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Welcome to Cyberia

Notes on the Anthropology of Cyberculture

by Arturo Escobar

Significant changes in the nature of social life are being brought about by computer, information, and biological technologies, to the extent that—some argue—a new cultural order, "cyberculture," is coming into being. This paper presents an overview of the types of anthropological analyses that are being conducted in the area of new technologies and suggests additional steps for the articulation of an anthropology of cyberculture. It builds upon science, technology, and society studies in various fields and on critical studies of modernity. The implications of technoscience for both anthropological theory and ethnographic research are explored.

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Significant changes are taking place in both the character of technology and our understanding of it. Computer, information, and biological technologies are bringing about a fundamental transformation in the structure and meaning of modern society and culture. Not only is this transformation clearly susceptible to anthropological inquiry but it constitutes perhaps a privileged arena for advancing anthropology's project of understanding human societies from the vantage points of biology, language, history, and culture. This paper reviews the types of cultural analysis that are being conducted today on the social nature, impact, and use of new technologies and suggests additional contexts and steps toward the articulation of an "anthropology of cyberculture."[1]

As a new domain of anthropological practice, the study of cyberculture is particularly concerned with the cultural constructions and reconstructions on which the new technologies are based and which they in turn help to shape. The point of departure of this inquiry is the belief that any technology represents a cultural invention, in the sense that it brings forth a world; it emerges out of particular cultural conditions and in turn helps to create new ones. Anthropologists might be particularly well prepared to understand these processes if they were to open up to the idea that science and technology are crucial arenas for the creation of culture in today's world. Anthropologists must venture into this world in order to renew their interest in the understanding and politics of cultural change and cultural diversity.

Modernity, Technology, and the Social Sciences

New trends in the social study of technology are dramatically changing conventional notions in the field. In conventional approaches, technology is narrowly identified with tools or machines and the history of technology with the history of these instruments and their progressive efficacy in contributing to economic development and well-being. As a form of "applied science," technology is held to be autonomous from society and value-neutral; since it is seen as neither good nor bad in itself, it cannot be faulted for the uses to which humans put it.[2] The underlying theory is that science and technology induce progress autonomously—a belief represented by

1. David Hess and Jennifer Terry provided me with useful information on aspects of this paper; I thank them for their help and support. From an etymological perspective, the terms "cyberculture," "cyberspace," "cyberocracy," and the like, are misnomers. In coining the term "cybernetics," Norbert Wiener had in mind the Greek work for "pilot" or "steersman" (*kybernētēs*); in other words, there is no Greek root for "cyber." Given the wide acceptance of the prefix "cyber," I will use cyberculture here as an element of analysis.

2. This posture was modified by the technology assessment that emerged in the early 1970s and has since become an important field. As critics observe, however, more often than not the purpose of technology assessment is not the reorientation of technologies but the adaptation of humans to the actual or potentially dangerous effects the assessment reveals (Sanmartín and Ortí 1992).

the metaphor of "the arrow of progress." The arrow of progress, which pervades studies in a variety of disciplines, embodies an evolutionary determinism that goes, roughly, from science to technology to industry to market and, finally, to social progress. Prominent exceptions to this technological imperative are found in the work of radical critics of technological society from Heidegger and Ortega y Gasset to Marcuse, Illich, Mumford, and Ellul.

Scholars of many persuasions argue that the events of the 1960s heralded a new understanding of science and technology. The emergence of "big science," the spread of consciousness about the negative effects of nuclear and industrial technologies and the concomitant rise of appropriate-technology movements, and the appearance of a class of experts in science and technology policy and assessment were among the factors that led to a new questioning of the traditional view of science and technology as independent of socioeconomic and political contexts (Sanmartín and Luján 1992). New views began to be crafted both within technoscientific communities and in the social sciences. In the latter arena, an entire field of teaching and research took shape around two different but interrelated projects: science and technology studies and science, technology, and society programs. These projects have become institutionalized in various forms, including associations such as the National Association for Science, Technology, and Society (NAST), the Society for Social Studies of Science (4S), and the Society for Philosophy and Technology (all in the United States).

