the world leader in technology it smugly assumed it was. To combat this humiliation (and more significantly, the fact that the Soviets could drop large objects on top of anywhere in the world), the Advanced Research Projects Agency (ARPA) was created. ARPA only had the importance for VR it did because a man with some imagination and thought for the future named J.C.R. Licklider happened to get hired. Licklider, along with Engelbart, is considered one of the technological prophets who is largely responsible for personal computing.

J.C.R. Licklider worked at MIT doing research in psychoacoustics before ARPA hired him. When he got tenure he joined a consulting firm named Bolt, Beranek, and Newman who let him pursue his research and learn about digital computers on the side. BB&N had a PDP-1, the first computer Digital Equipment Company made; available in 1960, it was the first true "minicomputer." In 1960 Licklider wrote "Man-Computer Symbiosis," which, for a contemporary reader, illustrates Licklider's remarkable prescience. Licklider had worked for the Defense Department before; the

DOD's Lincoln Laboratory, a top-secret facility associated with MIT, employed many of MIT's best in late 50s and early 60s to work on the "Semi-Automatic Ground Environment" (SAGE). Licklider was hired there to work on "human factors" in a new computerized radar network. The "Whirlwind" project, as it was called, used realtime video displays and light pens, and was thus a big predecessor for interactive computing.

Licklider became the director of the ARPA's Information Processing Techniques Office in 1962 because Jack Ruina, then the director of ARPA, was aware enough to sniff Licklider's ability to lead a revolution in human-computer interaction. Licklider got an office, a budget, and a mandate to make the state-of-the-art in information processing. As mentioned before, this was a big moment because someone who knew about human minds had some influence in directing computer technology. A substantial amount of computer technology in use today stems from developments funded by IPTO. Licklider culled young programmers from MIT, the University of California, the Rand Corporation, University of Utah, and a dozen other research groups from all over the country. His brilliant and informed vision converted Bob Taylor, a NASA administrator, who had been funding an unknown named Douglas Engelbart. At Taylor's urging, ARPA sent a few guys to check out Engelbart's ideas, and in 1964, promised Engelbart the best computer equipment and a million dollars to make his mind-amplifying systems.

Engelbart named his lab the "Augmentation Research Center," the first word being a clear indicator of where he wanted to go. His lab invented the mouse, which wasn't commercially available until the 1980's, back in the 60's. Hypertext, windows, video integration, conferencing, and online processing were all essentially invented at ARC. In 1968, Engelbart and crew gave one of the seminal equipment demonstrations in virtual reality (and personal computing) history. In front of a packed crowd at the Fall Joint Computer Conference, Engelbart used a system with a keyboard, a video screen, a mouse, and an earphone-mike system. The audience was blown away.

Licklider found a programmer at Lincoln Laboratory named Ivan Sutherland, who ended up becoming as, or more, important than either Licklider or Engelbart in moving computer technology towards human-sensitive interfaces. Some people identify Sutherland as the "grandfather of VR" because of his hugely influential Sketchpad program. Sketchpad, which Sutherland completed in 1962, was so important because it showed a totally new way to use computers. Sketchpad allowed a user to draw shapes with a light pen and have those shapes be registered by the computer's memory in real-time. This was "the first great conversational human/computer interface [and] also the first great direct manipulation one."[120] Sutherland was one of the first to envision human-computer symbiosis, his brilliant program potentially being a small, but seminal, step in that direction.

Sutherland succeeded Licklider as IPTO director in 1964 (at age 26), and the following year left for Cambridge after recommending Bob Taylor (the NASA guy who found Engelbart) to be the next director. Sutherland went to Cambridge to work on his new inspiration: mounting small computer screens in binocular glasses. That idea led to his creation of the first head-mounted display (HMD), as of right now a central part of almost every VR system, in 1965. Almost all of Sutherland's research in the late 60's and early 70's was fundamental to VR technology. Beginning in 1966 at MIT's Lincoln Lab, fresh from IPTO, Sutherland had help from Harvard and money from ARPA and the Office of Naval Research, both of which had co-sponsored his initial HMD research.

<u>Immersion and Navigation</u>

The first effective HMD was called the "Sword of Damocles" because it descended from the ceiling and locked on to the user's head. At that time, ultrasonic head position tracking was too flawed to be better than an analog method, so movements were registered by a mechanical connection. On New Year's Day, 1970, at the University of Utah, the first fully functional HMD system was turned on. The team working on it finally got access to all the component equipment at one time because people weren't at work, hung over from the night before. The system had six interconnected subsystems: a clipping divider, a matrix multiplier, a vector generator, a headset, a head position sensor, and a general purpose computer. The Sword of Damocles could display 3000 lines of resolution at 30 frames per second, but in only a 40-degree field of view. (NASA's HMDs, twenty years later, had 120° f.o.v.; in the mid-80's, F-15 flight simulators had a 300° x 150° headset.) The first virtual object seen in an HMD was a two-inch wire frame cube, which appeared to float about 14" in front of the user's clamped in head. The clipping divider was built around an algorithm developed by John Warnock, then a graduate student, that clipped nonvisible lines (Warnock was later was a principle player at Xerox's PARC and went on to found Adobe Software). The central computing engine was a TX-2, already old by 1967, the first computer that used transistors rather than vacuum tubes. In 1970, the "Sorcerer's Apprentice" was added, a pistol-grip wand with buttons and switches that enabled

[120]Susan Brennan, "Conversation as Direct Manipulation," *The Art of Human-Computer Interface Design*, Brenda Laurel, ed.

more direct interactivity. In 1968, Sutherland formed a company with David Evans, a programmer who did a lot of graphics work for ARPA, that would supply "scene generators" for flight simulators. As of the most recent information I can find, Sutherland is now working on building sophisticated walking robots.

One of the many inspired by Ivan Sutherland's Sketchpad was Alan Kay, the man partially responsible for both the invention of time-sharing and the introduction of psychology into computer interface design. Kay was also among the audience at Douglas Engelbart's famous demo at the '68 Fall Joint Computer Conference, and that event, along with the implications of Sketchpad, was the catalyst for Kay's important work with interactivity. Kay went on to investigate the computer's potential as a tool for learning by exploring. One of the most talented of the programmers pulled in by ARPA, Kay left in 1970 for Xerox's new Palo Alto Research Center (PARC). The Mansfield Amendment (drafted during the Vietnam War) prevented ARPA from doing anything but weapons-related research; this fact, combined with young people being uncomfortable doing things for the DOD, drove a mass exodus of the brightest minds away from military applications. The center of the PC whirlwind shifted from ARC and ARPA to PARC in the early 70's because of this; PARC became a fantasyland of ideas and the money and minds to actualize them. Bob Taylor left IPTO to go to PARC, and from there assembled together all the best programmers from ARPA, among them Alan Kay. PARC (mostly led by designers formerly at Engelbart's ARC) made the Alto, the first "personal" computer, in those heady years of the early 70's. PARC also had bit-mapped graphics, which realized what Sketchpad did primitively (and thus brilliantly) — two-way communication: change the data and you see it visually, change the visuals and the data changes. The direct manipulation interface this enabled didn't have a big impact on the world until, on a casual tour of PARC, someone named Steve Jobs happened upon it.[121]

