There are No Philosophic Problems Raised by Virtual Reality

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here is widespread agreement that virtual reality presents serious new challenges to received ways of thinking about such fundamental concepts as reality, simulation, representation, perception and sensation. It has been seen as a practice that might have deep consequences for conventional ways of construing the mind-body problem, including the minimal requirements for a body, the requirements for the coherent reception of sensation and the relation between reason and intuition. Most fundamental of all, it has been said to entail a new kind of space, differing from Cartesian and other spaces and requiring new definitions of space and form.

This paper argues, on the contrary, that virtual reality does not raise any new philosophic problems. The questions of the body and of space, and even the ethical dilemmas of empathic "immersion" in fantasy worlds, have been elaborated in past art. My position has a twofold purpose: I want to suggest that we question our motives in claiming a radical relation to history and philosophy, and that we acknowledge the inevitable return of new technology to the continuous stream of western art.

At the same time, writing on virtual reality and cyberspace has already developed to the point where its language and its claims are not always easily recognizable by writers in related fields (e.g., in philosophy and the history of art). The independent use of philosophemes, stylistic terms and historical constructions signals the inception of a new way of talking about art. That departure is properly understood as occurring in criticism, rather than in—or against—philosophy.

All problems are philosophic

Every problem is philosophic. Since the concept of a problem itself is traditionally traced to Euclid, problems are at the root of the western elaboration of logical thought and therefore of philosophy. For that reason—and it is a wonderful one to contemplate, though I will not be doing that here—any thought I can formulate precisely enough to appear as a position or a proposition, a hypothesis, a stand or a stance, a notion or a supposition or a theory, will engage a range of further methods and issues that are properly within the realm of philosophy. A problem cannot be thought *as* a problem without that thought taking place in philosophy. That's the shortest way I know to say that all possible problems belong to philosophy, and therefore that every conceivable, ill-conceived and inconceivable question that was, is, or may ever be raised about virtual reality is properly philosophic.

Is virtual reality an oxymoron or a pleonasm (as a recent editorial in *Wired* asked)?[1] Is it ethical to spend time in a "space" where F2F's (face-to-face encounters) need not ever happen, and where there is a peculiar relish in calling the body "meat"? Is there a connection between projection and rendering subroutines and the scenarios of aggression and fantasy that continue to dominate commercial virtual reality? And—a question that especially interests me—is it coherent to develop the methods, the poetry and the philosophy of these activities in a prose that has developed such an extensive terminology, and has grown so many of its own standards of analysis, that it can carry on for the space of entire monographs and conferences without ever making firm contact with the various discourses that gave rise to it?

These are ethical, epistemological, ontological, narratological and logical questions, and they would normally be answered in those fields: but the emerging discourse of cyberspace and virtuality has few remaining points of contact with the disciplines it has left behind—not because it deals with different concepts or experiences, but because its writers prefer to mimic with their prose and their lexica the newness of their technology.[2] That, in the end, may be the most intriguing philosophic question of all, and I will come back to it.

All I want to imply to begin with is that every conceivable problem—every statement that can be conceived as a problem—is already philosophic, regardless of whether it is treated that way in a text. So on the face of it there is not much sense in my title—why claim that no philosophic problems are raised by virtual reality, when all problems must be philosophic? There is an increasingly large literature on virtual reality (already, I think, it is beyond the grasp of two or three people reading continuously), and an increasing fraction of that literature takes it for granted that virtual reality is in the process of opening radical, fundamental questions about the nature of reality and its simulacra, of subjectivity and individuation, of space and time, of body and mind, of phenomenology and perception and of truth. Normally those kinds of claims are expressed as conditionals or hypotheticals—an author may say, for example, that virtual reality is in the process of questioning our old notions of reality—but the existence and difficulty of the questions are not generally in doubt. It has become part of the discourse on virtual reality to say that virtual reality has the power to radically alter, deconstruct or rebuild some of the foundational moments of western metaphysics.

It is that notion that I want to argue against here. It seems to me that it is important to take note of the fact that virtual reality is not challenging any philosophic concepts that have not been challenged before, and that it is not a disruptively new departure for art or experience. Emphasizing this is ultimately a way of deepening the *psycho-*

logical inquiry into virtual reality, because it shows how much some practitioners and observers need to believe that something new is happening, even if it means—and in some instances, *especially because* it means—jettisoning the weight of traditional discourse. The discourse on virtual reality *requires* the idea that it is radical in relation to experience, art and philosophy, and it seems to me there is a parallel here to the way that a neurotic or an addict requires a fictional construct or a drug. The need is psychological, and it is generated by a certain way of behaving that has to do with fantasy—but in this context I am more concerned with the preparation for that argument, and especially with the status of philosophic claims about virtual reality.

