

more or less fairly by the economically ascendant from the economically naïve, the poor, the hard-pressed heirs of fallen dynasties and impoverished religious orders. Then too there are the marks on the artifacts themselves: the attempt to scratch out or deface the image of the devil in numerous late-medieval and Renaissance paintings, the concealing of the genitals in sculptured and painted figures, the iconoclastic² smashing of human or divine representations, the evidence of cutting or reshaping to fit a new frame or purpose, the cracks or scorch marks or broken-off noses that indifferently record the grand disasters of history and the random accidents of trivial incompetence. Even these accidents—the marks of a literal fragility—can have their resonance: the climax of an absurdly hagiographical Proust exhibition several years ago was a display case holding a small, patched, modest vase with a notice, “This vase broken by Marcel Proust.”³

As this comical example suggests, wounded artifacts may be compelling not only as witnesses to the violence of history but as signs of use, marks of the human touch, and hence links with the openness to touch that was the condition of their creation. The most familiar way to recreate the openness of aesthetic artifacts without simply renewing their vulnerability is through a skillful deployment of explanatory texts in the catalogue, on the walls of the exhibit, or on cassettes. The texts so deployed introduce and in effect stand in for the context that has been effaced in the process of moving the object into the museum. But insofar as that context is partially, often primarily, visual as well as verbal, textual contextualism has its limits. Hence the mute eloquence of the display of the palette, brushes, and other implements that an artist of a given period would have employed or of objects that are represented in the exhibited paintings or of materials and images that in some way parallel or intersect with the formal works of art.

Among the most resonant moments are those in which the supposedly contextual objects take on a life of their own, make a claim that rivals that of the object that is formally privileged. A table, a chair, a map, often seemingly placed only to provide a decorative setting for a grand work, become oddly expressive, significant not as “background” but as compelling representational practices in themselves. These practices may in turn impinge upon the grand work, so that we begin to glimpse a kind of circulation: the cultural practice and social energy implicit in map-making drawn into the aesthetic orbit of a painting which has itself enabled us to register some of the representational significance of the map. Or again the threadbare fabric on the old chair or the gouges in the wood of a cabinet juxtapose the privileged painting or sculpture with marks not only of time but of use, the imprint of the human body on the artifact, and call attention to the deliberate removal of certain exalted aesthetic objects from the threat of that imprint.

For the effect of resonance does not necessarily depend upon a collapse of the distinction between art and non-art; it can be achieved by awakening in the viewer a sense of the cultural and historically contingent construction of art objects, the negotiations, exchanges, swerves, exclusions by which certain representational practices come to be set apart from other

representational practices that they partially resemble. A resonant exhibition often pulls the viewer away from the celebration of isolated objects and toward a series of implied, only half-visible relationships and questions. How have the objects come to be displayed? What is at stake in categorizing them as of “museum-quality”? How were they originally used? What cultural and material conditions made possible their production? What were the feelings of those who originally held these objects, cherished them, collected them, possessed them? What is the meaning of my relationship to these same objects now that they are displayed here, in this museum, on this day?

* * *

1990

N. KATHERINE HAYLES

b. 1943

Repeating a memorable phrase from William Gibson's *Neuromancer* (1984), the founding novel of cyberpunk fiction, N. Katherine Hayles describes the posthuman body as “data made flesh.” She argues that the post-World War II era marks an epistemic shift in the history of science and technology. This new cultural condition of virtuality is characterized by the increasing permeation of material reality by information codes and patterns. In the wake of cybernetic theories that erase the boundaries between human existence and computer simulation, subjectivity comes to be recast in terms of information paradigms. For Hayles, the contemporary technoscientific mutation of subjectivity initiates a dismantling of the liberal humanist individual and the birth of a new age of the posthuman. But unlike other posthumanists, who entertain dehumanizing fantasies of scientific power and immortality, Hayles stresses the importance of concrete material embodiment. This emphasis ensures that the subject retains both agency and singularity. Literary texts play a central role for Hayles: as cultural documents, revealing and often prophetic, they cast light on today's ongoing transformations at the intersection of technology, the body, and culture.

Hayles holds degrees in science and literature. She received a B.S. in chemistry from the Rochester Institute of Technology in 1966, an M.S. in chemistry from the California Institute of Technology in 1969, an M.A. in English from Michigan State University in 1970, and a Ph.D. in English from the University of Rochester in 1977. After teaching at Dartmouth College, the University of Missouri at Rolla, the University of Iowa, the California Institute of Technology, and the University of California at Los Angeles, where she was a professor of English and design/media arts from 1992 to 2008, she joined Duke University's Program in Literature. Hayles's numerous honors and awards include two National Endowment for the Humanities Fellowships, a Guggenheim Fellowship, a Fellowship at the National Humanities Center, and a Medal of Honor from the University of Helsinki. Her book *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (1999) received the René Wellek Prize for the Best Book in Literary Theory from the American Comparative Literature Association and the Eaton Award for the

2. Literally, “destroying religious images.”

3. Marcel Proust (1871–1922), major French novelist.

Best Book in Science Fiction Criticism and Theory from the University of California at Riverside. Hayles is past president of the Society for Literature, Science, and the Arts.

Like DONNA HARAWAY'S pioneering writings on cyborg theory, Hayles's work treats the miscegenation of human and machine as an occasion for reconsidering traditional humanist accounts of subjectivity. While Haraway adopts the cyborg (human+machine) as an "ironic political myth" in the service of socialist feminism, Hayles uses it to examine the philosophical assumptions underlying cybernetic research. In *How We Became Posthuman*, she sees the cyborg as a cultural icon of postmodern society that is closely linked to developments in science—specifically, how "information lost its body." She posits three historical phases of human and machine relations in cybernetics: homeostasis or autonomy of the human body, from 1945 to 1960; reflexivity or integration of machine and body, from 1960 to 1980; and virtuality or symbiosis, from 1980 to the present. The progression is toward increasingly disembodied states of human existence. But Hayles warns against dematerialized definitions of information and corporeality, which she condemns as ill-advised philosophical extensions of the Cartesian separation of mind and body.

Hayles's theory resonates with the critique of the unified, universal human subject—a legacy of the Enlightenment—that has been mounted in recent decades by poststructuralist, feminist, postcolonial, and other postmodern thinkers. It amplifies the conception of subjectivity as fragmented and heterogeneous, embedded at once in embodied existence, in materialized sets of cultural codes, in social institutions, and in technoscientific devices. In emphasizing posthuman *embodiment*, Hayles sees her project as a "rememory" of the sometimes overlooked engineering as well as broader cultural factors conducive to the condition of virtuality. The multiple interchanges between science and literature help illuminate these historical contingencies of virtuality. To counter abstract models of cybernetics, Hayles draws on narrative fiction such as Bernard Wolfe's *Limbo* (1952) and Philip K. Dick's major novels of the 1960s. These texts offer, in her view, "embodied forms of discourse" that broach a range of social, political, and psychological issues by connecting scientific concepts to particular real-life situations.

In our selection, "Virtual Bodies and Flickering Signifiers," the second chapter of *How We Became Posthuman*, Hayles argues that the development of information theory after World War II reflects a shift in how reality itself is perceived, as it is increasingly viewed through the categories of pattern and randomness rather than presence and absence. In cyberspace, where presence is largely an optical illusion, the physical body is recast in terms of electronically encoded information patterns. The phrase "virtual bodies" designates, for Hayles, a new posthuman ontology of simultaneous corporeal substance and cybernetic disembodiment. Reconfiguring JACQUES LACAN'S theory of "floating signifiers" to accommodate information technologies, Hayles suggests that virtual reality functions in a digital mode of signification through "flickering signifiers." Unlike the material keystrokes of a typewriter, for instance, flickering signifiers on a computer screen reconfigure the very sense of what it means to be embodied: embodiment now involves digital traces of highly flexible networks of magnetic codes and commands. Whereas Lacan's famous psycholinguistic coupling of language and the unconscious predicates the subject ultimately on the notion of castration in a Freudian model of presence/absence, Hayles's cybernetic pairing of language and machine founds the posthuman on mutation within a paradigm of pattern/randomness. The posthuman cyborg refers to a multifaceted and flexible identity that is constantly being deconstructed and recombined in different configurations along various informational circuits.

Like other theorists of the posthuman body, Hayles works in the context of postindustrial society. This is a world in which water is fluoridated; the air inside and outside buildings is tainted by innumerable chemicals (human-made and natural); and

food is subjected to genetic modifications as well as other enhancements such as chemical fertilizers and antibiotics. Beginning at an early age, individuals receive multiple immunizations. Prostheses—from dental fillings and contact lenses to stents and hip replacements to transplanted body parts—modify human flesh. Under such conditions the sharply etched classical binary distinctions—man/machine, nature/culture, purity/contamination, private/public—implode and intermix. Where some theorists of the posthuman body see utopia over the horizon, others glimpse dystopia. Hayles takes a middle road, expressing both exaltation and concern, wonder and anxiety. She brings us down to earth while celebrating virtual reality. She remains attentive to engineering, hardware, human flesh, DNA, and organs. Not surprisingly, she regards the postmodern embrace of simulation, dematerialization, and disembodiment as a totalizing fantasy.

Cyber technology factors into, while also being shaped by, contemporary literature, especially the texts Hayles calls "information narratives." For her, works of fiction by William Gibson, such as *Neuromancer*, *Count Zero* (1984), and *Mona Lisa Overdrive* (1988), in addition to Don DeLillo's *White Noise* (1985) and Mark Leyner's *My Cousin, My Gastroenterologist* (1990), exemplify cultural forms of resistance to virtual disembodiment. Information narratives revamp literary authorship and readership as well as traditional elements of fiction, including plot, character, setting, and point of view. By presenting complex analogical relations between technology and culture, they contextualize and localize the abstract theory of the posthuman, grounding it in concrete physical existence. In light of such narratives, Hayles regards the scientific development of cybernetics as a historically and culturally specific phenomenon that has created "embodied virtualities." Ultimately, she wants to see pattern and presence as "mutually enhancing" elements in a responsible and sober exploration of the boundaries of the human.