Science, technology, and society programs already exist in many universities of the world, albeit with no unifying orientation beyond the aim of analyzing science and technology as complex enterprises shaped by socioeconomic and political processes. Science and technology studies (STS), more generally, attempt to explain the implications of the constitution of science and technology as dominant forms of knowledge and practice in modern culture. The analysis sometimes leads to consideration of ethical and political questions to "help orient our understanding of the place of technology in human affairs" (Winner 1993*a*:364). It is widely held that science and technology studies have radically altered past approaches to technology, displacing the linear view of technological change and opening up powerful research programs that are resulting in a veritable theoretical renewal. At the heart of this renewal is the methodology of social constructivism, cultivated especially by sociologists and historians; in order to study science and technology as social constructs, scholars have taken to research laboratories, technology interest groups, and historical archives with new eyes. Constructivists demonstrate that, contrary to the technological determinism of past times, contingency and flexibility are the essence of technological change; by showing that social processes are inherent to technological innovations, they deal a fatal blow to the alleged separation of technology from society and of both of these from nature. The general belief is that science and technology systems are regulated according to flexible technosocial arrangements which, within certain structural constraints, constitute social closure around concrete developments. Some researchers have gone beyond this to assert that nature and machines have become important actors in the historical processes that determine technological change.[3]

Besides the methodological decision to look closely at the technologies themselves and the systems that surround them—a step with which anthropologists could certainly sympathize—social constructivism has introduced several suggestive conceptual innovations. One of these is the notion of "interpretive flexibility," which refers to the fact—long known to anthropologists—that different actors ("relevant social groups," in the constructivists' parlance) interpret technological artifacts in different ways. The purpose of analysis is seen as identifying the various socially relevant groups, the variability in their interpretations of the technical entity in question, and the mechanisms by which such variability is reduced and closure achieved around a given option. This would explain why particular technologies are adopted and not others. The result of all this research is a multipath and multilevel evolutionary model of technological change. In Callon and Latour's "action-network theory," research and development are similarly studied in terms of the way in which actors—human and nonhuman—struggle to identify the problem to be solved (San Martín and Luján 1992).

Despite its importance and visibility, social constructivism has aroused controversy and critique. That the constructivists seek to explain why technologies arise and certain social constituencies prevail but not the effects of specific technologies on people, power structures, and communities is seen by some as an easy and perhaps irresponsible form of relativism; they also remain silent on the "irrelevant" social groups which are nevertheless affected by technology (Winner 1993*a*). In a more philosophical vein, according to the same critic, the constructivists take for granted the deeper cultural background that shapes technological interpretation and practice. To look at interpretive flexibility is appropriate "up to a point," but without a parallel analysis of the meanings that particular technological accomplishments have for people it "soon becomes moral and political indifference" (Winner 1993*a*:372). From a different perspective, it is said that social constructivism underplays the role of science in technological development and minimizes the effect of other factors in that process such as the economy, the media, and the public sector (Sanmartín and Ortí 1992). At the very least, anal-

3. This in no way pretends to be an exhaustive account of the constructivist approach, whose proponents do not necessarily constitute a homogeneous group. Among the most-cited works by these authors are Knorr-Cetina and Mulkay (1983), Latour and Woolgar (1979), Bijker, Hughes, and Pinch (1987), Latour (1987, 1988), and Woolgar (1988, 1991). Other important names associated with constructivism are Michael Callon, H. M. Collins, Thomas Hughes, and John Law. For reviews of these works, see Winner (1993*a*) and Medina (1992).

ysis of technosocial closure must be supplemented with questions about the suitability of the personal and social practices informed by the technologies under consideration—questions that, again, the constructivists seem to overlook (Medina 1992).

Some of the critiques reviewed above are considered in other anthropological, philosophical, and poststructuralist studies of science and technology. For anthropologists, inquiry into the nature of modernity as the background for current understanding and practice of technology is of paramount importance. In this anthropology is closer to the philosophy than to the new sociology of technology. Cyberculture is in fact fostering a fresh reformulation of the question of modernity in ways no longer so mediated by literary and epistemological considerations. Whether our era is postmodern or modified modern ("late," "meta-," or "hyper-," as some have proposed) is a question that cannot be answered prior to investigation of the present status of science and technology. To the extent that science and capital still function as organizing principles of dominant social orders, some insist, we have not yet taken leave of modernity, despite the unprecedented modes of operation developed by both of these principles in recent decades.[4] According to Foucault (1973), the modern period brought with it particular arrangements of life, labor, and language embodied in the multiplicity of practices through which life and society are produced, regulated, and articulated by scientific discourses. In what ways does cyberculture continue to act on these domains? Are the systems that account for the production of life (body, self, nature), labor (production, the economy), and language (discourse, communication, the speaking subject) being significantly modified? Whether Foucaultian biopolitics and disciplinary grids are being superseded by technology and genetic engineering is a matter for heated debate. Anthropologists might become guests of honor in this debate.