Since no essay, no matter how long, could suffice to prove my negative proposition, I will concentrate on what I think are the two major arguments that have been produced in favor of virtual reality's ability to disrupt fundamental categories of experience. The first concerns what virtual reality does with notions of the body, and the second with the term reality itself, along with its cognates such as space. Though I am not at all sure that the many claims might not be ordered differently—for example, into questions of society and individual, or phenomenology and epistemology—the division into body and reality fits a large percentage of the material I have collected. The division itself is of interest, since it repeats and expresses the attachment to "cold" digital abstraction and the corollary fascination with dismantling, fragmenting and dispersing the body.

Problems of the body

In its most general form, the claim here is that virtual reality somehow deconstructs the body and presents us with new, unheard-of objects that must now be imagined as bodies. Cyberspace, according to David Tomas, has the potential to "overthrow the sensorial and organic architecture of the human body" by "disembodying and reformatting its sensorium in powerful, computer-generated, digitized spaces." Allied claims are made in behalf of various blendings of machine and human—mechanomorphs,

metalmorphs, "cyberpsychically digital life-forms," "postorganic hardware-based cyborgs" and the computer technique of morphing itself have each been seen as examples of new modes of existence for bodies.[3] They are imagined as sexually and socially new, and as new blendings of the artificial (artificial life, artificial intelligence) and the natural. The attention that has recently been focused on these creations makes it appear they are things that computer graphics has forced on our awareness— things never before seen or imagined.

But all of them are as old as the hills. Morphing is the literal visualization of the transformations described in Ovid's *Metamorphoses:* painless, entertaining, organic, silent, continuous change presented in ekphrastic detail. Ovid's metamorphoses are a particular kind of bodily transformation; historically, others have been painful, inorganic, instantaneous, metaphorical or invisible. Morphing belongs in a line of descent that begins with Hellenistic Greek mythographers and reaches its height— perhaps until the twentieth century—in Ovid. Inorganic transformations such as cyborgs, prostheses and neural interfaces, are also ancient.

Unusual kinds of bodies have long been imagined as partly organic and partly machine or tool. That kind of hybrid is indispensable in poetic description (a tiger's teeth are like iron nails, in the words of one Chinese novel), and it has been visualized in many ways. Unusual and mythical animals are often credited with prostheses—they are *grylli,* in the ancient term: bodies composed of namable parts of other bodies. The "machine aesthetic" that developed in the twentieth century, and the artistic movements that drew on it such as cubism, surrealism and dada are only the nearest relatives to computer-generated hybrids.

It is sometimes said that computer graphics in general, and virtual reality in particular, substitute machines for bodies: that they make a complete transition from organic to inorganic. The "information system" would then operate by "absorbing the opacity of the body, grinding the meat into information and deriding erotic life by reducing it to a transparent play of puppets."[4]

Cyberpunk's well-known (and seriously under-analyzed) fascination with everything that is *not* organic, and its flirtation with transcendent incorporeal informational existence, are symptoms of that desire. But bodies made of simple building blocks have been drawn and painted since the Renaissance, when they were first instituted for reasons that are largely similar to those that have led to their wide use in computer graphics: they were easier and quicker to draw than fully-fleshed figures. Artist's mannequins and art-school drawings made of cubes and cones are the cousins of the wire-frame geometric figures that populate personal computer and arcade software.

The appearance of unheard-of bodies that shock or disorient is also a traditional component of the western concept of the body. It can be traced to the medieval bestiaries and the elaborations of Herodotus's list of the mythical races that lived beyond the ocean. More recently, amazing bodies have been the subject of monographs on birth defects (beginning in the sixteenth century), and later of the emerging studies of microscopy (in the eighteenth), comparative zoology (in the nineteenth) and paleontology (in the twentieth).[5] Each of those fields presented bodies that were, by the standards of their day, nearly incomprehensible *as* bodies: children born as half-fauns, the microscopic "Proteus" (the amoeba) that had no fixed head or anus, the bizarre inhabitants of the deep sea and the exotic creatures that swam in Cambrian seas. The possibility *and* the existence of monstrosity, to give this subject its more traditional name, have long been necessary to support the concept of the ordinary, the normative and the beautiful.