Hayles has been faulted for advancing the posthuman as a unified theory applying to all humanity. Feminist critics point out that her insistence on embodiment risks not only reverting to essentialized notions of a preexisting reality but also ignoring the asymmetrical treatments of female and male bodies, a topic incisively explored by SUSAN BORDO. Hayles also appears to be downplaying the social linguistic construction of identity, a crucial aspect of feminist criticism in recent decades. Moreover, though it is accurate as a social diagnosis, her posthumanist project does not explain how the neoliberal consumer—a subject suited to late capitalist times—is maintained. Finally, Hayles is open to criticism for overlooking the roles of ideology and hegemonic institutions, as well as technoscience—the ways that corporations and the state harness science and technology, sometimes for dubious ends and typically without input from citizens, in what Haraway labels the "informatics of domination." Nevertheless, Hayles's work effectively registers the increasing displacement of organic presence by information pattern in contemporary science, technology, and culture, including literature.

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In her first book, *The Cosmic Web: Scientific Field Models and Literary Strategies in the Twentieth Century* (1984), Hayles argues that early-twentieth-century "field theory" introduces a dynamic and integrated perspective on reality that constitutes a paradigm shift in science, philosophy, and literature. A sequel and complement to her first book, *Chaos Bound: Orderly Disorder in Contemporary Literature and Science* (1990) shows how contemporary scientific chaos theory offers a cultural matrix that can be shared by science and literature, treating chaos not as simply meaningless disorder but as a productive means of generating higher orders of information and complexity. *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (1999) examines the fate of human embodiment in a world increasingly dominated by information technology. Hayles here

investigates three related aspects of the information age: the story of how information lost its body, the development of the cultural icon of the cyborg, and the emergence of posthuman identities. In *Writing Machines* (2002), whose page layouts sometimes resemble computer screens and abstract information patterns, Hayles playfully and creatively illustrates her notion of "flickering signifiers." Focusing on the complex ways in which various forms of media interpenetrate, she insists on the materiality of different kinds of literary artifacts such as hyperfiction, the artist's book, and the traditional novel. *My Mother Was a Computer: Digital Subjects and Literary Texts* (2005) offers new ways of understanding the relationships between language and code. It investigates processes of intermediation through which traditional cultural practices interact with digital media. More recently, Hayles's *Electronic Literature: New Horizons for the Literary* (2008) provides a systematic survey of the field of electronic literature, isolating major genres and central theoretical issues pertaining to networked and programmable media. It is accompanied by a CD featuring volume 1 of the *Electronic Literature Collection*, co-edited by Hayles with Nick Montfort, Scott Rettberg, and Stephanie Strickland; the collection of sixty works is intended for courses on contemporary electronic literature. In addition to her own books, Hayles has edited the essay collection *Chaos and Order: Complex Dynamics in Literature and Science* (1991); guest edited *Technocriticism and Hypernarrative* (1997), a special issue of *Modern Fiction Studies* (43.3); and edited *Nanoculture: Implications of the New Technoscience* (2004). She has also published numerous articles in books and journals on literature, computer culture, cyborg theory, and the history of technology.

Notable assessments of Hayles's work have come from literary critics concentrating on science fiction and on feminist theory. Istvan Csicsery-Ronay Jr.'s "Till We Have Interfaces," *Science Fiction Studies*, no. 78 (1999), offers a pointed review of *How We Became Posthuman*. While praising Hayles as a sharp diagnostician of the social and cultural implications of information technologies, Csicsery-Ronay observes that her theory of the posthuman ends in anxiety and uncertainty, failing to indicate what comes after the demise of the liberal humanist subject. In "Theory of a Different Order: A Conversation with Katherine Hayles and Niklas Luhmann," in *Observing Complexity: Systems Theory and Postmodernity* (ed. William Rasch and Cary Wolfe, 2000), Cary Wolfe, William Rasch, and Eva Knodt specify potential shortcomings of Hayles's work. Though commending her theory for usefully avoiding the impasse of relativism, they note that it occasionally resorts to a representationalist understanding of "objective" reality that threatens to undercut the very project of cybernetics. In her review of *How We Became Posthuman* in *Signs* 27 (2002), Amelia Jones acknowledges the literary and cultural significance of Hayles's theory even as she points out its limitations from a feminist perspective. According to Jones, Hayles's insistence on material embodiment potentially undermines the constitutive role of discourse in building feminist identities.

From How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics

Chapter 2. Virtual Bodies and Flickering Signifiers

We might regard patterning or predictability as the very essence and raison d'être of communication . . . communication is the creation of redundancy or patterning.

Gregory Bateson,¹ *Steps to an Ecology of Mind*

The development of information theory in the wake of World War II left as its legacy a conundrum: even though information provides the basis for much of contemporary U.S. society, it has been constructed never to be present in itself. In information theoretic terms, as we saw in chapter 1,² information is conceptually distinct from the markers that embody it, for example newspaper or electromagnetic waves. It is a pattern rather than a presence, defined by the probability distribution of the coding elements composing the message. If information is pattern, then noninformation should be the absence of pattern, that is, randomness. This commonsense expectation ran into unexpected complications when certain developments within information theory implied that information could be equated with randomness as well as with pattern.³ Identifying information with *both* pattern and randomness proved to be a powerful paradox, leading to the realization that in some instances, an infusion of noise into a system can cause it to reorganize at a higher level of complexity.⁴ Within such a system, pattern and randomness are bound together in a complex dialectic that makes them not so much opposites as complements or supplements to one another. Each helps to define the other; each contributes to the flow of information through the system.

Were this dialectical relation only an aspect of the formal theory, its impact might well be limited to the problems of maximizing channel utility and minimizing noise that concern electrical engineers. Through the development of information technologies, however, the interplay between pattern and randomness became a feature of everyday life. As Friedrich Kittler has demonstrated in *Discourse Networks 1800/1900*, media come into existence when technologies of inscription intervene between the hand gripping the pen or the mouth framing the sounds and the production of the texts. In a literal sense, technologies of inscription are media when they are perceived as mediating, inserting themselves into the chain of textual production. Kittler identifies the innovative characteristics of the typewriter, originally designed for the blind, not with speed but rather with "spatially designated and discrete signs," along with a corresponding shift from the word as flowing *image* to the word "as a geometrical figure created by the spatial arrangements of the letter keys" (here Kittler quotes Richard

1. English-born American ethnologist and biologist (1904–1980), who was involved in the early development of cybernetics theory: *Steps to an Ecology of Mind* was published in 1972.

2. Titled "Toward Embodied Virtuality."

3. The paradox is discussed in N. Katherine Hayles, *Chaos Bound: Orderly Disorder in Contemporary Literature and Science* (Ithaca: Cornell University Press, 1990), pp. 31–60 [Hayles's note].

note].

4. Self-organizing systems are discussed in Grégoire Nicolis and Ilya Prigogine, *Exploring Complexity: An Introduction* (New York: Freeman and Company, 1989); Roger Lewin, *Complexity: Life at the Edge of Chaos* (New York: Macmillan, 1992); and M. Mitchell Waldrop, *Complexity: The Emerging Science at the Edge of Order and Chaos* (New York: Simon and Schuster, 1992) [Hayles's note].

Herbertz).⁵ The emphasis on spatially fixed and geometrically arranged letters is significant, for it points to the physicality of the processes involved. Typewriter keys are directly proportionate to the script they produce. One keystroke yields one letter, and striking the key harder produces a darker letter. The system lends itself to a signification model that links signifier to signified⁶ in direct correspondence, for there is a one-to-one relation between the key and the letter it produces. Moreover, the signifier itself is spatially discrete, durably inscribed, and flat.

How does this experience change with electronic media? The relation between striking a key and producing text with a computer is very different from the relation achieved with a typewriter. Display brightness is unrelated to keystroke pressure, and striking a single key can effect massive changes in the entire text. The computer restores and heightens the sense of word as image—an image drawn in a medium as fluid and changeable as water.⁷ Interacting with electronic images rather than with a materially resistant text, I absorb through my fingers as well as my mind a model of signification in which no simple one-to-one correspondence exists between signifier and signified. I know kinesthetically as well as conceptually that the text can be manipulated in ways that would be impossible if it existed as a material object rather than a visual display. As I work with the text-as-flickering-image, I instantiate within my body the habitual patterns of movement that make pattern and randomness more real, more relevant, and more powerful than presence and absence.

The technologies of virtual reality, with their potential for full-body mediation, further illustrate the kind of phenomena that foreground pattern and randomness and make presence and absence seem irrelevant. Already an industry worth hundreds of millions of dollars, virtual reality puts the user's sensory system into a direct feedback loop with a computer.⁸ In one version, the user wears a stereovision helmet and a body glove with sensors at joint positions. The user's movements are reproduced by a simulacrum, called an avatar, on the computer screen. When the user turns his or her head, the computer display changes in a corresponding fashion. At the same time, audio-phones create a three-dimensional sound field. Kinesthetic sensations, such as G-loads⁹ for flight simulators, can be supplied through more extensive and elaborate body coverings. The result is a multisensory interaction that creates the illusion that the user is *inside* the computer. From my experience with the virtual reality simulations at the Human Interface Technology Laboratory¹

and elsewhere, I can attest to the disorienting, exhilarating effect of the feeling that subjectivity is dispersed throughout the cybernetic circuit. In these systems, the user learns, kinesthetically and proprioceptively, that the relevant boundaries for interaction are defined less by the skin than by the feedback loops connecting body and simulation in a technobio-integrated circuit.

Questions about presence and absence do not yield much leverage in this situation, for the avatar both is and is not present, just as the user both is and is not inside the screen. Instead, the focus shifts to questions about pattern and randomness. What transformations govern the connections between user and avatar? What parameters control the construction of the screen world? What patterns can the user discover through interaction with the system? Where do these patterns fade into randomness? What stimuli cannot be encoded within the system and therefore exist only as extraneous noise? When and how does this noise coalesce into pattern? Working from a different theoretical framework, Allucquère Roseanne Stone has proposed that one need not enter virtual reality to encounter these questions, although VR brings them vividly into the foreground. Merely communicating by email or participating in a text-based MUD (multi-user dungeon) already problematizes thinking of the body as a self-evident physicality.² In the face of such technologies, Stone proposes that we think of subjectivity as a multiple warranted by the body rather than contained within it. Sherry Turkle, in her fascinating work on people who spend serious time in MUDs, convincingly shows that virtual technologies, in a rip tide of reverse influence, affect how real life is seen. "Reality is not my best window," one of her respondents remarks.³

In societies enmeshed within information networks, as the U.S. and other first world societies⁴ are, these examples can be multiplied a thousandfold. Money is increasingly experienced as informational patterns stored in computer banks rather than as the presence of cash; surrogacy and *in vitro* fertilization court cases offer examples of informational genetic patterns competing with physical presence for the right to determine the "legitimate" parent; automated factories are controlled by programs that constitute the physical realities of work assignments and production schedules as flows of information through the system;⁵ criminals are tied to crime scenes through DNA patterns rather than through eyewitness accounts verifying their presence; access to computer networks rather than physical possession of data determines nine-tenths of computer law;⁶ sexual relationships are pursued through the virtual spaces of computer networks rather than through meetings at

5. Friedrich A. Kittler, *Discourse Networks, 1800/1900*, translated by Michael Metteer (Stanford: Stanford University Press, 1990), p. 193 [Hayles's note]. Kittler (b. 1943), German literary critic and media theorist. Herbertz (1878–1959), professor of philosophy at the University of Bern.