Modernity has been characterized by theoreticians such as Foucault (1973), Habermas (1987), and Giddens (1989) in terms of the continuous appropriation of taken-for-granted cultural backgrounds and practices by explicit mechanisms of knowledge and power. With modernity many aspects of life previously regulated by traditional norms—health, knowledge, work, the body, space, and time—were progressively appropriated by discourses of science and the accompanying forms of technical and administrative organization. Organic and mechanical models of physical and social life gave way to models centered on the production and maximization of life itself, including the coupling of the body and machines in new ways in factories, schools, hospitals, and family homes. There began an intimate imbrication of processes of capital and knowledge for the simultaneous production of value and life.[5] The spread of the written word, the preeminence of the machine, the control of time and space, and the biological and biochemical revolutions of the past 100 years produced unprecedented biotechnical arrangements which today find new forms of expression in cybercultural regimes.

Although the relation between science, technology, and culture has remained insufficiently theorized (Lécourt 1992), science and technology or, better, technoscience has been central to the modern order. Heidegger's treatment of technology as a paradigmatic practice of modernity remains exemplary in this regard. Science and technology, for Heidegger, are ways of creating new realities, new manifestations of being. Modern science necessarily constructs ("enframes") nature as something to be appropriated, something whose energy must be released for human purposes. This is "the danger in the utmost sense" to the extent that enframing leads to destructive activities and, particularly, to the destruction of other, more fundamental ways of revealing the essence of being ("poiesis") which Heidegger sees present in the arts and in certain Eastern philosophies. Technology for Heidegger also has an important ontological role in that the world becomes present for us through technical links of various kinds; it is through technical practices that the social character of the world comes to light (Heidegger 1962). More recently, some philosophers have judged technical rationality the primary mode of knowing and being, thus reversing the traditional primacy of science over technology and theory over practice (Medina and Sanmartín 1989, Mitcham 1990).[6]

For these philosophers, the priority accorded science and theory over technical creativity has led moderns to believe that they can describe nature and society according to laws. Rather than as the effect of practices, nature and society appear as objects with mechanisms and are therefore treated instrumentally (Medina and Sanmartín 1989). The new technologies seem to deepen these trends in ways that are best visualized by contemporary science fiction. New science-fiction landscapes are populated with cyborgs of all kinds (human beings and other organisms with innumerable prostheses and technological interfaces) moving in vast cyberspaces, virtual realities, and computer-mediated environments.[7]

4. That the recent transformations of biological and technological arrangements are not the result of a radical shift in cultural and epistemological structures but a deepening of the process of modernization and creation of life-worlds that started in the late 18th century is the point of departure of the recent collection *Incorporations* (Crary and Kwinter 1992). The point has also been made by Rabinow (1992*a*).

5. This imbrication of capital and life is captured in Foucault's notion of "bipower," which he explains in terms of two processes: an anatomo-politics of the human body, effected by the normalization and disciplining of everyday life, and a bio-politics of population, effected by planning, regulatory, and administrative mechanisms (1980:135–59). See also Guattari (1992) and Deleuze and Guattari (1987).

6. The philosophy of technology took off in the seventies and eighties (see Mitcham 1990). Important in this regard were the creation of Carl Mitcham's Philosophy and Technology Studies Center in New York, a similar group at the Universidad Politécnica de Valencia (INVESCIT), and the Society for Philosophy and Technology.