Although the Holodeck on *Star Trek: The Next Generation* has been taken as an ideal form for virtual reality, more sober assessments acknowledge inevitable disharmonies between sensory input and expectation. It is not yet possible to build a sound system that would generate sounds appropriately modified by their interaction with the entire virtual environment, and barring the development of a full neural interface, a body cannot be wired to respond to an environment. Since there will

always be discrepancies, "alternate world disorder" (nausea and other symptoms of discrepancies among sensory inputs) will be an integral part of virtual reality: there will be some chafing, some discomfort, some irritating gap between virtual and real. Because it is integral to the activity, "AWD" becomes an *expressive* issue rather than a purely technical one.

This bears on the claim that virtual reality and related technologies remake bodies by rearranging and enhancing the senses. Hypertext, for example, has been said to reform the relation between reason and intuition. (A claim, it seems to me, that has been almost entirely unsubstantiated, since hypertexts are principally literalizations of ordinary patterns of association.) Myron Krueger and others have experimented with unusual substitutions and synaesthesic effects, where motions generate sounds and colors.[6] Jaron Lanier has experimented with virtual reality as a new, nonverbal communication medium.[7] All such configurations will *inevitably* rearrange sensation and perception, and therefore they will involve AWD as an *integral* component in the virtual reality experience.

Virtual worlds that aspire to have lasting interest will have to manage those moments in expressively interesting ways, and to demonstrate that they mean to manage them rather than merely minimize them. This artistic issue is relevant here because it constitutes the limits of the deconstruction of the body. Wherever aspects of the observer's body and perceptions are at cross-purposes with what is given in the simulation, the deconstructed body will return to the awareness of its original. The nausea generated by a C-max film may be a flaw, but it is also an expressively interesting moment—as I am "returned" from the arctic, or from outer space, or from a Rolling Stones concert, to the unpleasant awareness of my body. That chafing is the remainder of the various quotients of the organic and inorganic, the irrational surd that is left over when the digitized, abstracted, mechanized, morphed, desexed body is recalled to its original fallen "meat." A purely digitized body, floating in weightless cyberspace, is only the historically naive counterpart to the purely

enlightened angelic body, floating in the weightless spheres of heaven: their impossibility has been constant since they were first imagined.

Problems of reality and representation

The second general set of claims made about virtual reality is that it alters the meanings and functions of fundamental abstract concepts of space, form, reality and representation. Michael Heim's *Metaphysics of Virtual Reality,* the most extensive recent meditation on the philosophic claims of virtual reality, considers several such concepts in the course of an informal definition of virtual reality. First there is the possibility that virtual reality may eventually simulate reality more accurately or thoroughly than conventional representations. But since the experience of simulation has varied through history, simulation is an unreliable criterion. Utter absorption, hypnotic entrancement, full immersion, empathic reverie and other states of perfect unselfconscious overwhelmed attention have recurred whenever new technology was introduced. They are not the province of head mounted displays.

The first optical instruments were addictive, and the camera obscura was an obsession from the moment it was invented. Anyone who has seen a child discover its first kaleidoscope or magnifying glass has sufficient proof that visual enchantment does not require computers of any kind. In the eighteenth century, viewers were astounded by Loutherbourg's *Eidophusikon*—a precursor of the diorama, consisting in one instance of a painted scene of hell, lit from in front and behind, accompanied by harpsichord music. Today it would be pale fare. Raymond Roussel thought that his enchanting and bizarre novels, such as the *Impressions of Africa,* could be adequately conveyed on a stage by a few cheap props. He put stiff actors on-stage with fish tanks and rubber snakes, seriously hoping to replicate his hallucinatory and masterfully conjured scenes. The result was disastrous: viewers such as Andre Breton and Marcel Duchamp thought they were hilarious and awkward. Simulation and accuracy in representation have always been relative to

their historical reception and loosely linked in concept. We may well find current virtual reality, and even current fantasies such as the Holodeck and the *Lawnmower Man,* unintentionally funny and entertaining for very different reasons than they originally conceived.