6. The sign was divided into *signified* (the meaning conveyed) and *signifier* (the symbol or sound that conveys that meaning) by the Swiss linguist FERDINAND DE SAUSSURE (1857–1913), who argued that in language, the relation between the two is arbitrary.

7. The fluidity of writing on the computer is eloquently explored by Michael Joyce in *Of Two Minds: Hypertext Pedagogy and Poetics* (Ann Arbor: University of Michigan Press, 1995) [Hayles's note].

8. Howard Rheingold surveys the new virtual technologies in *Virtual Reality* (New York: Summit Books, 1991). Also useful is Ken Pimentel and Kevin Teixeira, *Virtual Reality: Through the New Looking Glass* (New York: McGraw-Hill, 1993). Benjamin Woolley takes a skeptical approach toward claims for the new technology in *Virtual Worlds: A Journey in Hyped Hyperreality* (Oxford: Blackwell, 1992) [Hayles's note]. Rheingold (b. 1947), American writer of fiction and nonfiction.

9. Forces of acceleration; one G is equivalent to the force exerted by Earth's gravity on a body at rest.

1. A multidisciplinary research and development lab focusing on human-machine interfaces, established in 1989 at the University of Washington.

2. Allucquère Roseanne Stone, *The War of Desire and Technology at the Close of the Mechanical Age* (Cambridge: MIT Press, 1995) [Hayles's note].

3. Sherry Turkle, *Life on the Screen: Identity in the Age of the Internet* (New York: Simon and Schuster, 1995) [Hayles's note]. Turkle (b. 1948), Abby Rockefeller Mauzé Professor of the Social Studies of Science and Technology at the Massachusetts

4. The highly industrialized (largely Western) nations in a global economy, which dominate the "underdeveloped" countries of the "third world," many of which are former colonies.

5. In *The Age of the Smart Machine: The Future of Work and Power* (New York: Basic Books, 1988), Shoshana Zuboff explores, through three case studies, the changes in U.S. workplaces as industries become informatized [Hayles's note].

6. Computer law is discussed in Katie Hafner and John Markoff, *Cyberpunk: Outlaws and Hackers on the Computer Frontier* (New York: Simon and Schuster, 1991); also informative is Bruce Sterling,

when the book is linked with magnetic encodings.) The printing metaphors pervasive in the discourse of genetics are constituted through and by this similarity of corporeal encoding in books and bodies.

The entanglement of signal and materiality in bodies and books confers on them a parallel doubleness. As we have seen, the human body is understood in molecular biology simultaneously as an expression of genetic information and as a physical structure. Similarly, the literary corpus is at once a physical object and a space of representation, a body and a message. Because they have bodies, books and humans have something to lose if they are regarded solely as informational patterns, namely the resistant materiality that has traditionally marked the durable inscription of books no less than it has marked our experiences of living as embodied creatures. From this affinity emerge complex feedback loops between contemporary literature, the technologies that produce it, and the embodied readers who produce and are produced by books and technologies. Changes in bodies as they are represented within literary texts have deep connections with changes in textual bodies as they are encoded within information media, and both types of changes stand in complex relation to changes in the construction of human bodies as they interface with information technologies. The term I use to designate this network of relations is *informatics*. Following Donna Haraway, I take *informatics* to mean the technologies of information as well as the biological, social, linguistic, and cultural changes that initiate, accompany, and complicate their development.¹

I am now in a position to state the thesis of this chapter explicitly. The contemporary pressure toward dematerialization, understood as an epistemic shift toward pattern/randomness and away from presence/absence, affects human and textual bodies on two levels at once, as a change in the body (the material substrate) and as a change in the message (the codes of representation). The connectivity between these changes is, as they say in the computer industry, massively parallel and highly interdigitated. My narrative will therefore weave back and forth between the represented worlds of contemporary fictions, models of signification implicit in word processing, embodied experience as it is constructed by interactions with information technologies, and the technologies themselves.

The compounding of signal with materiality suggests that new technologies will instantiate new models of signification. Information technologies do more than change modes of text production, storage, and dissemination. They fundamentally alter the relation of signified to signifier. Carrying the instabilities implicit in Lacanian² floating signifiers one step further, information technologies create what I will call *flickering signifiers*, characterized by their tendency toward unexpected metamorphoses, attenuations, and dispersions. Flickering signifiers signal an important shift in the plate tectonics of language. Much of contemporary fiction is directly influenced by information technologies; cyberpunk, for example, takes informatics as

1. Donna Haraway, "Manifesto for Cyborgs: Science, Technology, and Socialist Feminism in the 1980s," *Socialist Review* 80 (1985): 65–108; see also Donna Haraway, "The High Cost of Information in Post World War II Evolutionary Biology: Ergonomics, Semiotics, and the Sociobiology of Communications Systems," *Philosophical Forum* 13, nos. 2–3 (1981–82): 244–75 [Hayles's note]. On the American theorist HARAWAY (b. 1944), and for her "Manifesto for Cyborgs," see below.

2. Of the French psychoanalyst JACQUES LACAN (1901–1981); Hayles explains his "floating signifiers" in the following section.

which the participants are physically present.⁷ The effect of these transformative formations is to create a highly heterogeneous and fissured space in which discursive formations based on pattern and randomness jostle and compete with formations based on presence and absence. Given the long tradition of dominance that presence and absence have enjoyed in the Western tradition, the surprise is not that formations based on them continue to exist but that these formations are being displaced so rapidly across a wide range of cultural sites.

These examples, taken from studies of information technologies, illustrate concerns that are also appropriate for literary texts. If the effects that the shift toward pattern/randomness has on literature are not widely recognized, perhaps it is because they are at once pervasive and elusive. A book produced by typesetting may look very similar to one generated by a computerized program, but the technological processes involved in this transformation are not neutral. Different technologies of text production suggest different models of signification; changes in signification are linked with shifts in consumption; shifting patterns of consumption initiate new experiences of embodiment; and embodied experience interacts with codes of representation to generate new kinds of textual worlds.⁸ In fact, each category—production, signification, consumption, bodily experience, and representation—is in constant feedback and feedforward loops with the others.

As the emphasis shifts to pattern and randomness, characteristics of print texts that used to be transparent (because they were so pervasive) are becoming visible again through their differences from digital textuality. We lose the opportunity to understand the implications of these shifts if we mistake the dominance of pattern/randomness for the disappearance of the material world. In fact, it is precisely because material interfaces have changed that pattern and randomness can be perceived as dominant over presence and absence. The pattern/randomness dialectic does not erase the material world; information in fact derives its efficacy from the material infrastructures it appears to obscure. This illusion of erasure should be the *subject* of inquiry, not a presupposition that inquiry takes for granted.

To explore the importance of the medium's materiality, let us consider the book. Like the human body, the book is a form of information transmission and storage, and like the human body, the book incorporates its encodings in a durable material substrate. Once encoding in the material base has taken place, it cannot easily be changed. Print and proteins in this sense have more in common with each other than with magnetic encodings, which can be erased and rewritten simply by changing the polarities. (In chapter 8⁹ we shall have an opportunity to see how a book's self-representations change

¹ *The Hacker Crackdown: Law and Disorder on the Electronic Frontier* (New York: Bantam, 1992)

[Hayles's note]. Hayles plays on the old adage "Possession is nine-tenths of the law" (i.e., physical possession usually establishes ownership).

7. Sherry Turkle documents computer network romances in *Life on the Screen*. Nicholson Baker's *Vox: A Novel* (New York: Random House, 1992) imaginatively explores the erotic potential for better living through telecommunications; and Rheingold looks at the future of erotic encounters in cyberspace in "Teledildonics and Beyond," *Virtual Reality*, pp. 345–77 [Hayles's note].

8. Among the studies that explore these connections are Jay Bolter, *Writing Space: The Computer, Hypertext, and the History of Writing* (Hillsdale, N.J.: Lawrence Erlbaum Associates, 1991); Michael Heim, *Electric Language: A Philosophical Study of Word Processing* (New Haven: Yale University Press, 1987); and Mark Poster, *The Mode of Information: Poststructuralism and Social Context* (Chicago: University of Chicago Press, 1990) [Hayles's note].

9. Titled "The Materiality of Informatics."

its central theme. Even narratives without this focus can hardly avoid the rippling effects of informatics, however, for the changing modes of signification affect the *codes* as well as the subjects of representation.

SIGNIFYING THE PROCESSES OF PRODUCTION

"Language is not a code," Lacan asserted, because he wanted to deny one-to-one correspondence between the signifier and the signified.³ In word processing, however, language is a code. The relation between machine and compiler languages is specified by a coding arrangement, as is the relation of the compiler language to the programming commands that the user manipulates. Through these multiple transformations, some quantity is conserved, but it is not the mechanical energy implicit in a system of levers or the molecular energy of a thermodynamical system. Rather it is the informational structure that emerges from the interplay between pattern and randomness. When a text presents itself as a constantly refreshed image rather than as a durable inscription, transformations can occur that would be unthinkable if matter or energy, rather than informational patterns, formed the primary basis for the systemic exchange. This textual fluidity, which users learn in their bodies as they interact with the system, implies that signifiers flicker rather than float.