MIT's "Architecture-Machine Group" (Arch-Mac), led by Nicholas Negroponte and Richard Bolt, was another big player of the early 1970's. Arch-Mac came up with some highly influential computer visualization systems; their so-called "Dataland," part of their Spatial Data Management Systems (SDMS), was the best developed of these. Negroponte forecasted in 1970 that all media will combine into a hybrid "metamedium," and resolving to bring together cognitive science, computer science, and cinematic and telecommunication technologies, formed the legendary Media Lab. Stewart Brand's book *The Media Lab: Inventing the Future at MIT*, whose title referred to

---

[121]Jobs took the technology he saw at PARC, reworked and enhanced it, and, in 1984, dropped the Apple Macintosh on the world.

their famous slogan, brought attention to Arch-Mac's role in computing; ARPA had been quietly funding them for 15 years. The US Navy got SDMSs and various multimedia systems from the Media Lab throughout the 70's. One of the best known of the Media Lab's inventions was the "Put That There" system developed in the late 70's. This setup had the user positioned in front of a large screen with various graphical objects and windows of information on it. A voice recognition system coupled with a pointer allowed the user to point at something and say "put that" to a "there" that was consequently pointed at. There was also the "World of Windows," which had disparate information streams flowing over each other, one of which would foreground when the user's eyes focussed on it. Many of the interactive systems at Media Lab used ultrasonic position sensors developed by Polhemus Navigation Systems which did away with the clunky Sword of Damocles hardware. In the 90's, although not a center for virtual reality research, the Media Lab is working with tactile feedback (led by Margaret Minsky, AI pioneer Marvin's daughter) and others, under David Zeltzer, are working on autonomous characters, how they move and appear (but not how they react or what they say). These characters, the plan is, will eventually populate virtual environments and interact realistically with humans.

Arch-Mac produced a lot of their important work in the late 70's and early 80's under Scott Fisher, who moved there from teaching at MIT's Center for Advanced Visual Studies in 1978. He co-made the "Aspen Movie Map," which was created to utilize important elements of two key concepts: *immersion* and *navigation*. The "Movie Map" was a controllable videodisk of Aspen, Colorado whose projections surrounded the viewer/user with touch-sensitive screens. The user could "move" through the city at will and even go into buildings and get information about them displayed at the top of the frame. The system gave the user a fair amount of control, enough so that he felt at least somewhat like he was in the projected space. But Fisher knew that choosing from what was essentially a limited menu of actions didn't provide the immersive experience they were shooting for. From 1980 to 1982, for his master's degree, Fisher decided to work on reproducing motion parallax, the effect we see of objects shifting in relation to one another, and the subsequent calculations our brains perform to construct a three-dimensional worldview from the string of parallel (left and right eyes) 2D views. By setting up a Polhemus sensor together with videodisk images of multiple points of view within a small radius projected inside stereoscopic PLZT glasses, he was able to have one's virtual point of view respond to relatively small changes in head position. PLZT, or piezoceramic, viewers worked on a "time-multiplexed" system, meaning that electronic shutters interleaved left-eye views with right-eye views. Each eye's view is calculated slightly off-set from the other's; this is the basis of any stereoscopic effect. Whereas time-multiplexed systems alternate images, "time-parallel" systems show both images at the same time. These latter systems are either anaglyphic (different-colored lenses, the principle behind those cheap cardboard 3D glasses; the image shows both interlocularly distinct images together, each being filtered out by the apposite eye's colored lens), split screen (lenses or mirrors deflect separate images to each eye), or dual CRTs. LCD displays have since supplanted PLZT glasses as the standard for VR system HMD's. Ivan Sutherland, of course, had achieved motion parallax with his Sword of Damocles system 12 years earlier, but Fisher was going for something more than a floating cube. Although Sutherland's setup used a computer-generated view, Fisher was trying videodisk retrieval because computers were still way too slow to generate anything even slightly complex in real-time. Another crucial bed of VR activity, the Department of Computer Science at the University of North Carolina in Chapel Hill had run into the same problem some years before.

Seeing the Unseeable

UNC has been a major source of virtual reality advances throughout most of VR's history, doing pioneering work in the fields of scientific visualization, medical imaging, architectural tools, HMDs, reality engine architecture, and position sensors. The core group there, led by Frederick Brooks, has been working specifically on virtual reality since the late 1960's; their focus being the creation of scientific and medical tools, not consumer electronics or entertainment. Brooks was already a legend in the software world when he left IBM to work at UNC. Brooks had directed the team that made the IBM 360 series operating system software (probably the most difficult programming ever done, and the catalyst for the computerization of the entire business and scientific world). Brooks shares Engelbart's views in his insistence that humans will always be better than machines at some things, which Brooks breaks down into three areas: pattern recognition, evaluations, and context (quick recall of an obscure memory when useful). Like Engelbart, Brooks worked on visual interfaces with computers because it was obvious to do so given that humans take in massive amounts of data through their eyes. The UNC team, under Brooks, started the task of actualizing Ivan Sutherland's core vision: a computer-human symbiosis of sorts that would enhance many of our cognitive abilities.

Brooks decided that the molecular structures of "life" molecules in nucleic acids was his first "driving problem," ideal because it couldn't be solved by human or computer *alone*. He and his students began work in 1969, and by 1972 were combining force-reflection feedback with interactive graphics. Brooks and students found a couple of ARMs (Argonne Remote Manipulators), robotic arms which had been used by humans safely behind lead shields to move radioactive substances. (The idea for the robotic appendage substituting for a real one came from science fiction writer Robert Heinlein's story, *Waldo* (1940); the first working model was built as early as 1947.) Normally the human operator manipulated one machine, which was basically a cage-like arm which strapped on to the real one, while another identical arm duplicated all of the user's motions in the remote area. UNC got two of them and substituted a computer world model for the "slave" device. The idea was to use the data read by the ARM to inform the computer how one's virtual arm was moving; this way, every motion one made would be exactly duplicated. The problem was, at the time UNC had that idea, computing power allowed the real-time portrayal of about seven simple blocks on a table, maximum, with no surfaces, colors, or textures. This was not much use, so they put the ARM away until computers were available to them that had 100 times more processing speed, which, it turned out, took less than 15 years.

The other applications to grow from work at UNC include the rapidly expanding field of medical imaging. Computer visualization techniques have revolutionized medecine already: X-rays are limited to a single "slice," but CAT scans use a computer to assemble a "fan" of slices. Even with this system, 3D reconstruction takes place in the doctors' heads. Ultrasound feeds back images in real-time, but it is still a 2D representation of the three-dimensional. Stephen Pizer at UNC is working on computer-augmented surgery planning, diagnosis, and radiation treatment planning. Radiation treatment planning involves beaming through healthy tissue to get at a tumor. Various angles are considered to maximize tumor targeting and minimize hitting healthy, radiosensitive tissue. The planner system uses an HMD to sight along the beam path, with rendered images of the patient's body having all layers of skin, muscle, and tissue selectively visible, translucent, or invisible. This "X-ray spectacle" concept is more Henry Fuch's vision than Pizer's. Pizer thinks doctors will use a lightweight HMD to have an augmented image superimposed on a real patient within 5-10 years. Fuchs believes such a system will be common in 20-30, maybe 50, years, although UNC has already produced an ultrasound scanner link that superimposes its images over the real world. Computers are still too slow to process 3D sensor output into a viewable image in real-time.