Heim also considers defining virtual reality as a new way of interacting with reality. It doesn't matter, he points out, how realistic the representations are: a player or an object in a virtual reality game might be represented by a silhouette, a wire frame or just a sign or a vector. What counts is that it is manipulable, so that the operator can interact with the representation. This too has precedents, and as in a number of other instances they turn out to be largely religious ones. As the historian Louis Marin has pointed out, the eucharist is an aniconic sign, since it does not resemble the bread of the last supper.[8] Worshippers "interact" with it by swallowing it.

In other religious rituals there are freedoms commensurate with virtual reality scenarios. Australian Walbiri sand paintings are collaborative stories, and the *devapuja* ritual in Jaina worship requires the worshipper to draw a symbolic diagram representing the paths to salvation. So while it is true that interaction is not a normal property of western painting and sculpture, many other practices do involve interaction and they might be profitably studied alongside virtual reality.

On the other hand, a deeper inquiry might ask why we would *want* to confine interaction to physical manipulation. Imaginative interaction has been one of the staples of western illusionistic painting since the Greeks, and its vicissitudes are arguably the true antecedents of virtual reality's literal manipulations. The complementary question might be why those who are involved with virtual reality wish to develop literal, "physical" interaction, and why they are generally uninterested in the porous boundary between literal and imaginative interaction.

A third criterion is immersion: virtual reality is said to remake representation by enveloping the observer in the representation or by shrinking the distance between observer and object—traditionally the third term in the equation

of vision—to zero. But immersion or "presence," as it is also called, arguably depends on simulation, since the more effective the simulation the deeper the immersion will seem to be.[9]

Heim mentions the example of F-16 Falcon pilots who see a "virtual cockpit," since at such speeds "the less you see of the real world, the more control you can have over your aircraft." At times the pilots can also see the real landscape "behind" the virtual images, so that "the simulation is an augmented rather than a virtual reality."[10] Full immersion, or perfect simulation, has been a marginal or dubious goal in western art: it is identified with naive religious art, kitsch and popular entertainment; and it typifies nineteenth-century attempts at the "complete work of art" (Gesamtkunstwerk) by Wagner, Scriabin and others, that constitute the closest precedents for virtual reality.

The software in the F-16 Falcon is far more typical of the experience of art: it involves a shimmering awareness of two "realities," two representations, just as the viewer of a painting might sense the depicted scene and its original. And in addition the pilot would have intermittent awareness of the pixels and graphics themselves, in the way that the viewer of a painting may think alternately of the painted surface and the illusionistic depth. As Heim notes, "a virtual world needs to be not quite real or it will lessen the pull of imagination."[11]

Immersion is seldom complete, and for that reason it is a good definition of virtual reality, one that might serve to distinguish it from the majority of western art and at the same time ally it with tendencies that began in the late eighteenth century (with tableaux vivants and panoramas) and flourished in the nineteenth (with the Gesamtkunstwerk). But that history remains to be written; my concern here is only to suggest that immersion, even when it is a goal, is not a new issue.

Heim also proposes telepresence as a defining trait of virtual reality. When an operator on the Earth can drive a vehicle on Mars, or a surgeon in one city can control a laproscopic operation in another city, it appears that something is taking place that depends on virtual reality, and that has never happened before. But what is religious imagery, if not the scene of "telepresence"? What is an icon, if not a way of invoking a distant—indeed, a transcendent—reality, and making it imminent? What is prayer, if not the summoning of an inaccessible image?

Again the parallels are religious ones, and I believe that religion is one of the closest affinities of virtual reality. Heim speaks of virtual reality "transforming" and "redeeming" our sense of reality, and he uses the metaphor of the Holy Grail to describe ideal virtual reality. The romantic trope of the sublime, which Heim invokes as another way of describing virtual reality, is widely studied as a modern signifier of the transcendental.[12] The difference, often enough, has to so with the way that reality is construed. A virtual reality operator might say that telepresence is a legitimate novelty because it can actually change physical objects at a distance... but a devout worshipper would say the same of an icon and a prayer.