To explain what I mean by flickering signifiers, I will briefly review Lacan's notion of floating signifiers. Lacan, operating within a view of language that was primarily print-based rather than electronically mediated, not surprisingly focused on presence and absence as the dialectic of interest.⁴ When he formulated the concept of floating signifiers, he drew on Saussure's idea that signifiers are defined by networks of relational differences between themselves rather than by their relation to signifieds. He complicated this picture by maintaining that signifieds do not exist in themselves, except insofar as they are produced by signifiers. He imagined them as an ungraspable flow floating beneath a network of signifiers, a network that itself is constituted through continual slippages and displacements. Thus, for him, a doubly reinforced absence is at the core of signification—the absence of signifieds as things-in-themselves as well as the absence of stable correspondences between signifiers. The catastrophe in psycholinguistic development corresponding to this absence in signification is castration, the moment when the (male) subject symbolically confronts the realization that subjectivity, like language, is founded on absence.

How does this scenario change when floating signifiers give way to flickering signifiers? Foregrounding pattern and randomness, information technologies operate within a realm in which the signifier is opened to a rich internal play of difference. In informatics, the signifier can no longer be understood as a single marker, for example an ink mark on a page. Rather it exists as a flexible chain of markers bound together by the arbitrary relations

specified by the relevant codes. As I write these words on my computer, I see the lights on the video screen, but for the computer, the relevant signifiers are electronic polarities on disks. Intervening between what I see and what the computer reads are the machine code that correlates alphanumeric symbols with binary digits, the compiler language that correlates these symbols with higher-level instructions determining how the symbols are to be manipulated, the processing program that mediates between these instructions and the commands I give the computer, and so forth. A signifier on one level becomes a signified on the next-higher level. Precisely because the relation between signifier and signified at each of these levels is arbitrary, it can be changed with a single global command. If I am producing ink marks by manipulating movable type, changing the font requires changing each line of type. By contrast, if I am producing flickering signifiers on a video screen, changing the font is as easy as giving the system a single command. The longer the chain of codes, the more radical the transformations that can be effected. Acting as linguistic transducers, the coding chains impart astonishing power to even very small changes. Such amplification is possible because the constant reproduced through multiple coding layers is a pattern rather than a presence.

Where does randomness enter this picture? Within information theory, information is identified with choices that reduce uncertainty, for example when I choose which book, out of eight on a reading list, my seminar will read for the first week of class. To get this information to the students, I need some way to transmit it. Information theory treats the communication situation as a system in which a sender encodes a message and sends it as a signal through a channel. At the other end is a receiver, who decodes the signal and reconstitutes the message. Suppose I write my students an email. The computer encodes the message in binary digits and sends a signal corresponding to these digits to the server, which then reconstitutes the message in a form the students can read. At many points along this route, noise can intervene. The message may be garbled by the computer system, so that it arrives looking like "#e%\^&s**." Or I may have gotten distracted thinking about DeLillo halfway through the message, so that although I meant to assign Calvino for the first week, the message comes out, "If on a winter's night a white noise."⁵ These examples indicate that for real-life communication situations, pattern exists in dynamic tension with the random intrusions of noise.

Uncertainty enters in another sense as well. Although information is often defined as *reducing* uncertainty, it also *depends* on uncertainty. Suppose, for example, *Gravity's Rainbow*⁶ is the only text on the reading list. The probability that I would choose it is 1. If I send an email telling my students that the text for this week is *Gravity's Rainbow*, they will learn nothing they did not already know, and no information is communicated. The most surprising information I could send them would be a string of random letters. (Remember that information in the technical sense has nothing to do with meaning; the fact that such a message would be meaningless is thus paradoxically

5. A conflation of the titles of 2 novels: *If on a Winter's Night a Traveler* (1979), by the Italian writer Italo Calvino (1923–1985), and *White Noise* (1985), by the American writer Don DeLillo

(b. 1936).

6. A 1973 postmodern novel by the American writer Thomas Pynchon.

3. Jacques Lacan, "Radiophonies," *Scilicet* 213 (1970): 55, 68. For floating signifiers, see *Le Séminaire XX: Encore* (Paris: Seuil, 1975), pp. 77–90, and "Psychoanalysis and Cybernetics, or on the Nature of Language," pp. 294–308, in *The Seminar of Jacques Lacan: Book II*, edited by Jacques-Alain Miller (New York: W. W. Norton and Company, 1991) [Hayles's note].

4. Although presence and absence loom much larger in Lacanian psycholinguistics than do pattern and randomness, Lacan was not uninterested in information theory. In the 1954–55

pattern, for only against the background of nonpattern can pattern emerge. Randomness is the contrasting term that allows pattern to be understood as such. The crisis named by mutation is as wide-ranging and pervasive in its import within the pattern/randomness dialectic as castration is within the tradition of presence/absence, for it is the visible mark that testifies to the continuing interplay of the dialectic between pattern and randomness, replication and variation, expectation and surprise.

Shifting the emphasis from presence/absence to pattern/randomness suggests different choices for tutor texts. Rather than studying Freud's discussion of "fort/da"¹ (a short passage whose replication in hundreds of commentaries would no doubt astonish its creator), theorists interested in pattern and randomness might point to David Cronenberg's film *The Fly*.² At a certain point, the protagonist's penis does fall off (quantitatively, he puts it in his medicine chest as a memento of times past), but the loss scarcely registers in the larger mutation he is undergoing. The operative transition is not from male to female-as-castrated-male but from human to something radically other than human. Flickering signification brings together language with a psychodynamics based on the symbolic moment when the human confronts the posthuman.

As I indicated in chapter 1, I understand human and posthuman to be historically specific constructions that emerge from different configurations of embodiment, technology, and culture. My reference point for the human is the tradition of liberal humanism; the posthuman appears when computation rather than possessive individualism³ is taken as the ground of being, a move that allows the posthuman to be seamlessly articulated with intelligent machines. To see how technology interacts with these constructions, consider the picture that nineteenth-century U.S. and British anthropologists have drawn of "man" as a tool-user.⁴ Using tools may shape the body (some anthropologists made this argument), but the tool nevertheless is envisioned as an object that is apart from the body, an object that can be picked up and put down at will. When the claim that man's unique nature was defined by tool use could not be sustained (because other animals were shown also to use tools), the focus shifted during the early twentieth century to man the tool-maker. Typical is Kenneth P. Oakley's 1949 *Man the Tool-Maker*, a magisterial work with the authority of the British Museum behind it. Oakley, in charge of the Anthropological Section of the museum's Natural History Division, wrote in his introduction, "Employment of tools appears to be [man's] chief biological characteristic, for considered functionally they are detachable extensions of the forelimb."⁵ The kind of tool he envisioned was mechanical rather than informational; it goes *with* the hand, not *on* the head. Significantly, he imagined the tool to be at once "detachable" and an

individual is conceived of as owning him- or herself.

4. The gender encoding implicit in "man" (rather than human) is also reflected in the emphasis on tool usage as a defining characteristic rather than, say, altruism or nurturing, traits traditionally encoded female [Hayles's note].

5. Kenneth P. Oakley, *Man the Tool-Maker* (London: Trustees of the British Museum, 1949), p. 1 [Hayles's note]. Oakley (1911–1981), English physical anthropologist and geologist.

1. Gode/there (German); in *Beyond the Pleasure Principle* (1920), SIGMUND FREUD (1856–1939),

the Austrian founder of psychoanalysis, describes his grandson's game of throwing a wooden reel away from himself and pulling it back with a string (thereby establishing control over presence and absence).

2. A 1986 film, directed by the Canadian filmmaker Cronenberg (b. 1943); its protagonist, a scientist, is gradually transformed into a fly.

3. Individualism is "possessive" insofar as the

irrelevant to calculating the amount of information it contains.) These intuitions are confirmed by the mathematical theory of information.⁷ For an individual message, the information increases as the probability that the event will occur diminishes; the more unlikely the event, the more information it conveys. Appropriately, this quantity is usually called the "surprisal." Let's say that nine of my reading assignments were on *Gravity's Rainbow*, and one was on *Vineland*.⁸ The students would gain more information from a message telling them that the assignment was *Vineland* than from a message stating that the assignment was *Gravity's Rainbow*—the more probable event and hence the more expected. Most of the time, however, electrical engineers are not interested in individual messages but in all the messages that can be produced from a given source. Thus they do not so much want to know the surprisal as the *average* amount of information coming from a source. This average reaches a maximum when it is equally likely that any symbol can appear in any position—which is to say, when there is no pattern or when the message is at the extreme of randomness. Thus Warren Weaver, in his interpretation of Shannon's theory of information, suggested that information should be understood as depending on both predictability and unpredictability, pattern and randomness.⁹

What happens in the case of mutation? Consider the example of the genetic code. Mutation normally occurs when some random event (for example, a burst of radiation or a coding error) disrupts an existing pattern and something else is put in its place instead. Although mutation disrupts pattern, it also presupposes a morphological standard against which it can be measured and understood as a mutation. If there were only randomness, as with the random movements of gas molecules, it would make no sense to speak of mutation. We have seen that in electronic textuality, the possibilities for mutation within the text are enhanced and heightened by long coding chains. We can now understand mutation in more fundamental terms. Mutation is crucial because it names the bifurcation point at which the interplay between pattern and randomness causes the system to evolve in a new direction. It reveals the productive potential of randomness that is also recognized within information theory when uncertainty is seen as both antagonistic and intrinsic to information.

We are now in a position to understand mutation as a decisive event in the psycholinguistics of information. Mutation is the catastrophe in the pattern/randomness dialectic analogous to castration in the presence/absence dialectic. It marks a rupture of pattern so extreme that the expectation of continuous replication can no longer be sustained. But as with castration, this only appears to be a disruption located at a specific moment. The randomness to which mutation testifies is implicit in the very idea of

the probability that s_i will occur [Hayles's note].

8. A 1990 novel by Pynchon.

9. Claude E. Shannon and Warren Weaver, *The Mathematical Theory of Communication* (Urbana: University of Illinois Press, 1949). For a further discussion of this aspect of information theory, see Hayles, *Chaos Bound*, pp. 31–60 [Hayles's note]. Weaver (1894–1978), American scientist and mathematician. Shannon (1916–2001), American engineer and mathematician known as the father of information theory.

7. For an individual event s_i , the information $I(s_i) = -\log p(s_i)$, where p is the probability, expressed as a decimal between 1 and 0, that s_i will occur. To give a sense of how this function varies, consider that $-\log$ base 2 of .9 (an event that occurs nine times out of ten) is .15, whereas $-\log$ base 2 of .1 (an event that occurs only one in ten times) is 3.33. Hence, as the probability p decreases (becomes less likely), $-\log p$ increases. In the case of elements whose probabilities do not conditionally depend on one another, the average information of a source s is $I(s) = \sum -p(s_i) \log p(s_i)$, where p is again

"extension," separate from yet partaking of the hand. If the placement and the kind of tool mark Oakley's affinity with the epoch of the human, the construction of the tool as a prosthesis points forward to the posthuman.