7. A genre of science fiction known as "cyberpunk" has been on the rise since the 1984 publication of William Gibson's *Neuromancer*, considered the point of origin of the cyberspatial era. For an introduction to cyberpunk, see McCaffrey (1991). While some see in cyberpunk a veiled critique of the Reagan years, the way in which

But while science-fiction writers and technology builders are generally uncritical of these trends, it remains to be seen to what extent and in what concrete ways the transformations envisioned by them are in the process of becoming real. This is another task for the anthropology of cyberculture.[8]

The Nature of Cyberculture

While any technology can be studied anthropologically from a variety of perspectives—the rituals it originates, the social relations it helps to create, the practices developed around them by various users, the values it fosters—"cyberculture" refers specifically to new technologies in two areas: artificial intelligence (particularly computer and information technologies) and biotechnology.[9] It would be possible to separate out these two sets of technologies for analytical purposes, although it is no coincidence that they have achieved prominence simultaneously. While computer and information technologies are bringing about a regime of *technosociality* (Stone 1991), a broad process of sociocultural construction set in motion in the wake of the new technologies, biotechnologies are giving rise to *biosociality* (Rabinow 1992*a*), a new order for the production of life, nature, and the body through biologically based technological interventions. These two regimes form the basis for what I call cyberculture. They embody the realization that we increasingly live and make ourselves in technobiocultural environments structured by novel forms of science and technology.

Despite this novelty, cyberculture originates in a well-known social and cultural matrix, that of modernity, even though it orients itself towards the constitution of a new order—which we cannot yet fully conceptualize but must try to understand—through the transformation of the range of possibilities for communicating, working, and being. Modernity constitutes the "background of understanding"—the taken-for-granted tradition and way of being in terms of which we interpret and act—that inevitably shapes the discourses and practices generated by and around the new technologies. This background has created an image of technology as a neutral tool for releasing nature's energy and augmenting human capacities to suit human purposes (Heidegger 1977). This background must be made explicit as a step towards reorienting the dominant tradition. Some see the ultimate purpose of this reorientation as contributing to the democratization of science and technology and to the development of technologies and technoliterate practices better suited to human use and human purposes than the present ones (Winograd and Flores 1986, Winner 1993*a*, Medina 1992).

Given this brief presentation, anthropological research might be guided by the following overall inquiries:

1. What are the discourses and practices that are generated around/by computers and biotechnology? What domains of human activity do these discourses and practices create? In what larger social networks of institutions, values, conventions, etc., are these domains situated? More generally, what new forms of social construction of reality ("technoscapes") and of negotiation of such construction(s) are introduced by the new technologies? How do people routinely engage technoscapes, and what are the consequences of doing so in terms of the adoption of new ways of thinking and being? In what ways do our social and ethical practices change as the project of technoscience advances?

2. How can these practices and domains be studied ethnographically in various social, regional, and ethnic settings? What established anthropological concepts and methods would be appropriate to the study of cyberculture? Which would have to be modified? How, for instance, will notions of community, fieldwork, the body, nature, vision, the subject, identity, and writing be transformed by the new technologies?

3. What is the background of understanding from which the new technologies emerge? More specifically, which modern practices—in the domains of life, labor, and language—shape the current understanding, design, and modes of relating to technology? What continuities do the new technologies exhibit in relation to the modern order? What kinds of appropriations, resistances, or innovations in relation to modern technologies (for instance, by minority cultures) are taking place which might represent different approaches to and understandings of technology? What happens to non-Western perspectives as the new technologies extend their reach?

4. What is the political economy of cyberculture? In what ways, for instance, are the relations between First and Third World restructured in the light of the new technologies? What new local articulations with forms of global capital based on high technology are appearing?

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the movement has grown and been presented by the media is troubling; see, for instance, the lead story on cyberpunk and "the electronic underground" in the February 8, 1993, issue of *Time*. See also *Mondo 2,000*, perhaps the most visible printed medium of cyberpunk, and its *User's Guide to the New Edge* (1992). For a critical analysis of these trends, see Rosenthal (1992).

8. The literature on cyberspace and virtual reality produced by their chroniclers and practitioners is characterized by the grandiosity of its claims. Two examples, by two prominent designers, Scott Fisher and Myron Kruger, may suffice: "The possibilities of virtual realities, it appears, are as limitless as the possibilities of reality. They can provide an interface that disappears—a doorway to other worlds" (Fisher, quoted in Rheingold 1991:131). More interesting, from Kruger: "We are incredibly attuned to the idea that the sole purpose of our technology is to solve problems. It also creates concepts and philosophy. We must more fully explore this aspect of our inventions because *the next generation of technology will speak to us, understand us, and perceive our behavior.* It will enter every home and office. . . . We must recognize this if we are to understand and choose what we become as a result of what we have made" (quote in Rheingold 1991:113, emphasis added). Some liken the current transformation to the industrial revolution, although this time "fueled not by oil but by a new commodity called artificial intelligence" (Kurzweil 1990:13).