These are each reasonable aspects of a definition of virtual reality, and each of them depends on the idea that representation itself has altered—that it is more accurate, more immediate, more encompassing than it had been before computers. Another argument concentrates on the notion of reality. As Heim notes, the term "virtual reality" is not used at MIT and NASA (where "virtual environment" is preferred) or at the University of North Carolina or Washington (where "virtual world" is used).[13] "Virtual reality" seems too presumptuous, or too broad, and "environment" or "world" sounds more local or technical. "World," as Heim knows, is a technical philosophic term, used by Nelson Goodman to denote a coherent system of signification—anything from the "world" of physics to the "world" of art criticism.[14]

Yet in Goodman's sense, the claim that virtual reality presents or creates a new world is trivial, since any system qualifies (it is the word "system" that becomes the issue).[15] Goodman's philosophy has been powerfully critiqued by Quine, Davidson and others, and even where it informs the phrase "virtual world" it cannot help defend claims of virtual reality's novelty.

There have been many less concise claims about the reality offered by virtual reality. Heim suggests that virtual reality "offers the opportunity to shift the western philosophy of presence," and that it is an "ontological shift" toward a "full-fledged, aggressive, surrogate reality."[16] There is no way to quickly assess these claims; I would just observe that if they are to make sense, they need to be related to some standard other than Goodman's embattled concept of "well-made worlds."

The word "cyberspace" itself shows how unlikely it is that these positions might be adjudicated in accord with philosophic constructions. Cyberspace is partly a kind of space, and partly a nonspatial metaphor. To the extent that it refers to the dimensionless intersection of databanks and memory chips (in telecommunications, computer memory and the electronic transfer of funds), it is a nonspatial concept, but its affect, from William Gibson onward, has been described in terms of spatial metaphors: the cold unfeeling eyes of the information managers and faceless corporations looking "down" on the humble messages sent by private citizens, the "ice" of industrial encryptions, and so forth. Into this mix of realism and affect there come legitimate spatial metaphors: the "inside" and "outside" of protected systems, the "central" and "marginal" nodes of a network.

Writers who use the word cyberspace normally intend this amalgam, which renders the term more or less immune from cogent comparison to other spaces. Instead it is a poetic construction like many other spatial metaphors such as "social space" and "personal space," and perhaps the relatives of cyberspace should be sought in those pre-technological terms instead of the stricter spaces of mathematics and philosophy.[17] When Tomas describes a "new form of electronic space" that "holds revolutionary promise as the fin-de-siècle metasocial postindustrial work space," when Rene Berger talks about a "new type" of reality—perhaps the "first complex reality"—and when William Gibson invokes a "space that wasn't space" and a "nonspace," they are conjuring with this hybrid concept.[18] Any such formulations

should be treated as poetic metaphors: they make sense in relation to their fictional and critical contexts, and they lose sense when they are based on Euclid, Descartes or any nonmetaphorical, mathematical model of space.

"At the speed of war," one writer says, "Descartes' world becomes brittle. Cyberspace will shatter it like a mirror."[19] That only makes sense when it is read apart from computer graphics' continuing absolute fidelity to Cartesian geometry. But virtual reality is entirely bound to what is eponymously called "Cartesian" or "Euclidean space," with its rigorous perspective routines. There are no virtual realities that do not present their information in absolutely canonical linear perspective. What is represented is distinct from how it is represented, so that stock markets, information networks, non-Euclidean and multidimensional data are all represented as perspective projections. (In this respect the freedom that virtual reality programmers sometimes desire is already there in traditional painting and drawing, where five centuries of practice have resulted in only a handful of representations that are projectivally correct up to the limits of their media.) Cyberspace is partly an ineffectual reaction against that tyranny, though the more it departs from the inescapable norm the more it loses meaning.

Envoi

At the beginning of this essay I suggested that discourse on virtual reality and its allied terms has grown to such an extent that entire monographs and conferences can proceed without making contact with the non-technological sources they appear to depend upon. Perspective—still the central and inescapable requirement of virtual worlds—and Euclidean geometry have lost their foundations in the new constructions of cyberspace. In Heim's prose, Platonic, Leibnizian, atomist, analytic and other philosophies are refracted toward new ends. And most important, I think, is the near absence of the history of art and of awareness of the connecting threads that bind the images of virtual reality to their western past. I have written on that topic in another place, and here I want to emphasize a kindred point.[20]

Fractal geometry has gone this route: in the humanities, the hunger for unusual terms has given rise to a singularly incoherent way of writing about artworks (stressing their "turbulence," their "iterations" and their tendency toward "chaos"); and in the sciences, an impoverished sense of visual art has given rise to ineffectual attempts to create art by adding garish color palettes, texture-mapped moons and perspectival space fantasies to two-dimensional graphs. The result is a drunken conversation between two partly misinformed ways of writing and imagemaking. There is little coherent chaotic dynamics in art critical writing, and little interesting visual art in texts on fractal geometry.[21] Virtual reality has begun to move in this direction, and it has already engendered historically and visually impoverished visual worlds, populated by mobile wireframes, computer palettes and "first-person" dramas of aggression.