By the 1960s, Marshall McLuhan was speculating about the transformation that media, understood as technological prostheses, were effecting on human beings.⁶ He argued that humans react to stress in their environments by withdrawing the locus of selfhood inward, in a numbing withdrawal from the world he called (following Hans Selye and Adolphe Jonas⁷) "autoamputation." This withdrawal in turn facilitates and requires compensating technological extensions that project the body-as-prosthesis back out into the world. Whereas Oakley remains grounded in the human and looks only distantly toward the posthuman, McLuhan clearly sees that electronic media are capable of bringing about a reconfiguration so extensive as to change the nature of "man."

As we saw in chapter 1, similar shifts in orientation informed the Macy Conference⁸ discussions taking place during the same period (1946–53). Participants wavered between a vision of man as a homeostatic self-regulating mechanism whose boundaries were clearly delineated from the environment⁹ and a more threatening, reflexive vision of a man spliced into an informational circuit that could change him in unpredictable ways. By the 1960s, the consensus within cybernetics had shifted dramatically toward reflexivity. By the 1980s, the inertial pull of homeostasis as a constitutive concept had largely given way to self-organization theories implying that radical changes were possible within certain kinds of complex systems.¹ In the contemporary period, the posthuman future of humanity is increasingly evoked, ranging from Hans Moravec's argument for a "postbiological" future in which intelligent machines become the dominant life form on the planet, to the more sedate and in part already realized prospect of a symbiotic union between human and intelligent machine, a union that Howard Rheingold calls "intelligence augmentation."² Although these visions differ in the degree and kind of interfaces they imagine, they concur that the posthuman implies not only a coupling with intelligent machines but a coupling so intense and multifaceted that it is no longer possible to distinguish meaningfully between the biological organism and the informational circuits in which the organism is enmeshed. Accompanying this change is a corresponding shift in how signification is understood and corporeally experienced. In contrast to Lacanian

6. Marshall McLuhan, *Understanding Media: The Extension of Man* (New York: McGraw Hill, 1964), pp. 41–47 [Hayles's note]. McLuhan (1911–1980), Canadian communications theorist and philosopher.

7. Yugoslavian-born British psychiatrist (b. 1913). Selye (1907–1982), Austrian-born Canadian endocrinologist.

8. A series of 10 conferences (1946–53) that led to the foundation of cybernetics.

9. The term *homeostasis*, or self-regulating stability through cybernetic corrective feedback, was introduced by physiologist Walter B. Cannon in "Organization for Physiological Homeostasis," *Physiological Reviews* 9 (1929): 399–431. Cannon's work influenced Norbert Wiener, and homeostasis became an important concept in the initial phase of cybernetics from 1946 to 1953; see chapters 3 and 4 [in *How We Became Posthuman*].

for details [Hayles's note]. Wiener (1894–1964), American theoretical and applied mathematician, pioneer of cybernetics.

1. Key figures in moving from homeostasis to self-organization were Heinz von Foerster, especially in *Observing Systems* (Salinas, Calif.: Intersystems Publications, 1981), and Humberto R. Maturana and Francisco J. Varela, *Autopoiesis and Cognition: The Realization of the Living* (Dordrecht: Reidel, 1980), discussed in detail in chapter 6 [of *How We Became Posthuman*] [Hayles's note].

2. Howard Rheingold, *Virtual Reality*, pp. 13–49; Hans Moravec, *Mind Children: The Future of Robot and Human Intelligence* (Cambridge: Harvard University Press, 1988), pp. 1–5, 116–22 [Hayles's note]. Moravec (b. 1948), Austrian-born researcher at the Robotics Institute of Carnegie Mellon University, known for his work on artificial intelligence.

psycholinguistics, derived from the generative coupling of linguistics and sexuality, flickering signification is the progeny of the fascinating and troubling coupling of language and machine.

INFORMATION NARRATIVES AND BODIES OF INFORMATION

The shift from presence and absence to pattern and randomness is encoded into every aspect of contemporary literature, from the physical object that constitutes the text to such staples of literary interpretation as character, plot, author, and reader. The development is by no means even; some texts testify dramatically and explicitly to the shift, whereas others manifest this shift only indirectly. I will call those texts in which the displacement is most apparent *information narratives*. Information narratives show, in exaggerated form, changes that are more subtly present in other texts as well. Whether in information narratives or contemporary fiction generally, the dynamic of displacement is crucial. One could focus on pattern in any era, but the peculiarity of pattern in these texts is its interpenetration with randomness and its implicit challenge to physicality. *Pattern tends to overwhelm presence*, leading to a construction of immateriality that depends not on spirituality or even consciousness but only on information.

Consider William Gibson's³ *Neuromancer* (1984), the novel that—along with the companion volumes *Count Zero* (1986) and *Mona Lisa Overdrive* (1988)—sparked the cyberpunk movement. The *Neuromancer* trilogy gave a local habitation and a name to the disparate spaces of computer simulations, networks, and hypertext windows that, before Gibson's intervention, had been discussed as separate phenomena. Gibson's novels acted like seed crystals thrown into a supersaturated solution; the time was ripe for the technology known as cyberspace to precipitate into public consciousness. In *Neuromancer* the narrator defines cyberspace as a "consensual illusion" accessed when a user "jacks into" a computer. Here the writer's imagination outstrips existing technologies, for Gibson imagines a direct neural link between the brain and the computer through electrodes. Another version of this link is a socket, implanted behind the ear, that accepts computer chips, allowing direct neural access to computer memory. Network users collaborate in creating the richly textured landscape of cyberspace, a "graphic representation of data abstracted from the banks of every computer in the human system. Unthinkable complexity. Lines of light ranged in the non-space of the mind, clusters and constellations of data. Like city lights, receding."⁴ Existing in the nonmaterial space of computer simulation, cyberspace defines a regime of representation within which pattern is the essential reality, presence an optical illusion.

Like the landscapes they negotiate, the subjectivities who operate within cyberspace also become patterns rather than physical entities. Case, the computer cowboy who is the protagonist of *Neuromancer*, still has a physical presence, although he regards his body as so much "meat" that exists primarily to sustain his consciousness until the next time he can enter cyberspace. Others have completed the transition that Case's values imply. Dixie Flatline, a cowboy who encountered something in cyberspace that flattened

3. American-born Canadian novelist (b. 1948).

4. William Gibson, *Neuromancer* (New York: Ace Books, 1984), p. 51 [Hayles's note].

his EEG, ceased to exist as a physical body and lives now as a personality construct within the computer, defined by the magnetic patterns that store his identity.

The contrast between the body's limitations and cyberspace's power highlights the advantages of pattern over presence. As long as the pattern endures, one has attained a kind of immortality—an implication that Hans Moravec makes explicit in *Mind Children*. Such views are authorized by cultural conditions that make physicality seem a better state to be from than to inhabit. In a world despoiled by overdevelopment, overpopulation, and time-release environmental poisons, it is comforting to think that physical forms can recover their pristine purity by being reconstituted as informational patterns in a multidimensional computer space. A cyberspace body, like a cyberspace landscape, is immune to blight and corruption. It is no accident that the vaguely apocalyptic landscapes of films such as *Terminator*, *Blade Runner*, and *Hardware*⁵ occur in narratives focusing on cybernetic life-forms. The sense that the world is rapidly becoming uninhabitable by human beings is part of the impetus for the displacement of presence by pattern.

These connections lie close to the surface in *Neuromancer*. "Get just wasted enough, find yourself in some desperate but strangely arbitrary kind of trouble, and it was possible to see Ninsei as a field of data, the way the matrix had once reminded him of proteins linking to distinguish cell specialities. Then you could throw yourself into a highspeed drift and skid, totally engaged but set apart from it all, and all around you the dance of biz, information interacting, data made flesh in the mazes of the black market."⁶ The metaphorical slippages between urban sprawl, computer matrix, and biological protein culminate in the final elliptical phrase, "data made flesh."⁷ Information is the putative origin, physicality the derivative manifestation. Body parts sold in black-market clinics, body neurochemistry manipulated by synthetic drugs, body of the world overlaid by urban sprawl—all testify to the precariousness of physical existence. If flesh is data incarnate, why not go back to the source and leave the perils of physicality behind?

The reasoning presupposes that subjectivity and computer programs have a common arena in which to interact. Historically, that arena was first defined in cybernetics by the creation of a conceptual framework that constituted humans, animals, and machines as information-processing devices receiving and transmitting signals to effect goal-directed behavior.⁸ Gibson matches this technical achievement with two literary innovations that allow subjectivity, with its connotations of consciousness and self-awareness, to be articulated together with abstract data. The first is a subtle modification in point of view, abbreviated in the text as "pov." More than an acronym, pov is a substantive noun that constitutes the character's subjectivity by serving as a positional marker substituting for his absent body.

In its usual Jamesian sense, point of view presumes the fiction of a person who observes the action from a particular angle and tells what he sees.

5. Three science fiction films that present dark visions of the future: *Terminator* (1984), directed by James Cameron; *Blade Runner* (1982), directed by Ridley Scott; and *Hardware* (1990), directed by Richard Stanley.

6. Gibson, *Neuromancer*, p. 16 [Hayles's note].

7. An echo of John 1.14—"And the Word was made

flesh, and dwelt among us"—where "the Word" is Jesus and God.

8. The seminal text is Norbert Wiener, *Cybernetics; or, Control and Communication in the Animal and the Machine* (Cambridge: MIT Press, 1948) [Hayles's note].

In the preface to *The Portrait of a Lady*, James⁹ imagines a "house of fiction" with a "million windows" formed by "the need of the individual vision and by the pressure of the individual will." At each window "stands a figure with a pair of eyes, or at least with a field glass, which forms, again and again, for observation, a unique instrument, insuring to the person making use of it an impression distinct from every other."¹ For James, the observer is an embodied creature, and the specificity of his or her location determines what the observer can see when looking out on a scene that itself is physically specific. When an omniscient viewpoint is used, the limitations of embodiment linger in the poreality begin to fall away, but the suggestion of embodiment lingers in the idea of focus, the "scene" created by the eye's movement.