9. It is not apparent why computer and information technologies both fall under the rubric of artificial intelligence. To the extent that computers can be thought of as today's dominant intellectual technologies, it is valid to propose that "all informatics may be thought of as artificial intelligence" (Lévy 1991:8).

How do automation, intelligent machines, and biotechnology transform the labor process, the capitalization of nature, and the creation of value worldwide? If different groups of people (classes, women, minorities, ethnic groups, etc.) are differentially placed in new technological contexts, how can anthropologists theorize and explore this ordering of technocultural construction? Finally, what are the implications of this analysis for a cultural politics of science and technology?

The Anthropological Project

THEORETICAL FORMULATIONS

Interest in science and technology on the part of social/cultural anthropologists has been growing steadily in recent years. Steps have already been taken towards building an institutional presence for the anthropology of science and technology within the American Anthropological Association.[10] Several panels related to science and technology issues were held at the 1992 and 1993 AAA meetings.[11] Topics of interest to anthropologists in recent years have included ethnographies of scientists, studies of reproductive and medical technologies, topics in gender and science, ethics and values, and science and engineering education. The more fashionable studies of computer and biological technologies, virtual reality, virtual communities, and cyberspace are attracting increasing attention. An effort to theorize the anthropology of science and technology is also under way.[12]

Although most anthropological science and technology studies have taken place in highly industrialized countries, increasing attention to issues in Third World contexts can be expected, given that the globalization of cultural and economic production relies more and more on the new technologies of information and life. Whether it is in the domains of biotechnology-driven development, information, or warfare, the encounter between North and South continues to be heavily mediated by technologies of many kinds. Recently, the impact of technologies such as television and videocassettes on local notions of development and modernity and their effect on long-standing social and cultural practices have been approached ethnographically (Abu-Lughod 1990, Dahl and Rabo 1992, García Canclini 1990). Once seen as producing worldwide homogenization and generalized acculturation, cosmopolitan science and technology are now viewed in terms of their real or potential contribution to the formation of hybrid cultures and to processes of self-affirmation of their selective and partially autonomous adoption.[13] There is also hope that advances in biotechnology might be used by local groups in biodiversity-rich regions of the world to defend their territories and articulate novel economic and cultural strategies. As David Hess (1993) argues, however, the effect of cosmopolitan technologies on Third World groups remains insufficiently understood, particularly from the vantage point of the cultural politics that they set in motion, including issues of cultural destruction, hybridization, and homogenization and the creation of new differences through forms of connectedness fostered by the new technologies—another aspect of what Arjun Appadurai (1991) calls "global ethnoscapes." Work on these issues is advancing rapidly, particularly in connection with the redefinition of development (Hess 1993, Escobar 1994).

Anthropological reflection on the relation between culture and technology is of course not new. The impact of Western technologies on cultural change and evolution has been a subject of study since the early 1950s.[14] Questions of technological control and political economy have been broached. Nevertheless, studies of material culture and technology have suffered from dependence on what a reviewer of the field recently called "the standard view of technology" (based on a decontextualized teleology that goes from simple tools to complex machines). Only with modern science and technology studies has the possibility arisen of seeing science and technology in relation to complex technosocial systems. This "lays the foundation once again for fruitful communication among social anthropologists, ethnoarchaeologists, archaeologists, and students of human evolution" (Pfaffenberger 1992:513). It also fosters exchange between anthropologists and other disciplines involved in these studies such as philosophy, cognitive science, and linguistics.

In the First World, attempts at articulating an anthropological strategy explicitly centered on new information, computer, and biological technologies have just begun. An important precursor in this regard was Margaret Mead's work in the context of the emergence of cybernetics during World War II and up to the middle of the 1960s.[15] At the beginning of the 1990s, it is possible

10. The first step was taken at the 1992 annual meeting of the Society for the Social Studies of Science, where a group of American anthropologists (Michael Fischer, Sharon Traweek, Rayna Rapp, David Hess, Lisa Handwerker, Shirley Gorenstein, and David Hakken) met to discuss strategies for establishing a Committee on Science and Technology within the AAA. This process is detailed in the 1992 edition of the *Social/Cultural Anthropology of Science and Technology Newsletter*, edited by David Hess.