Shared, Responsive Environments

The concepts of virtual reality were being articulated throughout the 1970's by Myron Krueger, an artist and programmer who invented the term "artificial reality." Krueger was interested in human-computer interaction and human-human interaction in a computer mediated environment. He had been part of a project called GLOWFLOW at the University of Wisconsin, which opened in 1969. The project involved a space that changed in response to the actions of its inhabitants with synthesized sounds and various lighting effects. Krueger became fascinated with the idea of "responsive environments," and went on to create more and more complex spaces where humans formed relationships with technology. Most of his projects in the 70's constructed surroundings that engendered totally new conceptions of interaction, response, social constraint, and even machine-intelligence. VIDEOPLACE (1975) became his most famous installation, although in general Krueger has gotten no credit for his pioneering virtuality ideas. VIDEOPLACE created a virtual space that participants interacted in, often from very distant physical locations. Krueger wrote a complicated program that gave a computer primitive recognition capabilities by detecting edges and movement in live video images. From there, he was able to program a "critter" which interacted with VIDEOPLACE's users: ran along their outlines, jumped on heads, followed people as they moved.

"The responsive environment has been presented as the basis for a new aesthetic medium based on real-time interactions between men and machines. In the long range it augurs a new realm of human experience, artificial realities which seek not to simulate the physical world but to define arbitrary, abstract, and otherwise impossible relationships between action and result... [T]he next generation of technology will speak to us, understand us, and perceive our behavior. It will enter every home and office and intercede between us and much of the information and experience we receive. The design of such intimate technology is an aesthetic issue as much as an engineering one. We must recognize this if we are to understand and choose what we become as a result of what we have made."[122]

Krueger now has an Artificial Reality Laboratory in the back of the Connecticut State Museum of Natural History where he labors away, underfunded and largely

---

[122]Myron Kreuger, "Responsive Environments," *Proceedings of the National Computer Conference*, 1977, pp. 423-433.

uncredited. VIDEOPLACE, however, was installed in a lab as part of the new Kanagawa Science Park in Tokyo. The big Japanese telecommunication companies are very interested in Krueger's work and are currently putting millions into developing applications derived from it. One of the pieces Krueger sent to Japan was VIDEODESK, which uses the recognition software developed for VIDEOPLACE to read the video silhouettes of a person's hands over a desk. It can put multiple users in one manipulable space with access to a plethora of virtual tools: "There's no need for a mouse or a physical keyboard. One gesture can cause a keyboard to be projected onto the artificial desk. You could paint with your fingers, or with the use of a three-dimensional drawing system, you can sculpt 'graphic clay' with your hands." In a shared virtual space, users could communicate text, graphic materials, visual ideas, etc. quickly and effectively. In general, Krueger came up with many of the concepts behind VR years before others, but, like Morton Heilig, nobody listened.

New Plateaus in the Power of Computing

In the meantime, the US military was developing flight simulators that used some of the most sophisticated technology ever built by man. A study of combat losses had revealed that downed planes were almost always being flown by pilots with five or fewer missions; after the fifth mission, the survival rate was about 95%. This report convinced the Air Force to spend some money to find a way to effectively give every pilot five missions before they ever went up in the air. Thus, the flight simulator was born. As mentioned before, the Link Trainer was the first to give a pilot some sliver of what it was like to be flying. The availability of the first video cameras in the 50's enabled simulators to begin using scenery that responded in real-time. From then until 1968, most flight simulators used video cameras that would fly through elaborate scale models of airfields and target areas. The perspective of the moving camera was projected on to a large screen in front of the pilot. Computer graphics replaced this system in '68 because Evans and Sutherland, the company Ivan Sutherland formed, started selling their digital scenery generation to aircraft companies and to the Air Force. In 1979, the military tried out HMDs developed from Sutherland's original designs because the huge projection systems necessary for a sense of immersion were bulky and expensive. Every year, jet fighters were getting more and more sophisticated, and their instrumentation more and more overwhelming. The Air Force realized that simulators were necessary, not just to give pilots some experience of flying, but to train them to deal with the plane itself: pilots were fighting their own over-complex cockpits.

A researcher named Thomas Furness had been working on visual displays for the military since 1966, and the Air Force decided to let him build a state-of-the-art simulator. In 1982, Furness co-produced the Visually Coupled Airborne Systems Simulator (VCASS), which looked like a huge Darth Vader helmet encasing the pilot's head. It used a symbolic representation of the world; the display showed types of terrain, projected flight paths, indicated weather conditions, and disclosed a host of other visual data from DOD maps that could be synchronized and updated with real-time radar. The helmet used a Polhemus Navigation Systems position sensor to feed the orientation of the pilot's head into the system. Somebody inside the VCASS helmet was immersed in an environment which, although it didn't look "real," was utterly engaging. Even seasoned pilots were excited by it, especially when target tracking and voice command capabilities were added. A pilot could focus on a target and say "fire," and have the computer sense where his gaze was directed, identify the target, project its upcoming trajectory, communicate with the navigational systems in the missiles, and trigger the weapons, all in milliseconds.

Because the military was behind it, Furness had access to computers far more powerful than university research programs could get. The images rendered by the VCASS system were far more complex than anything ever attempted before, and the resolution of the video displays in front of the pilot's eyes was higher than just about anything commercially available even today. More funding was added to Furness's program, a lot more funding. In 1986, the research project was given the name "Super Cockpit" and more and more sophisticated enhacements were added. The new helmets were as much for supplementing real life on an actual flight as simulating. They used half-silvered mirrors to overlay virtual data readouts and superimpose information about everything the pilot could see. Lavish fiberoptic technology was used to convey super high-resolution displays, and piezoelectric vibrotactile actuator gloves were added that could eliminate a few microseconds of trigger-pulling. Data from Forward-Looking Infrared (FLIR) sensors bestowed night vision on the pilot if he so chose. 3D sound — applying mathematical algorithms to sound data in order to simulate the sound source being in different spatial locations — was utilized to take advantages of other senses that could absorb even more information. A low-pitched whine, for example, that sounded like it was coming from behind and to the side of the pilot alerted him instantly and intuitively to an enemy plane's presence. Furness also came up with a low-fuel warning that sounded like a woman's voice speaking at low volume just behind the pilot's ear. Putting aside possible Freudian analyses, the pilot received a piece of critical information in a manner that didn't distract him from other, potentially crucial, data and didn't make him panic.