Even for James, vision is not unmediated technologically. Significantly, he hovers between eye and field glass as the receptor constituting vision. Cyberspace represents a quantum leap forward into the technological construction of vision. Instead of an embodied consciousness looking through the window at a scene, consciousness moves *through* the screen to become the pov, leaving behind the body as an unoccupied shell. In cyberspace, point of view does not emanate from the character; rather, the pov literally is the character. If a pov is annihilated, the character disappears with it, ceasing to exist as a consciousness in and out of cyberspace. The realistic fiction of a narrator who observes but does not create is thus unmasked in cyberspace. The effect is not primarily metafictional, however, but is in a literal sense metaphysical, above and beyond physicality. The crucial difference between the Jamesian point of view and the cyberspace pov is that the former implies physical presence, whereas the latter does not.

Gibson's technique recalls Alain Robbe-Grillet's² novels, which were among the first information narratives to exploit the formal consequences of combining subjectivity with data. In Robbe-Grillet's work, however, the effect of interfacing narrative voice with objective description was paradoxically to heighten the narrator's subjectivity, for certain objects, like the jalousied windows or the centipede in *Jalousy*, are inventoried with obsessive interest, indicating a mindset that is anything but objective. In Gibson, the space in which subjectivity moves lacks this personalized stamp. Cybermillions of the domain of virtual collectivity, constituted as the resultant of millions of vectors representing the diverse and often conflicting interests of human and artificial intelligences linked together through computer networks.³

To make this space work as a level playing field on which humans and computers can meet on equal terms, Gibson introduces his second innovation. Cyberspace is created by transforming a data matrix into a landscape in

9. HENRY JAMES (1843–1916), American writer of fiction and criticism; his novel *The Portrait of a Lady* was published in 1881.

1. Henry James, *The Art of the Novel* (New York: Charles Scribner's Sons, 1937), pp. 47, 46 [Hayles's note].

2. French writer and filmmaker (1922–2008); his novel *Jalousy* was published in 1957.

3. Peter Kollok, my colleague at UCLA and a sociologist, has studied virtual communication at several sites on the Internet. See Marc Smith and Peter Kollok, eds., *Communities in Cyberspace*

(London: Routledge, 1998); see also Stone's discussion of MUDs in *The War of Desire and Technology*, Turkle's discussion in *Life on the Screen*, and Amy Bruckman's article "Gender Swapping on the Internet," available at anonymous ftp://media.mit.edu/pub/asb/paper/gender-swapping [see www.cc.gatech.edu/elc/papers/bruckman/gender-swap-ping-bruckman.pdf]. Espen J. Aarseth has a discussion of the literary and formal characteristics of MUDs in *Cybertext: Perspectives on Ergodic Literature* (Baltimore: Johns Hopkins University Press, 1997) [Hayles's note].

which narratives can happen. In mathematics, "matrix" is a technical term denoting data that have been arranged into an n-dimensional array. Expressed in this form, data seem as far removed from the fascinations of story as random-number tables are from the *National Inquirer*.⁴ Because the array is already conceptualized in spatial terms, however, it is a small step to imagining the matrix as a three-dimensional landscape. Narrative becomes possible when this spatiality is given a temporal dimension by the pov's movement through it. The pov is *located* in space, but it *exists* in time. Through the track it weaves, the desires, repressions, and obsessions of subjectivity can be expressed. The genius of *Neuromancer* lies in its explicit recognition that the categories Kant⁵ considered fundamental to human experience—space and time—can be used as a conjunction to join awareness with data. Reduced to a point, the pov is abstracted into a purely temporal entity with no spatial extension; metaphorized into an interactive space, the datascape is narrativized by the pov's movement through it. Data are thus humanized, and subjectivity is computerized, allowing them to join in a symbiotic union whose result is narrative.

Such innovations carry the implications of informatics beyond the textual surface into the signifying processes that constitute theme and character. I suspect that Gibson's novels have been so influential not only because they present a vision of the posthuman future that is already upon us—in this they are no more prescient than many other science fiction novels—but also because they embody within their techniques the assumptions expressed explicitly in the themes of the novels. This kind of move is possible when the cultural conditions authorizing the assumptions are pervasive enough that the posthuman is experienced as an everyday, lived reality as well as an intellectual proposition.

The shift of emphasis from ownership to access is another manifestation of the underlying transition from presence/absence to pattern/randomness. In *The Condition of Postmodernity*, David Harvey characterizes the economic aspects of the shift to an informated society as a transition from a Fordist regime to a regime of flexible accumulation.⁶ As Harvey and many others have pointed out, in late capitalism, durable goods yield pride of place to information.⁷ A significant difference between information and durable goods is replicability. Information is not a conserved quantity. If I give you information, you have it and I do too. With information, the constraining factor separating the haves from the have-nots is not so much possession as access. Presence precedes and makes possible the idea of possession, for one can possess something only if it already exists. By contrast, access implies pattern recognition, whether the access is to a piece of land (recognized as such through the boundary pattern defining that land as different from adjoining parcels), confidential information (constituted as confidential through the

comparison of its informational patterns with less-secure documents), or a bank vault (associated with knowing the correct pattern of tumbler combinations). In general, access differs from possession because the former tracks patterns rather than presences. When someone breaks into a computer system, it is not a physical presence that is detected but the informational traces that the entry has created.⁸

When the emphasis falls on access rather than ownership, the private/public distinction that was so important in the formation of the novel is radically reconfigured. Whereas possession implies the existence of private life based on physical exclusion or inclusion, access implies the existence of credentialing practices that use patterns rather than presences to distinguish between those who do and those who do not have the right to enter. Moreover, entering is itself constituted as access to data rather than as a change in physical location. In Don DeLillo's *White Noise* (1985), for example, the Gladneys' home, traditionally the private space of family life, is penetrated by noise and radiation of all wavelengths—microwave, radio, television.⁹ The penetration signals that private spaces, and the private thoughts they engender and figure, are less a concern than the interplay between codes and the articulation of individual subjectivity with data. Jack Gladney's death is prefigured for him as a pattern of pulsing stars around a computerized data display, a striking image of how his corporeality has been penetrated by informational patterns that construct as well as predict his mortality.

Although the Gladney family still operates as a social unit (albeit with the geographical dispersion endemic to postmodern life), their conversations are punctuated by random bits of information emanating from the radio and TV. The punctuation points toward a mutation in subjectivity that comes from joining the focused attention of traditional novelistic consciousness with the digitized randomness of miscellaneous bits. The mutation reaches incarnation in Willie Mink, whose brain has become so addled by a designer drug that his consciousness is finally indistinguishable from the white noise that surrounds him. Through a route different from that used by Gibson, DeLillo arrives at a similar destination: a vision of subjectivity constituted through the interplay of pattern and randomness rather than presence and absence.

The bodies of texts are also implicated in these changes. The displacement of presence by pattern thins the tissue of textuality, making it a semi-permeable membrane that allows awareness of the text as an informational pattern to infuse into the space of representation. When the fiction of presence gives way to the recognition of pattern, passages are opened between the text-as-object and those representations within the text that are characteristic of the condition of virtuality. Consider the play between text as physical object and as information flow in Italo Calvino's *If on a winter's night a traveler* (1979). The text's awareness of its own physicality is painfully apparent in the anxiety it manifests toward keeping the literary corpus intact. Within the space of representation, texts are subjected to birth defects, maimed and torn apart, lost and stolen. The text operates as if it

4. A human supermarket tabloid (founded 1926).
5. IMMANUEL KANT (1724–1804), German philosopher; he argues in *The Critique of Pure Reason* (1781) that space and time are pure forms of intuition that precede and structure all experience.

6. David Harvey, *The Condition of Postmodernity: An Enquiry into the Origins of Cultural Change* (New York: Blackwell, 1989) [Hayles's note]. Harvey (b. 1935), English geographer and Marxist theorist. "Fordist regime": economic system char-

8. For an account of how tracks are detected, see Hafner and Markoff, *Cyberpunk*, pp. 35–40, 68–71 [Hayles's note].

9. Don DeLillo, *White Noise* (1985; New York: Penguin, 1986) [Hayles's note].

knows it has a physical body and fears that its body is in jeopardy from a host of threats, from defective printing technologies and editors experiencing middle-age brain fade to nefarious political plots. Most of all, perhaps, the text fears losing its body to information.

When "you," the reader, are foiled in your pursuit of its story by the frailty of the text's physical corpus, the narrator imagines you hurling the book through a closed window, reducing the text's body to "photons, undulatory vibrations, polarized spectra." Not content with this pulverization, you throw it through the wall so that the text breaks up into "electrons, neutrons, neutrinos, elementary particles more and more minute." Still disgusted, in an act of ultimate dispersion, you send it through a computer line, causing the textual body to be "reduced to electronic impulses, into the flow of information." With the text "shaken by redundancies and noises," you "let it be degraded into a swirling entropy." Yet the very story you seek can be envisioned as a pattern, for that night you sleep and "fight with dreams as with formless and meaningless life, seeking a pattern, a route that must surely be there, as when you begin to read a book and you don't yet know in which direction it will carry you."¹

Once the text's physical body is interfaced with information technologies, however, the pattern that is story stands in jeopardy of being disrupted by the randomness implicit in information. The disruptive power of randomness becomes manifest when you find yourself entangled with Lotaria, a reader who believes books are best read by scanning them into computers and letting the machine analyze word-frequency patterns. Seduced by Lotaria against your better judgment, you get tangled up with her and with rolls of printout covering the floor. The printouts contain part of the story that you desperately want to finish, which Lotaria has entered into the computer. Distracted by her multiple entanglements, Lotaria presses the wrong key, and the rest of the story is "erased in an instant demagnetization of the circuits. The multicolored wires now grind out the dust of dissolved words: the the, of of of, from from from from, that that that that, in columns according to their respective frequency. The book has been crumbled, dissolved, can no longer be recomposed, like a sand dune blown away by the wind."² Now you can never achieve satiation, never reach the point of satisfied completion that comes with finishing a book. Your anxiety about *reading interruptus* is intensified by what might be called *print interruptus*, a print book's fear that once it has been digitized, the computer will garble its body, breaking it apart and reassembling it into the nonstory of a data matrix rather than an entangled and entangling narrative.