11. Panels at the 1992 meetings included cyborg anthropology, cultural perspectives on computing, cultural barriers to technological innovation, virtual communities, consequences of interactive information technology for culture and education, and cyborgs and women (in honor of Donna Haraway).

12. For a directory and bibliography of anthropological science and technology studies, see Hess (1992), Hess and Layne (1992), Pfaffenberger (1992), and Hakken (n.d.).

13. The case of the Kayapo in the Amazon rain forest, who have become adept at using video cameras, airplanes, and revenues from gold mining in their struggle for cultural autonomy, is already becoming legendary.

14. Among the best-known studies is Godelier's (1971) work on the effects of the introduction of steel axes on Australian Aborigines and the Baruya of Papua New Guinea. For an excellent discussion of earlier studies, see Hess (1993).

15. Mead was an active participant in the Macy Conferences on Cybernetics (Mead 1950–56) as well as a central figure in the founding of the American Society for Cybernetics (Mead 1968). The life of this illustrious "cybernetics group," which included besides Mead Gregory Bateson, Heinz von Foerster, Norbert Wiener, and Kurt Lewin, among others, is chronicled in a recent book (Heims 1991). It should be pointed out that the Macy Conferences

to identify three different proposals. The first, by the anthropologist David Thomas, builds upon the growing literature on the notions of "cyberspace"[16] and "cyborg"—broadly speaking, a mixture of human and machine. Arguing that advanced forms of Western technology are bringing about a "rite of passage" between industrial and "postorganic" societies, between "organically human and cyberpsychically digital life-forms as reconfigured through computer software systems," Thomas (1991:33) calls on anthropologists to engage "virtual worlds technologies during this early stage of speculation and development," particularly from the point of view of how these technologies are socially produced. From print-based paradigms of visual literacy to the virtual worlds of digitized information, we are witnessing a transition to a new postcorporeal stage that has great promise for creative social logics and sensorial regimes. Cyberspace affords unprecedented possibilities for anthropologists in terms of realizing this promise.

The second project, "cyborg anthropology," formally launched with a two-panel session held at the annual meetings of the AAA in San Francisco in December 1992, takes science and technology studies, in particular feminist ones, as a point of departure. While its domain is the analysis of science and technology as cultural phenomena, the main goal of cyborg anthropology is the ethnographic study of the boundaries between humans and machines that are specific to late-20th-century societies. Believing that "anthropos" as the subject and object of anthropology must be displaced, the emerging cyborg anthropologists argue that human and social reality is as much a product of machines as of human activity, that we should grant agency to machines, and that the proper task for an anthropology of science and technology is to examine ethnographically how technology serves as agent of social and cultural production.[17]

Critical positions regarding these two projects are beginning to be articulated, most notably in visual anthropology. Given the importance of vision for virtual reality, computer networks, graphics, and interfaces and for imaging technologies—from satellite surveillance, warfare, and space exploration to medical technologies such as tomography and the visualization of the foetus (Haraway 1988, de Landa 1991, Cartwright and Goldfarb 1992, Duden 1990)—it is not surprising that the branch of anthropology most attuned to the analysis of visuality as a cultural and epistemological regime has been the first to react to uncritical celebration of cyberspatial technologies (e.g., Benedikt 1991, Rheingold 1991). Claims by cyberspace designers that the new technologies will "make the body obsolete, destroy subjectivity, create new worlds and universes, change the economic and political future of humanity, and even lead to a posthuman order" are for these critics at best wishful thinking motivated by the seductiveness of virtual reality and like technologies and at worst misguided efforts at engineering social reality (Gray and Driscoll 1992:39). So, they argue, is the seemingly exclusive focus on a cyborgian society mediated by human-machine interactions.[18] Rather than suggesting that a whole new anthropological subdiscipline is needed, Gray and Driscoll prefer to speak of "anthropology of, and in, cyberspace." From this perspective, anthropologists would study technologies in the cultural contexts from which they originate and in which they operate, including their continued links to the dominant values of rationality, instrumentality, profit, and violence. It is no coincidence, these writers continue, that virtual reality—one of the recent developments at the heart of the cyberspatial movement—has been and is likely to continue to be circumscribed by military and economic interests and that, despite its much-touted potential for liberatory and humanizing purposes, the military and profit-oriented applications will undoubtedly remain dominant. Their prescription is for examining these technologies from the perspective of how they allow various groups of people to negotiate specific forms of power, authority, and representation.