The same year the Super Cockpit program was kicked off, 1986, UNC dragged their ARM out of storage because they finally had computers that were 100 times faster than what they had in 1972. With the increased computing speed, they were able to use the ARM in a system for trying out molecular docking. The user wore an HMD, or stood in front of a large stereoscopic projection wearing polarized sunglasses, in which he saw molecules graphically represented by colorful, compounded spheres. Electromagnetic forces and molecular bond stretching laws were all programmed in to the simulation. So far, most VR research had focused on visual and audio perceptions (with the exception of Heilig's Sensorama) but UNC was working to bring in the tactile realm. Not only did one see a virtual arm and hand take the place of one's own, but the mechanical ARM provided haptic feedback as well: physical sensations of unyielding forces and attracting magnetic pulls. A user of their VR docking prototype would try to manipulate a certain odd-shaped molecule into a more complex, compound one; if the angle or physiochemical interplays didn't permit a bond according to the (simplified) laws of nature, one would feel the molecule resisting entry. Experimentation based solely on this visual/haptic feedback could eventually lead to a satisfying click as the docking molecule slid in to place. The system was called GROPE-III, and although it was quite an accomplishment, it still couldn't compute much faster than 3 frames per second. But its central achievement was actualizing Ivan Sutherland's vision of a human gaining new perceptual and problem-solving abilities by interfacing with a computer. Frederick Brooks once said: "If mathematics is queen of the sciences, computer graphics is the royal interpreter."

Among the talented staff under Brooks at UNC is Warren Robinett, an ambitious hacker who had a vision of a computer world people could explore and learn in. Like many VR visionaries, he wants to use computers to expand human perception: "We have certain built-in senses such as vision, hearing, and smell, but there are many phenomena which are completely imperceptible to us. Some examples are X-rays, radioactivity, electricity, and the inside of opaque objects. ...[We're] working on hooking up an ultrasound scanner to the HMD, so that instead of looking at an ultrasound image on a monitor screen, a doctor could put on the headset and see directly into the living tissue."[123] Robinett had formerly been a key member of NASA's VR team, but he had started out at Atari during their glory days, the late 70's. Robinett was noted for

[123]Howard Rheingold, *Virtual Reality*, pp. 25-26.

making an educational program called *Rocky's Boots* which used graphic symbols to teach logic. He was also responsible for the Atari graphical version of *Adventure*, which, even in its text version, was a captivating virtual world. He achieved some fame for programming *Adventure* against orders, at a time when Atari's game cartridges had 4K of RAM.[124]

Atari was an overnight company sold to a global entertainment corporation whose managers were impressed by the sudden cashflow from video games (more in the year of Pac-Man than Hollywood and Las Vegas combined). Warner had taken over Atari after *Pong* hit, and although nobody at Warner knew anything about technological R&D (they wanted profit), they created Atari's Sunnyvale Research Laboratory in the early 1980s to dream up the education and entertainment of the future. Warner hired Alan Kay (who had been at PARC) to assemble the best programmers he could, which he did fairly succesfully. Scott Fisher (the one who was doing immersion and navigation at Arch-Mac) was one of these, attracted by the Atari mandate and the tens of millions of dollars to have important fun with. Fisher went to Atari Research around 1982, and lots of other Arch-Mac programmers came with him. Another programmer who Kay lured to Atari was Jaron Lanier, who is now regarded as one of the biggest figures in the VR business. Lanier, under Scott Fisher, worked on interface concepts at Atari. Although the potential of Atari Research was tremendous because of their funding and the people working there, the video game boom slowed down, and Warner cut the whole program. After Atari Research fell apart, many of their corps of programmers worked together again at Apple and NASA. The latter became the place where virtual reality really came together as a field of its own, what's been called the beginning of the "reality-industrial complex."

NASA, VPL, and Autodesk: Virtual Reality Gets Noticed by the World

Scientific, commercial, and military factors finally converged at NASA's Ames Research Center in Mountain View in the mid 80's. Many people in VR today were sparked by visits to the NASA/Ames Human Factors Research Division — the rush of commercial and academic interest in virtual reality in the late 1980's was largely produced by NASA's demonstrations of usable, affordable, VR products. A lot of the people working on VR at Ames were part of the post-Apple generation who grew up on

---

[124]The cheapest Macintosh you can buy now has four megabytes of RAM, 1000 times more memory than the Atari cartridges.

the PCs created by their elders. This new generation was ready to catapult computer interaction into the next realm.

Back in 1981, NASA had two men, Michael McGreevy and Dr. Stephen Ellis, studying spatial information transfer, including the potentials of HMDs. McGreevy, after a lot of grief, was able to squeeze out $10,000 to build a prototype design system. He had heard about Thomas Furness's work for the Air Force, although the specifics were all classified, so he asked Furness how much it would cost to get one of their custom-built headsets for Ames. Furness said he build one for NASA for $1 million. McGreevy went to Radio Shack to start hunting around for components. Unbelievably, he was able to build his own HMD using LCDs from Radio Shack mini-TVs instead of expensive, high-res CRTs. This gave NASA's initial setup a resolution of 100 x 100 pixels, compared with the Air Force's 1,000 - 1,500 pixels per side (10,000 field pixels total vs. millions). Patched with a Picture System graphics computer from Evans and Sutherland, a Polhemus, and a DEC PDP-11/40 host CPU, the Virtual Visual Environment Display System (VIVED) was functional by 1985. NASA/Ames hired Scott Fisher in that year to help head their growing program. Fisher negotiated with VPL, the company Jaron Lanier had formed, to use their DataGlove in '85 (VPL had been selling their gloves for a while, but Fisher had the vision and resources to combine it with an HMD), and brought in Warren Robinett in 1986. It's hard to say who did what exactly: McGreevy started NASA's VR project and brought in contractors, he and James Humphries, a hardware contractor McGreevy found who had the idea about using Radio Shack LCDs, put together the basic "goggles" system (LCDs plus wide-angle optics plus the Polhemus sensor). Fisher brought his broad conceptual framework from Arch-Mac and Atari and worked, along with specialists, on 3D audio and the gloves section; McGreevy pushed the project to NASA administrators. NASA became primarily interested in VR for its use in telerobotics for space repair and building. Many people podging their inventions and ideas together made NASA the influence it has been. Robinett left in 1988 because things started getting politicky and bureaucratic. After sailing the South Pacific for a while, Robinett returned to the States and joined with the University of North Carolina.

Douglas Kerr took over for Robinett and reprogrammed the system for an HP 9000 cpu, which was powerful enough to do shaded polygons instead of wireframe. The new system was renamed the Virtual Interface Environment Workstation (VIEW). It had 300 lines of resolution, a speech recognition system, and a 3D audio system called the Convolvotron. The user put on the headset and DataGlove and could navigate through a decent-looking virtual space. Both Fisher and McGreevy linked the work of visual perception researcher J.J. Gibson's "affordance" concept — that which makes an image part of our experience. Pointing made you fly; thumb angle controlled speed; closing one's fist grabbed an object. VIEW was eventually nixed for budgetary reasons (too bad there weren't more obvious military applications for it), but McGreevy is working on planetary visualization now with some of its leftovers.

Fisher left for reasons similar to Robinett's in 1990 to form Telepresence Research with Brenda Laurel. In the few years before Fisher left, though, NASA/Ames had demonstrated the viability of fringe concepts to the commercial sector. Although NASA is no longer a leader in virtual reality, a lot of commercial development was sparked by it. Some of those companies: Autodesk, Sense8, Telepresence Research, Fake Space Labs, Pop Optix, Polhemus Navigation Systems, RPI, Enter, Division, Simmgraphics, and VPL Research.