This anxiety is transmitted to readers within the text, who keep pursuing parts of textual bodies only to lose them, as well as to readers outside the text, who must try to make sense of the radically discontinuous narrative. Only when the chapter titles are perceived to form a sentence is the literary corpus reconstituted as a unity. Significantly, the recuperation is syntactical rather than physical. It does not arise from or imply an intact physical body. Rather, it emerges from the patterns—metaphorical, grammatical, narrative, thematic, and textual—that the parts together make. As the climactic

scene in the library suggests, the reconstituted corpus is a body of information, emerging from the discourse community among whom information circulates. The textual body may be dismembered or ground into digital word dust, the narrative implies, but as long as there are readers who care passionately about stories and want to pursue them, narrative itself can be recuperated. Through such textual strategies, *If on a winter's night* testifies vividly to the impact of information technologies on bodies of books.

Human bodies are similarly affected. The correspondence between human and textual bodies can be seen as early as William Burroughs's *Naked Lunch*, written in 1959, in the decade that saw the institutionalization of cybernetics and the construction of the first large-scale electronic digital computer.³ The narrative metamorphizes nearly as often as bodies within it, suggesting by its cut-up method a textual corpus that is as artificial, heterogeneous, and cybernetic as they are.⁴ Since the fissures that mark the text always fall *within* the units that compose the textual body—within chapters, paragraphs, sentences, and even words—it becomes increasingly clear that they do not function to delineate the textual corpus. Rather, the body of the text is produced precisely by these fissures, which are not so much ruptures as productive dialectics that bring the narrative as a syntactic and chronological sequence into being.

Bodies within the text follow the same logic. Under the pressure of sex and addiction, bodies explode or mutate, protoplasm is sucked out of cocks or nostrils, plots are hatched to take over the planet or nearest life-form. Burroughs anticipates Fredric Jameson's⁵ claim that an information society is the purest form of capitalism. When bodies are constituted as information, they can be not only sold but fundamentally reconstituted in response to market pressures. Junk instantiates the dynamics of informatics and makes clear the relation of junk-as-information to late capitalism. Junk is the "ideal product" because the "junk merchant does not sell his product to the consumer, he sells the consumer to his product. He does not improve and simplify his merchandise. He degrades and simplifies the client."⁶ The junkie's body is a harbinger of the postmodern mutant, for it demonstrates how presence yields to assembly and disassembly patterns created by the flow of junk-as-information through points of amplification and resistance.

The characteristics of information narratives include, then, an emphasis on mutation and transformation as a central thematic for bodies within the text as well as for the bodies of texts. Subjectivity, already joined with information technologies through cybernetic circuits, is further integrated into the circuit by novelistic techniques that combine it with data. Access vies with possession as a structuring element, and data are narrativized to accommodate their integration with subjectivity. In general, materiality

3. William S. Burroughs, *Naked Lunch* (New York: Grove, 1959). [Hayles's note]. Burroughs (1914–1997), American experimental novelist, essayist, and major counterculture figure.

4. David Porush discusses the genre of "cybernetic fiction," which he defines as fictions that resist the dehumanization that is sometimes attendant on cybernetics, in *The Soft Machine: Cybernetic Fiction* (New York: Methuen, 1985); Burroughs's titular story is discussed on pp. 85–

111. Robin Lydenberg has a fine exposition of Burroughs's style in *Word Cultures: Radical Theory and Practice in William S. Burroughs' Fiction* (Urbana: University of Illinois Press, 1987) [Hayles's note].

5. American literary critic and Marxist cultural theorist (b. 1934; see above).

6. Burroughs, *Naked Lunch*, p. xxxix [Hayles's note].

1. Italo Calvino, *If on a winter's night a traveler*, translated by William Weaver (New York: Harcourt Brace Jovanovich, 1981), pp. 26–27, orig-

nally published in 1979 in Italian [Hayles's note].

2. *Ibid.*, p. 220 [Hayles's note].

and immateriality are joined in a complex tension that is a source of exultation and strong anxiety.

Information technologies leave their mark on books in the realization that sooner or later, the body of print will be interfaced with other media. All but a handful of books printed in the United States and Europe in 1998 will be digitized during some phase of their existence. Print texts such as *If on a winter's night a traveler* bear the imprint of this digitalization in their narratives, as if the text remembers the moment when it was nothing but electronic polarities on a disk. At moments of crisis, the repressed memory erupts onto the textual surface in the form of an acute fear that randomness will so interpenetrate its patterns that story will be lost and the textual corpus will be reduced to a body of meaningless data. These eruptions are vivid testimony that even print texts cannot escape being affected by information technologies.

To understand more about the effects of informatics on contemporary fictions, let us turn now to consider the relation between text and subjectivity, specifically how information narratives constitute both the voice speaking the narrative and the reader.

FUNCTIONALITIES OF NARRATIVE

The very word *narrator* implies a voice speaking, and a speaking voice implies a sense of presence. Jacques Derrida, announcing the advent of grammatology, focused on the gap that separates speaking from writing. Such a change transforms the narrator from speaker to scribe or, more precisely, someone who is absent from the scene but toward whom the inscriptions point.⁷ Informatics pushes this transformation further. As writing yields to flickering signifiers underwritten by binary digits, the narrator becomes not so much a scribe as a cyborg authorized to access the relevant codes. The progression suggests that the dialectic between absence and presence came clearly into focus with the advent of deconstruction because it was already being displaced as a cultural presupposition by randomness and pattern. Presence and absence were forced into visibility, so to speak, because they were already losing their constitutive power to form the ground for discourse, becoming instead the subject of discourse. In this sense, deconstruction is the child of an information age, formulating its theories from strata pushed upward by the emerging substrata beneath.

To see how the function of the narrator changes as we progress deeper into virtuality, consider the seduction scene from "I Was an Infinitely Hot and Dense White Dot," one of the stories in Mark Leyner's *My Cousin, My Gastroenterologist*. The narrator, "high on Sinutab" and driving "isotropically," so that any destination is equally probable, finds himself at a "squalid little dive."

I don't know . . . but there she is. I can't tell if she's a human or a fifth-generation gynemorphic android and I don't care. I crack open an ampoule of mating pheromone and let it waft across the bar, as I sip my drink, a methyl isocyanate on the rocks—methyl isocyanate is the substance

which killed more than 2,000 people when it leaked in Bhopal, India, but thanks to my weight training, aerobic workouts, and a low-fat fiber-rich diet, the stuff has no effect on me. Sure enough she strolls over and occupies the stool next to mine. . . . My lips are now one angstrom unit from her lips. . . . I begin to kiss her but she turns her head away. . . . I can't kiss you, we're monozygotic replicants—we share 100% of our genetic material. My head spins. You are the beautiful day, I exclaim, your breath is a zephyr of eucalyptus that does a pas de bourre across the Sea of Galilee. Thanks, she says, but we can't go back to my house and make love because monozygotic incest is forbidden by the elders. What if I said I could change all that. . . . What if I said that I had a miniature shotgun that blasts gene fragments into the cells of living organisms, altering their genetic matrices so that a monozygotic replicant would no longer be a monozygotic replicant and she could then make love to a musclemans without transgressing the incest taboo, I say, opening my shirt and exposing the device which I had stuck in the waistband of my black jeans. How'd you get that thing? she gasps, ogling its thick fiber-reinforced plastic barrel and the Uzi-Biotech logo embossed on the magazine which held two cartridges of gelated recombinant DNA. I got it for Christmas. . . . Do you have any last words before I scramble your chromosomes, I say, taking aim. Yes, she says, you first.⁸

Much of the wit in this passage comes from the juxtaposition of folk wisdom and seduction clichés with high-tech language and ideas. The narrator slips a chemical that killed thousands when it leaked into the environment, but he is immune to damage because he eats a low-fat diet. The narrator leans close to the woman-android to kiss her, but he has not yet made contact when he is an angstrom away, considerably less than the diameter of a hydrogen atom. The characters cannot make love because they are barred by incest taboos, being replicants from the same monozygote, which would make them identical twins, but this does not seem to prevent them from being opposite sexes. They are governed by kinship rules enforced by tribal elders, but they have access to genetic technologies that intervene in and disrupt evolutionary modes of descent. They think their problem can be solved by an Uzi-Biotech weapon that will scramble their chromosomes, but the narrator, at least, seems to expect their identities to survive intact.

Even within the confines of a short story no more than five pages long, this encounter is not preceded or followed by events that relate directly to it. Rather, the narrative leaps from scene to scene, all of them linked by only the most tenuous and arbitrary threads. The incongruities make the narrative a kind of textual android created through patterns of assembly and disassembly. There is no natural body to this text, any more than there are natural bodies within the text. As the title intimates, identity merges with typography ("I was a . . . dot") and is further conflated with such high-tech reconstructions as computer simulations of gravitational collapse ("I was an infinitely hot and dense white dot"). Signifiers collapse like stellar bodies into an explosive materiality that approaches the critical point of nova, ready to blast outward into dissipating waves of flickering signification.

7. Jacques Derrida, *Of Grammatology*, translated by Gayatri C. Spivak (Baltimore: Johns Hopkins University Press, 1976) [Hayles's note].
8. Mark Leyner, *My Cousin, My Gastroenterologist* (New York: Harmony Books, 1990), pp. 6–7 [Hayles's note]. Leyner (b. 1956), American writer of novels, short stories, and humorous nonfiction.

The explosive tensions between cultural codes that familiarize the action and neologistic splices that dislocate traditional expectations do more than structure the narrative. They also constitute the narrator, who exists less as a speaking voice endowed with a plausible psychology than as a series of fissures and dislocations that push toward a new kind of subjectivity. To understand the nature of this subjectivity, let us imagine a trajectory that arcs from storyteller to professional to some destination beyond. Walter Benjamin's shared community of values and presence—the community that he had in mind when he evoked the traditional storyteller whose words are woven into the rhythms of work—echoes faintly in allusions to the Song of Songs and tribal elders.⁹ Overlaid on this is the professionalization that Jean-François Lyotard wrote about in *The Postmodern Condition*, in which the authority to tell the story is constituted by possessing the appropriate credentials that qualify one as a member of a physically dispersed, electronically bound professional community.¹ This phase of the trajectory is signified in a number of ways. The narrator is driving “isotropically,” indicating that physical location is no longer necessary or relevant to the production of the story. His authority derives not from his physical participation in a community but from his possession of a high-tech language that includes pheromones, methyl isocyanate, and gelated recombinant DNA, not to mention the Uzi-Biotech phallus. This authority too is displaced even as it is created, for the incongruities reveal that the narrative and therefore the narrator are radically unstable, about to mutate into a scarcely conceivable form, signified in the story by the high-tech, identity-transforming orgasmic blast that never quite comes.