When a way of writing splits definitively from its precedessors, and yet continues to cite them, borrowing and transforming terms and contexts, there are essentially two avenues open to analytic inquiry. It is always possible to proceed as if the links between the discourses had not yet been broken, as if what was being said in the new texts made sense by the standards of the old. One would then continue to write, as Heim says, for and from the "beloved *philosophia,*" finding and elaborating links to a philosophic past. I would advocate something of the same in regard to art history—that neuromancers give some thought to their antecedents in the devalued, noninteractive, nontechnological, nontelepresent realm of painting. But there is also a moment what that strategy ceases to make sense. From then on, it becomes necessary to speak in the new language, and to stop claiming that virtual reality either is or is not connected to a philosophic past.

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Footnotes

1. Nicholas Negroponte, "Virtual Reality: Oxymoron or Pleonasm?" *Wired* 1.6 (December 1993): 136.

2. In addition to the sources I cite below, see Philippe Queau, *Le Virtuel, vertus et vertiges* (Seyssel, Champ Villon / INA, 1993). For virtual reality in general see first Robert J. Carande, *Information Sources for Virtual Reality, A Research Guide* (Westport, CT: Greenwood Press, 1993).

3. David Tomas, "Old Rituals for New Space: *Rites de Passage* and William Gibson's Cultural Model of Cyberspace," *Cyberspace: First Steps,* edited by Michael Benedikt (Cambridge, Mass.: MIT Press, 1991), 32, 33, 40.

4. Heim, *Metaphysics of Virtual Reality* (Oxford and New York: Oxford University Press, 1993), 91.

5. See my "On Visual Desperation and the Bodies of Protozoa," *Representations* 40 (1992): 33-56. These aspects of the body are considered in a work in progress, *Formation and Deformation of the Human Body.*

6. Myron Krueger, "The Emperor's New Realities," *Virtual Reality World* 1 no. 1 (November / December 1993): 18-33.

7. Heim, *Metaphysics, op. cit.,* 116.

8. Louis Marin, *Portrait of the King,* translated by Thomas Conley (Minneapolis: University of Minnesota Press, 1984).

9. For "presence" see J. Michael Moshell and Richard Dunn-Roberts, "A Survey of Virtual Environments: Research in North America," *Virtual Reality World* 1 no. 1 (November / December 1993), 16. The authors suggest that presence, interaction and autonomy (predictable behavior of virtual objects) constitute "virtuality."

10. Heim, *Metaphysics, op. cit.,* 113.

11. Heim, *Metaphysics, op. cit.,* 133.

12. Heim, *Metaphysics, op. cit.,* 124, 137. For the sublime see Thomas Weiskel, *The Romantic Sublime: Studies in the Structure and Psychology of Transcendence* (Johns Hopkins, 1976).

13. Heim, *Metaphysics, op. cit.,* 123.

14. Nelson Goodman, *Ways of Worldmaking* (Indianapolis: Hackett, 1978); Heim, *Metaphysics, op. cit.,* chapter 9.

15. See my "What Really Happens in Pictures? Misreading with Nelson Goodman," forthcoming in *Word & Image.*

16. Heim, *Metaphysics, op. cit.,* 128, xiii.

17. See Elkins, *The Poetics of Perspective* (Ithaca: Cornell University Press, forthcoming, 1994).

18. David Tomas, "Old Rituals," *op. cit.,* 35, Rene Berger, "The Jubilatory Virtual: Assumption or dissolution of Complexity?" *Diogenes* no. 162 (summer 1993): 2, 6, and Gibson, *Count Zero* (New York: Ace, 1987), 33, 166, quoted in *ibid.*

19. Nicole Stenger, "Mind is a Leaking Rainbow," in *Cyberspace: First Steps,* edited by Michael Benedikt (Cambridge, Mass.: MIT Press, 1991), 51.

20. Elkins, "Art History and the Criticism of Computer-Generated Graphics," *Leonardo,* forthcoming, 1994.

21. Elkins, "The Drunken Conversation between Chaos and Painting," *M/E/A/N/I/N/G* 12 (1992):55-60.