Jaron Lanier, the founder of VPL Research, is one of the most recognizable figures in the virtual reality industry. Round-faced, dreadlocked, animated, and eccentric, Lanier is exactly the type the media love to hype. Despite his programming skills and place in the computer industry, he considers himself to be primarily a musician. In 1983, while he with Atari Research, Lanier made the fairly succesful video game *Moondust*, which gave him enough money to work on his dream of a visual programming language. Thomas Zimmerman, who went to work for Atari in 1982, talked with Lanier at a computer-musician meeting in 1983 and told him about a glove interface he had invented to play virtual instruments. Zimmerman had the ingenious idea of using plastic, optical-flex-sensing tubes that conducted light along with a photosensor at the ends. The sensors would register the amount of light let through from 15 different joints, the resultant value being an indicator of how much each joint was bent. Zimmerman and Lanier teamed up in 1984 and, along with some others, put together a system which prompted Stanford Research Institute to offer them a lab, but Lanier refused. *Scientific American* did a cover story on him in that year, and when asked for his company's name Lanier made up "VPL" in reference to his visual programming language idea. He called the new language he was working on "Mandala," and developed the input glove to use with it. Lanier's vision was of people exchanging total simulations, i.e. virtual worlds, for each other to explore and learn from (what he called "post-symbolic communication"). This was back in 1985, and it is a vision that is coming closer to fruition every year.

VPL improved on McGreevy's HMD, making a product between the Radio Shack device and the Super Cockpit helmet in resolution quality, but for 1/10 the cost of the latter. Lanier called it the EyePhones. The company's second sale ever was to NASA/

Ames, which put them (in an incidental position) on a *Scientific American* cover again in 1987. Between 1988 and 1990, VPL was the "gloves and goggles" vendor to the entire VR industry. In 1989, Lanier presented his Reality Built for Two (RB2) system a Pacific Bell technology convention. The virtual environment was called "Day Care World," and it was designed to illustrate how two people in the same virtual space could exchange and demonstrate ideas in an unprcedented manner. While in Day Care World, a simplified model of a center for pre-school kids, you could fly around, pick up blocks, turn on lights and fans, or choose to see from an adult's or child's perspective. The other person appeared as a cartoony solid. Walls could be resized, light sources moved, ceilings raised, all by pointing and gesturing. The demo was a mob scene; people literally shoved and clawed each other to get a look at it. At that time, the RB2 system consisted of a VPL DataGlove ($6300), EyePhones ($9400), a Polhemus Isotrak ($2500), and world modeling software called "Isaac" ($7200), for a total of $25,400 per inhabitant. This modest price did not include the computers needed to power everything; Silicon Graphics Workstations were the most powerful available and came in three versions, for $75,000, $95,000, and $250,000 respectively. The RB2 system needed two of the most expensive units, one for each person, bringing the grand total to $550,800.[125]

The 1989 SIGGRAPH show[126] marked the time when people got really excited, due in large part to the media buzzing hyperbolically, using misinformed phrases like "electronic LSD." By 1990, VPL had 500 worldwide customers, among them the Matsushita corporation of Japan who hired them to make a virtual kitchen system. Customers would enter their kitchen dimensions into the computer and then, donning HMDs and DataGloves, could walk around and place kitchen appliances in different configurations. (Japan's Ministry of International Trade and Industry (MITI) sponsored this as part of the New Industrialization House Production Technology and System Development Project — more on the Japanese later.) VPL also started working on interior design simulation for an American auto company, public virtual entertainment parlors, virtual cadavers for surgical simulations, nonmilitary aircraft design tools, and "financial visualization." Lanier has also produced videos with Stanley Jordan and the Grateful Dead. VPL made a DataSuit, which they sold for about $50,000, that was a full-body counterpart to the DataGlove. DataGloves and Suits are used to provide

---

[125]These prices are all as of October, 1990.

[126]The Special Interest Group for Graphics (SIGGRAPH) holds a massive convention every year which became the public unveiling moment *de rigeur* for high-powered technology.

animation maps in the US and at Fuji-TV in Japan. Actors wearing the equipment hooked up to computers have all of their movements recorded and mapped in to animated characters. A show on MTV used this process in real-time, so a guy off-screen running around and speaking would produce a "live" computerized host, in that show's case, in the form of an anthropomorphicized dog. Mattel built an ingeniously cheap version of the DataGlove for home entertainment purposes, called the PowerGlove, and released it in 1990 for only $100. The PowerGlove uses electrically conductive ink printed on flexible plastic strips and a cheap ultrasound position sensor (which VPL, and earlier, Sutherland, had rejected because it was inaccurate and slow). Two million Nintendo users bought a PowerGlove in 1991, although the product fell off because it was too problem-ridden for consistent enjoyment. The last few years Lanier has been working on RealityNet, a grand scheme for an international virtual telecommunication network which will probably become the closest thing in the near future to Gibson's cyberspace.[127] He is also working on integrating the real world into virtual realities, in addition to continuing work on his precious programming language, which he renamed "Embrace" in 1991.

In 1982, John Walker cofounded Autodesk and started selling inexpensive CAD (Computer-Assisted Design) tools to architects and engineers. Autodesk got huge, to make an understatement: by 1989 his company was worth $926 million. Walker was very interested in intelligence-amplifying; he had read about VPL and NASA's stuff in 1987-8, and decided to have his company go for the next generation of interface: interactivity/ immersion. His company's entry into VR created quite a stir. Autodesk bought most of Ted Nelson's *Xanadu*; opened a multimedia division, and began working on the info-exchange marketplace of the future. Walker wrote his now-famous "Through the Looking Glass: Beyond User Interfaces" memo in September, 1988, which outlined the "Autodesk Cyberspace initiative." The "Cyberia" project was begun that year, its goal was to reproduce a workable version of VPL's quarter-million dollar system for under $15,000. In March of 1989, Autodesk revealed the first PC-based virtual reality system, final price about $30,000. It used Intel's i860 chip, an IBM-clone 386 PC with two add-on Matrox graphics boards, a DataGlove and a Polhemus, and an in-house cheap HMD. The PC was the reality modeling engine, and two Amiga 500s were used as rendering engines. The i860 could put out 100,000 polygons per second, which meant only about 5 or 6 frames per second, real-time, of cartoon-quality simulation.

---

[127]Science fiction writer William Gibson coined the term "cyberspace" in his 1984 novel *Neuromancer*. The word has since been thrown around for all sorts of things it does and doesn't apply to.

Autodesk's Cyberia project faltered in late 1990, partly because several key employees left in '89. William and Meredith Bricken (a husband and wife team) were among those, William being the project leader. Bricken was a cognitive scientist at Atari years before whose interests made him part philosopher, part psychologist, and part programmer. Eric Gullichsen and Patrice Gelband, two other knowledgable VR designers, left to form their own company, Sense8. The Cyberia project never aimed to sell hardware, but instead to demonstrate the viability of an affordable VR system, and then market the world-building software to use with it. Walker's cyberspace vision surged again in 1991 when Autodesk released their Cyberspace Development Toolkit (CDK), but they've been moving along intermittently since then.