What is this form? Its physical manifestations vary, but the ability to manipulate complex codes is a constant. The looming transformation, already enacted through the language of the passage, is into a subjectivity who derives his authority from possessing the correct codes. Popular literature and culture contain countless scenarios in which someone fools a computer into thinking that he or she is an “authorized” person because the person possesses or stumbles upon the codes that the computer recognizes as constituting authorization. Usually these scenarios imply that the person exists unchanged, taking on a spurious identity that allows him or her to move unrecognized within an informational system. There is, however, another way to read these narratives. Constituting identity through authorization codes, the person using the codes is changed into another kind of subjectivity, precisely one who exists and is recognized because of knowing the codes. The surface deception is underlaid by a deeper truth. We become the codes we punch. The narrator is not a storyteller and not a professional authority, although these functions linger in the narrative as anachronistic allusions and wrenched referentiality. Rather, the narrator is a keyboarder, a hacker, a manipulator of codes.² Assuming that the text was digitized at some phase in its existence, in a literal sense he (it?) is these codes.

The construction of the narrator as a manipulator of codes obviously has important implications for the construction of the reader. The reader is similarly constituted through a layered archaeology that moves from listener to reader to decoder. Drawing on a context that included information technologies, Roland Barthes in *S/Z* brilliantly demonstrated the possibility of reading a text as a production of diverse codes.³ Information narratives make that possibility an inevitability, for they often cannot be understood, even on a literal level, without referring to codes and the informatics that produce and are produced by these codes. Flickering signification extends the productive force of codes beyond the text to include the signifying processes by which the technologies produce texts, as well as the interfaces that entmesh humans into integrated circuits. As the circuits connecting technology, text, and human expand and intensify, the point where quantitative increments shade into qualitative transformation draws closer.

Because codes can be sent over fiber optics essentially instantaneously, there is no longer a shared, stable context that helps to anchor meaning and guide interpretation. Like reading, decoding takes place in a location arbitrarily far removed in space and time from the source text. In contrast to the fixity of print, decoding implies that there is no original text—no first editions, no fair copies, no holographic manuscripts. There are only the flickering signifiers, whose transient patterns evoke and embody what G. W. S. Trow has called the context of no context, the suspicion that all contexts, like all texts, are electronically mediated constructions.⁴ What binds the decoder to the system is not the stability of being a member of an interpretive community or the intense pleasure of physically possessing the book, a pleasure that all bibliophiles know. Rather, it is the decoder's construction as a cyborg, the impression that his or her physicality is also data made flesh, another flickering signifier in a chain of signification that extends through many levels, from the DNA that in-forms the decoder's body to the binary code that is the computer's first language.

Against this dream or nightmare of the body as information, what alternatives exist? We can see beyond this dream, I have argued, by attending to the material interfaces and technologies that make disembodiment such a powerful illusion. By adopting a double vision that looks *simultaneously* at the power of simulation and at the materialities that produce it, we can better understand the implications of articulating posthuman constructions together with embodied actualities. One way to think about these materialities is through functionality. “Functionality” is a term used by virtual reality technologists to describe the communication modes that are active in a computer-human interface. If the user wears a data glove, for example, hand motions constitute one functionality. If the computer can respond to voice-activated commands, voice is another functionality. If the computer can sense body position, spatial location is yet another functionality. Functionalities work in both directions; that is, they describe the computer's capabilities and also indicate how the user's sensory-motor apparatus is being trained to accommodate the comput-

9. Walter Benjamin, “The Storyteller,” *Illuminations*, translated by Harry Zohn (New York: Schocken, 1969) [Hayles's note]. BENJAMIN (1892–1940). German literary and cultural critic.
1. Jean-François Lyotard, *The Postmodern Condition: A Report on Knowledge*, translated by Geoff Bennington and Brian Massumi (Minneapolis: University of Minnesota Press, 1984) [Hayles's note].

note]. LYOTARD (1924–1998). French philosopher.

2. It is significant in this regard that Andrew Ross

calls for cultural critics to consider themselves

hackers in “Hacking Away at the Counterculture,”

in *Technoculture*, edited by Constance Penley and

Andrew Ross (Minneapolis: University of Minnesota Press), pp. 107–34 [Hayles's note].

1956). Scottish-born American cultural critic.

3. Roland Barthes, *S/Z*, translated by Richard Miller (New York: Hill and Wang, 1974) [Hayles's note].

BARTHES (1915–1980). French literary critic and semiotician.

4. George W. S. Trow, *Within the Context of No*

Context (Boston: Little Brown, 1978) [Hayles's note].

Trow (1943–2006), American media critic and dramatist, a longtime staff writer at the *New Yorker*.

in environments that construct us as embodied virtualities.⁷ I believe that our best hope to intervene constructively in this development is to put an interpretive spin on it—one that opens up the possibilities of seeing pattern and presence as complementary rather than antagonistic. Information, like humanity, cannot exist apart from the embodiment that brings it into being as a material entity in the world; and embodiment is always instantiated, local, and specific. Embodiment can be destroyed, but it cannot be replicated. Once the specific form constituting it is gone, no amount of massaging data will bring it back. This observation is as true of the planet as it is of an individual life-form. As we rush to explore the new vistas that cyberspace has made available for colonization, let us remember the fragility of a material world that cannot be replaced.

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7. "Embodied virtuality" is Mark Weiser's phrase in "The Computer for the 21st Century," *Scientific American* 265 (September 1991): 94–104. Weiser distinguishes between technologies that put the user into a simulation with the computer (virtual reality) and those that embed computers within already existing environments (embodied virtual-

ity or ubiquitous computing). In virtual reality, the user's sensorium is redirected into functionalities compatible with the simulation; in embodied virtuality, the sensorium continues to function as it normally would but with an expanded range made possible through the environmentally embedded computers [Hayles's note].

DONNA HARAWAY

b. 1944

In the introduction to her book *Simians, Cyborgs, and Women: The Reinvention of Nature* (1991), Donna Haraway describes her transformation from a "proper, U.S. socialist feminist, white, female, hominid biologist" into a "multiply marked cyborg feminist" whose writings range freely from primatology to epistemology and on subjects from AIDS to feminist science fiction. Haraway's challenging and innovative theoretical work is part of the cultural studies of science and technology, a thriving subdiscipline interested in the history, sociology, and politics of technology. Her best-known text, "A Manifesto for Cyborgs" (1985), has been hailed as the central text of cyberfeminism—a new and often iconoclastic wave of feminist theory and practice that is seeking to reclaim technoscience. As she attempts to understand the place of technology within a postmodern, socialist feminism, Haraway argues that far from being antithetical to the human organism, technology is a material and symbolic apparatus that is already deeply involved in what it means to be human. The old political strategies—Marxist, liberal, and conservative—have become obsolete in the face of a global technoscience that is outpacing the ethical and political mechanisms we have devised for containing it. Her landmark essay is a call for "reconstructing socialist-feminist politics . . . through theory and practice addressed to the social relations of science and technology." In this manifesto, she introduces the mysterious boundary creature and new myth: the cyborg, a "hybrid of machine and organism" that, for Haraway, becomes a metaphor for the "disassembled and reassembled, post-modern collective and personal self" of contemporary cultural theory suited to the West's late capitalist social order.

er's responses. Working with a VR simulation, the user learns to move his or her hand in stylized gestures that the computer can accommodate. In the process, the neural configuration of the user's brain experiences changes, some of which can be long-lasting. The computer molds the human even as the human builds the computer.

When narrative functionalities change, a new kind of reader is produced by the text. The material effects of flickering signification ripple outward because readers are trained to read through different functionalities, which can affect how they interpret any text, including texts written before computers were invented. The impatience that some readers now feel with print texts, for example, no doubt has a physiological as well as a psychological basis. They miss pushing the keys and seeing the cursor blinking at them. Conversely, other readers (or perhaps the same readers in different moods) go back to print with a renewed appreciation for its durability, its sturdiness, and its ease of use. I began to appreciate certain qualities of print only after I had experience with computers. When I open a book, it almost always works, and it can maintain backward compatibility for hundreds of years. I also appreciate that on some occasions—when I am revising a piece of writing, for example—there isn't a cursor blinking at me, as if demanding a response. With print I can take as long as I want, and the pages never disappear or shut themselves down. As these examples illustrate, changes in narrative functionalities are deeper than the structural or thematic characteristics of a specific genre, for they shift the embodied responses and expectations that different kinds of textualities evoke. Arguing from a different historical context, Friedrich Kittler made a similar point when he wrote about medial ecology.⁵ When new media are introduced, the changes transform the environment as a whole. This transformation affects the niches that older media have carved for themselves, so they change also, even if they are not directly involved with the new media. Books will not remain unaffected by the emergence of new media.

If my assessment—that the emphasis on information technologies foregrounds pattern/randomness and pushes presence/absence into the background—is correct, the implications extend beyond narrative into many cultural arenas. As I indicated in chapter 1, one of the most serious of these implications is a *systematic devaluation of materiality and embodiment*. I find this trend ironic, for changes in material conditions and embodied experience are precisely what give the shift its deep roots in everyday experience. Implicit in nearly everything I have written here is the assumption that presence and pattern are opposites existing in antagonistic relation. The more emphasis that falls on one, the less the other is noticed and valued. Entirely different readings emerge when one entertains the possibility that pattern and presence are mutually enhancing and supportive. Paul Virilio has observed that one cannot ask whether information technologies should continue to be developed.⁶ Given market forces already at work, it is virtually (if I may use the word) certain that we will increasingly live, work, and play

5. Kittler, *Discourse Networks*. Joseph Tabbi and Michael Wurtz further explore the implications of medial ecology in *Reading Matters: Narrating in the New Media Ecology* (Ithaca: Cornell University Press, 1996) [Hayles's note].

6. Paul Virilio and Sylvère Lotringer, *Pure War*, translated by Mark Polizzotti (New York: Semiotext(e), 1983) [Hayles's note]. Virilio (b. 1932), French theorist of culture, architecture, and technology.