Sense8 proved in February of 1990 that VR could be even cheaper than Autodesk was demonstrating. Their WorldTool software system makes real-time rendering quicker on lower-powered CPUs (they sold it for $2,500 - $5,000 in 1991; this didn't include the hardware necessary for VR, of course). Ken Pimental, an Intel researcher who had a $100,000 fellowship to find or make VR software to integrate with Intel products, picked Sense8. Intel got something called DVI technology from RCA, which enabled high speed texture mapping.[128] The finished system was a breakthrough in late 1990 for PC realism. WorldToolKit also could run on multiple platforms, which encouraged the exchange of models. Decent virtual reality was suddenly available to homebrewers.

Technical Interlude: Polygons Per Second

Polygons are the geometric shapes that the computer builds every virtual object from. Modeling software allows a designer to portray any object in terms of geometric relationships; rendering software draws all of those polygons, computing each one's color, light sources, shadows, perspectival effects, and which obscure which. The benchmark of a VR system's speed is how many polygons it can calculate each second. Evans and Sutherland scene generators in the early 1970's achieved about 6,000 polygons per second, although there was no color or shading. Any VR system must compromise between the complexity and textural realism of the image (polygons per frame) and the smoothness of movement, i.e. the realism of presence (frames per second). Evans and Sutherland emphasized the latter, drawing a very sparse 300

---

[128]DVI graphics boards added-on allow a CPU to send compact instruction message which the boards can render while the CPU resumes calculations. A normal PC sends pixel-by-pixel instructions to its graphic board through a slow 8Mhz bus.

polygons per frame, but achieving 20 frames per second, which meant convincingly smooth motion. 10 frames per second is the minimum for a decent illusion of movement. The average architectural model contains between 50,000 and 100,000 polygons, but the power Autodesk's system afforded couldn't do better than one or two frames per second with that level of complexity. Simplifying the "world model" much more would mean losing detail fundamental to an architectural or engineering simulation, so Autodesk decided to base their system around worlds that would average about 20,000 polygons. The resultant increase to 5 or 6 frames per second was significant, although still pretty jerky. UNC's clever strategy is to go for speed (as close to natural movement as possible) over fine detail until the user's point of view stabilizes, then fill in detail.

1989 Silicon Graphics workstations put out a few thousand polygons per second. In 1992, SGi became the first company to market a powerful computer emphasizing its use for virtual reality, which they called the RealityEngine. It rendered 300,000 - 600,000 polygons per second, using eight Intel i860 RISC chips, 36 bit video, and 160 megabytes of videoRAM. The RealityEngine^2 came out in 1994 and renders 2 million polygons per second.

Henry Fuchs, one of the team at UNC working under Frederick Brooks, created a new computing engine architecture to attack the computation problem in VR. Fuchs, who has been working on virtual reality since the early 1970's, is a legendary graphics programmer who was a student of Alan Kay at the University of Utah back when Sutherland's HMD was still working. Fuchs custom-designed processing chips that manage the entire UNC network (250,000 processors) as one computer. UNC called this massively parallel computing architecture "Pixel-Planes," and it has gone through five generations since its inception. PixelFlow, the next generation at UNC after Pixel-Planes 5, is expected to be able to compute 30 million polygons per second.

A company named Division is currently working on something they have called "transputers." Transputer chips has computing and communication capabilities built in, and operate as processing modules that can be linked together in parallel to become more and more powerful. This is essentially a dedicated system which achieves the same effects as Pixel-Planes. Many believe transputers to be an inevitable development in high-powered computer design.

Possible Spaces, Diverse Inhabitants

In 1989, the Washington Technology Center (a state-run institution affiliated with the University of Washington) founded the Human Interface Technology Lab (HITL). The HIT Lab was a partly academic, partly commercial effort to match the strategic approach to VR R&D the Japanese were taking (more on this later). HITL needed a director, and they found one who was far more qualified than anyone they could have reasonably hoped for: Thomas Furness. Furness had been growing dissatisfied working for the military, even though the Super Cockpit program had millions and millions of dollars flowing through it. Although all of his work was classified, he was getting well known for his project results. In 1986 and '87 he got calls from people working with cerebral palsied patients, robot firefighters, and people interested in medical instrumentation displays. They all wanted to find out more about the state-of-the-art in interface and HMD technology. In 1989 Furness decided that the technology he was in charge of was too important to be used only by the military. After quitting the Air Force, he made public all of his VR human factors research, and decided to focus on mindware for the disabled. HITL named him their first director, and Furness got to work immediately.

The organizations Furness attracted included the Digital Equipment Corporation, the Port of Seattle, and Sun Microsystems, and later US West Communications, Alias and VPL Research. Although the lab had big sponsors behind it, few of them were interested in helping the disabled. Along with Robert Jacobson, Furness managed, despite this, to get more funding and have "reality engines" donated to HITL in 1990. William Bricken came to work with him after leaving Autodesk and started programming a universal VEOS (Virtual Environment Operating System). Over the last few years, HITL has been developing a laser microscanner beamed directly onto the retina that will achieve a resolution of 8,000 x 6,000 pixels. They also are handmaking CRTs that scan 2,000 lines, almost *four times* the resolution of the average TV set. That level of detail results in almost perfectly smooth graphics. The Port of Seattle project illustrated some of the potentials of VR environments and the equipment HITL was building. Under Furness, HIT Labs continues to move towards their stated objective of "establish[ing] an international knowledge base regarding the ergonomics, technology and application of virtual interfaces." Architectural visualization is now one of the larger areas of VR development. One difficulty with architectural visualization that persists today is the method of translating human movement. At UNC, the user, wearing an HMD, walks on a treadmill with moveable handlebars.

Tactile Feedback: the Final Frontier?

One of the biggest obstacles on the path to complete virtual realities is the lack of tangibility, physical weight and force. Force reflectance feedback, like that pioneered at UNC with its ARM, is a partial rectification of this, but an extremely crude one. As with many other areas of human operation dealt with by VR researchers, touch was discovered to be an unbelievably complex event. Integrating tactile feedback into a virtual world will probably take longer to do convincingly than any other aspect of VR.

There are various and diverse approaches being tried to achieve tactile feedback. One of these is being developed by James Hennequin, a British garage inventor, who invented the "balloon-o-glove" in the late '80s, originally for the popular Spitting Image puppets. Hennequin's invention uses "Flexators" — flat hoses that inflate and become round which can be controlled precisely with software. Flexators can be used to rock motion platforms as well as simulating the feel of a teacup in your hand. Hennequin formed Airmuscle Limited in 1991 to market his device. The Advanced Robotics Research Center (ARRC) in England made a glove with Hennequin that used 20 force-sensitive resistors on the underside of the hand, along with 20 Flexators that could be inflated up to 12 psi. They called it the "Teletact" glove, and it is actually one of the more promising devices, primitive as it seems, available.

Another company, called TiNi, makes tactile feedback gloves using nitinol, a "shape memory alloy" that returns to its cast shape when electrically stimulated. It is faster and more accurate than the Teletact, but less delicate.

MIT's Media Lab is doing work on haptic feedback under Margaret Minksy, daughter of AI founder Marvin. Minsky is concentrating on texture rather than shape because she feels the latter is simply too complex to even attempt now. She has built a joystick which has tiny computer-controlled motors supplying varying resistance in complex patterns. By changing settings on a terminal, moving the joystick can convey the feeling of sandpaper, rock, penduluous weights, glass, syrupy fluids, etc. Those who have tried it say it is incredibly realistic, and for some a more disconcerting experience than a high-resolution dynamic visual display.

The Association for the Creation and Research into Artistic Tools (ACROE) in Grenoble, France has patented "slice" motors for force-feedback applications which are miniature, ultrarapid and accurate. (ACROE, and the French VR effort in general, has been working on the transmission of gesture, and linking that with the visual and acoustic arts, since the late 70's.)

Researchers at the University of Pisa are working on "smart skin," using conducting gel between two layers of electrodes which monitor relative pressure all over surfaces. An epidermal layer of sensor-covered plastic sheets between thin rubber layers produces finer texture detail. The sensors are pinhead piezoelectric disks which emit an electric charge when pressured.

The Driving Applications of VR in the '90s and Beyond

From the Army's first digital computer in the 1940s to Air Force HMD work in the '80s, "the US military has been the prime contractor for the most significant innovations in computer technology."[129] The Department of Defense's ARPA created the enabling technologies for all PCs. The American appetite for "manufactured experience" which drove the film industry and later the development of television, is again the impetus pushing the entertainment industry into VR. Film studios and videogame corporations converged with weapons designers and communications conglomerates to propel virtual reality in the 80's and 90's. Now it seems that military applications will be replaced by architectural and financial visualization and medical imaging as driving forces. Scientific visualization and teleoperation is a bit lower on the scale: these fields will adapt the technology developed for the videogames, vehicle simulators, and the manufacturing robotics industry.

Financial visualization is currently a hot field in VR because of the computerization of the world's finances. The idea behind it is analagous to what an animated weather map illuminates for us — comprehension of data so massive it is otherwise unmanageable. In 1986, the London Stock Echange became the International Stock Exchange, and all of its transactions were suddenly entirely digital. International foreign exchange transactions in 1986 were $87 trillion; only 10% of that is trade, the rest is electronic number-swapping.[130] As a result, the financial services industry is becoming the biggest private customer of information technology. The Chemical Bank of London uses 50 workstations to give floor traders graphic depictions of incoming data realtime. Citicorp has funded project for 3D imaging of portfolio data. Paul Marshall, the president of Maxus Systems International, used Sense8's WorldToolKit and an Intel486 CPU to build a living data environment with major American Stock

---

[129]Howard Rheingold, *Virtual Reality*, p. 80.

[130]According to Peter Schwartz, formerly a consulting business futurist for Stanford Research Institute, who now works for the London Stock Echange. In addition, he points out that the $87 trillion figure is several times larger than the gross world product.

Exchange regions — transportation, health care, pharmaceuticals, computers, and retail subregions.

VR is being applied now to all sorts of areas, mostly in response to the information overload that threatens to overrun our culture. NASA wants VR for making unmanageable amounts of data from satellites meaningful. Other scientists and government agencies want to visualize species population dynamics, plate tectonics, shockwave propagation, quarks, pulsars, and black holes, oil-field geology, and human blood-flow. The Air Force is funding air traffic control VR systems. A small company called Reflection Technology makes portable visual displays for firemen that display building layouts, weather data, danger conditions, and crew positions. Greenleaf Medical Systems has marketed the GloveTalker, which lets hand gestures, be it sign language or something even less active, produce simspeech or text. Boeing, the giant aircraft company, is putting money into three defined programs: a) 3D sound for pilots and AWAC operators, b) augmented reality, primarily for manufacturing (diagrams and data superimposed over real parts), and c) immersive integration of design and testing (virtual models). Carnegie-Mellon University has something called "Project OZ", which is developing the intelligence algorithms behind artificial character "personalities," which might play a large part in communication and entertainment systems of the future. NASA is investigating using virtual reality to reduce astronauts' feelings of claustrophobia and enclosure on long missions. 3D Systems (37% owned by chemical company Ciba-Geigy) sells hundreds of systems that use stereolithography to produce prototypes. An ultraviolet laser traces cross-sections of the virtual model onto the surface of a liquid polymer solution, causing it to solidify. Layers, each one thousandths of an inch thick, are built up until a solid, three-dimensional object is created. MIT has a similar "3D printing system" that squirts a binding chemical onto a bed of powdered ceramic or steel in hundreds of layers, which is then fired in a furnace. These systems make VR object translation two-way: not only can we simulate the real world in a computer, but we can now concretely realize what has been always virtual.

Ballard, J. G. Fiction and non-fiction excerpts, interviews, biography. *Re/Search #8/9*. San Francisco, CA: Re/Search Publications, 1978.

Barlow, John Perry. "Being in Nothingness," *Mondo 2000*, Summer 1990, pp. 34-43.

Barlow, John Perry. "Life in the DataCloud: Scratching Your Eyes Back In — John Barlow Interviews Jaron Lanier," *Mondo 2000*, Summer 1990, pp. 44-51.

Bataille, Georges. Visions of Excess: Selected Writings, ed. Allan Stoekl. Minneapolis: University of Minnesota, 1985.

Baudrillard, Jean. Simulations. New York: Semiotext(e), 1983.

Benedikt, Michael, ed. Cyberspace: First Steps. Cambridge, Mass: MIT Press, 1991.

Benedikt, Michael. For An Architecture of Reality. New York, Lumen Books, 1987.

Benjamin, Walter. "The Work of Art in the Age of Mechanical Reproduction." Illuminations. New York: Schocken Books, 1969. 217-51.

Berman, Marshall. All That Is Solid Melts Into Air: the experience of modernity. London: Verso, 1983.

Borges, Jorge Luis. Labyrinths: Selected Stories & Other Writings. New York: New Directions Publishing Corporation, 1964.

Brand, Stewart. The Media Lab: inventing the future at MIT. London: Penguin, 1989.

Brittan, David. "Knowing Where Your Head Is At," *Technology Review*, February/March 1995, pp. 10-11.

Bukatman, Scott. Terminal Identity: The Virtual Subject in Post-Modern Science Fiction. Durham, North Carolina: Duke University Press, 1993.

Burroughs, William S. "The Electronic Revolution." Ah Pook is Here and Other Texts. New York: Riverrun Press, 1979. 123-57.

de Cervantes, Miguel. Don Quixote de la Mancha, translated by Smollett, Tobias, introduction by Fuentes, Carlos. London: André Deutsch, 1986.

Crary, Jonathan. "Critical Reflections." *ARTFORUM International Magazine*, Volume XXXII No. 6, February 1994. 58-9, 103.

Crary, Jonathan. Techniques of the Observer. Cambridge, Mass: MIT Press, 1990.

Crary, Jonathan and Kwinter, Sanford, eds. Zone 6: Incorporations. New York: Urzone, Inc., 1992.

Richard Dawkins, The Selfish Gene. Oxford: Oxford University Press, 1976.

Deleuze, Gilles and Guattari, Felix. Anti-Oedipus: Capitalism and Schizophrenia. New York: Viking Press, 1977.

Derrida, Jacques. Of Grammatology. Baltimore: John Hopkins University Press, 1976.

Ditlea, Steve. "Grand Illusion," *New York*, August 6, 1990, p.32.

Dove, Toni. "Theater Without Actors — Immersion and Response in Installation," *Leonardo*, Vol. 27, No. 4, 1994, pp. 281-287.

Dyens, Ollivier. "The Emotion of Cyberspace: Art and Cyber-ecology," in *Leonardo*, Vol. 27, No. 4, 1994, pp. 327-333.

Eco, Umberto. Travels in Hyperreality. New York: Harcourt, Brace, Jovanovich, 1985.

Ferris, Timothy. Coming of Age in the Milky Way. New York: Morrow, 1988.

Fisher, Scott. "Virtual Environments, Personal Simulation & Telepresence," *Multimedia Review: The Journal of Multimedia Computing*, vol. 1, no. 2, Summer 1990.

Gibbs, W. Wayt. "Virtual Reality Check," in *Scientific American*, December 1994, p. 40.

Gullichsen, Eric and Walser, Randal. "Cyberspace: Experiential Computing," *Nexus '89 Science Fiction and Science Fact*, 1989.

Haraway, Donna. Simians, Cyborgs, and Women. New York: Routledge, 1989.

Hatada, T., Sakata, H., and Kusaka, H. "Psychological Analysis of the 'Sensation of Reality' Induced by a Visual Wide-field Display," *SMPTE Journal*, vol. 89, 1980, pp. 560-569.

Hegel, G. W. F. Phenomenology of Spirit. Oxford: Oxford University Press, 1977 (originally published 1807).

Heidegger, Martin. A Question Concerning Technology and Other Essays. New York: Harper & Row, Publishers, 1977.

Heim, Michael. The Metaphysics of Virtual Reality. New York: Oxford University Press, 1993.

Jacobson, Linda, ed. Cyberarts: Exploring Art & Technology. New York: Miller-Freeman, 1993.

Hesse, Herman. Magister Ludi (The Glass Bead Game). New York: Bantam, 1982.

Kant, Immanuel. Prolegomena to Any Future Metaphysics. Translated by Carus, Paul. Indianapolis: Hackett Publishing Company, 1977.

Kranzberg, Melvin, and Davenport, eds. Technology and Culture. New York: New American Library, 1972.

Krueger, Myron. Artificial Reality II. New York: Addison-Wesley, 1993.

Krueger, Myron. "VIDEOPLACE: A Report from the ARTIFICIAL REALITY Laboratory," *Leonardo*, vol. 18, issue 3, October 1985.

Laurel, Brenda, ed. The Art of Human-Computer Interface Design. Cupertino, California: Apple Computer, 1990.

Laurel, Brenda. Computers as Theatre. Menlo Park, CA: Addison-Wesley, 1991.

Leibniz, Gottfried Wilhelm. Discourse on Metaphysics and Monadology. Translated by Montgomery, George. LaSalle, IL: Open Court, 1902.

Leifer, Larry, Van der Loos, Michael, and Michalowski, Stefan. "Telerobotics in Rehabilitation: Barriers to a Virtual Existence," paper presented at *Conference on Human-Machine Interfaces for Teleoperators and Virtual Environments*, March 4-9, 1990, Santa Barbara, CA, sponsored by the Engineering Foundation.

Lipton, Leonard. "Now Step Into a Movie: Sensorama," *Popular Photography*, July 1964, pp. 114-6.

Mander, Jerry. Four Arguments for the Elimination of Television. New York: William Morrow, 1978.

Mast, Gerald. A Short History of the Movies, 4th ed. New York: Macmillan Publishing Company, 1986.

Mast, Gerald and Cohen, Marshall, eds. Film Theory and Criticism. 3rd ed. New York: Oxford University Press, 1985. (Specifically, essays by David Antin, Rudolf

Arnheim, Andre Bazin, Stan Brakhage, Maya Deren, William Earle, Seigfried Kracauer, Christian Metz, Laura Mulvey, Susan Sontag, and James Spellerberg.)

Morris-Suzuki, Tessa. Beyond Computopia: information, automation and democracy in Japan. London: Kegan Paul, 1988.

Nadin, Mihai. "Emergent Aesthetics - Aesthetic Issues in Computer Arts." Computer Art in Context: SIGGRAPH 1989 Art Show Catalog. Ed. Mark Resch. Oxford: Pergamon Press, 1989. 43-48. Supplemental issue of *Leonardo*, the Journal of the International Society for the Arts, Sciences, and Technology.

Nelson, Ted. Computer Lib. Redmond: Tempus, 1987.

Nicholson, Linda J., ed. Feminism/Postmodernism. New York: Routledge, 1990.

Norman, D. A. and Draper, S., eds. User-Centered System Design: New Perspectives on Human-Computer Interaction. Hillsdale, NJ: Lawrence Erlbaum Associates, 1986.

Ostrow, Saul. "Clement Greenberg: The Last Interview," *World Art*, November 1994, pp. 24-32.

Pagels, Heinz R. The Dreams of Reason: the computer and the rise of the sciences of complexity. New York: Bantam, 1989.

Palfreman, Jon and Doron Swade. The Dream Machine. London: BBC, 1991.

Papert, S. Mindstorms: Children, Computers and Powerful Ideas. New York: Basic Books, 1980.

Pavel, Thomas. Fictional Worlds. Cambridge, Mass: Harvard Press, 1986.

Penley, Constance and Ross, Andrew, eds. Technoculture. Minneapolis: University of Minnesota Press, 1991.

Pimental, Ken and Teixeira, Kevin. Virtual Reality: Through the New Looking Glass. New York: Tab Books, 1993.

Pollack, Andrew. "What is Artificial Reality? Wear a Computer and See," *The New York Times*, April 10, 1989, p.1.

Popper, Karl. Objective Knowledge: An Evolutionary Approach. Oxford University Press, 1972, rev. 1979.

Poster, Mark. The Mode of Information: poststructuralism and social context. Cambridge: Polity Press, 1990.

Rheingold, Howard. Virtual Reality. New York: Summit Books, 1992.

Roszak, Theodore. The Cult of Information. Cambridge: Lutterworth, 1986.

Rushkoff, Douglas. Cyberia: Life in the Trenches of Hyperspace. San Francisco: Harper Collins, 1994.

Schoenberger, Karl. "Nintendo Investing in Research on Children," *Los Angeles Times*, May 16, 1990.

Segal, Howard. Future Imperfect: The Mixed Blessings of Technology in America. Amherst: University of Massachusetts Press, 1994.

Stone, Allucquére Rosanne. "Sex and Death Among the Disembodied," paper presented at the *Conference of the International Association for Philosophy and Literature*, 1990.

Turkle, Sherry. The Second Self: computers and the human spirit. New York: Simon & Schuster, 1985.

Virilio, Paul. War and Cinema: the logistics of perception, trans. Patrick Camiller. London: Verso, 1989.

"Virtual Reality" videotape, VHS. *Fresh Concepts*, PO Box 2517, Sausolito, CA, 94965. 60+ minutes.

Walser, Randal. "Elements of a Cyberspace Playhouse," *Proceedings of National Computer Graphics Association '90*, 1990.

Woolley, Benjamin. Virtual Worlds: A Journey in Hype and Hyperreality. New York: Blackwell Press, 1993.

Wright, R. "Computer Graphics as Allegorical Knowledge: Electronic Imagery in the Sciences," *Leonardo*, supplemental issue, Pergamon Press, 1991.