The anthropology of cyberculture similarly holds that we can assume a priori neither the existence of a new era nor the need for a new branch of anthropology. Indeed, the discipline is in principle well suited to what must start as a rather traditional ethnographic project: to describe, in the manner of an initial cultural diagnosis, what is happening in terms of the emerging practices and transformations associated with rising technoscientific developments. However, given that these developments are increasingly unprecedented sites of articulations of knowledge and power, it is also pertinent to raise the question of the theoretical adequacy of estab-

took place in the context of the Cold War, the first wave of computer technology, and the development of general systems theory. Today's historical and epistemological contexts are quite different.

16. The term "cyberspace"—first coined by William Gibson (1984) and introduced to intellectual, artistic, and academic circles in Benedikt's collection *Cyberspace: The First Steps* (1991)—refers to the growing networks and systems of computer-mediated environments. As a spatialized, computer-mediated network of interactions, cyberspace is seen as "enabling full copresence and interaction of multiple users, allowing input and output from and to the full human sensorium, permitting situations of real and virtual realities, remote data collection and control through telepresence, and total integration and intercommunication with a full range of intelligent products and environments in real space" (Novak 1991:225). For introductions to the concept of cyberspace, see Rheingold (1991) and Stone (1991, 1992). For a presentation of global computer networks, see Dertouzos (1991) and Cerf (1991). A brief review of recent guides to the Internet is found in the *Chronicle of Higher Education*, December 16, 1992, p. A9.

17. This description is based on the paper presented at the panel "Cyborg Anthropology 1: On the Production of Humanity and Its Boundaries," by Gary Lee Downey, Joseph Dumit, and Sarah Williams (1992). Papers were presented on such topics as the participation of women in high-energy physics in Japan, medical imaging technology, science-fiction fandom, computer-assisted psychotherapy, "low-tech cyborgs" (cyborgs in the Third World), reproductive technology, and cultural constructions of biotechnology.

18. For Roseanne Stone (1991, 1992), the emphasis on "postcorporality" arises from the traditional male discomfort with the body. This bias will be corrected, Stone believes, when more women participate in the design of virtual and cyberspatial technologies. Although this is beginning to happen, the results remain to be seen. From another angle, it can be argued that the emphasis on transcending the body in the cyber context is another aspect of disembodied "virtual theorizing" that at times has tenuous links with reality (Tsugawa 1992).

lished concepts in light of their historical and cultural specificity.

One of the most fruitful insights is that technoscience is motivating a blurring and implosion of categories at various levels, particularly the modern categories that have defined the natural, the organic, the technical, and the textual. The boundaries between nature and culture, between organism and machine are ceaselessly redrawn according to complex historical factors in which discourses of science and technology play a decisive role (Haraway 1991). "Bodies," "organisms," and "communities" thus have to be retheorized as composed of elements that originate in three different domains with permeable boundaries: the organic, the technical (or technoeconomic), and the textual (or, broadly speaking, cultural). While nature, bodies, and organisms certainly have an *organic* basis, they are increasingly produced in conjunction with *machines,* and this production is always mediated by scientific *narratives* ("discourses" of biology, technology, and the like) and by culture in general. Cyberculture must thus be understood as the overarching field of forces and meanings in which this complex production of life, labor, and language takes place. For some (Haraway 1991, Rabinow 1992*a*), while cyberculture can be seen as the imposition of a new grid of control on the planet, it also represents new possibilities for potent articulations between humans, nature, and machines. The organic, these critics suggest, is not necessarily opposed to the technological. Yet it must also be emphasized that new knowledge and power configurations are narrowing down on life and labor, as in the Human Genome project; indeed, the new genetics—linked to novel computer techniques, its promise most eagerly visualized in the image of the biochip—might prove to be the greatest force for reshaping society and life ever witnessed. Nature will be known and remade through technique; it will be literally built in the same way that culture is, with the difference that the making of nature will take place through the reconfiguration of social life by micropractices originating in medicine, biology, and biotechnology (Rabinow 1992*a*). Evelyn Fox Keller similarly points out that the relation between nature and culture is likely to be radically reconceived to the extent that molecular biology is creating the sense of a "new malleability of nature." This is easily seen in the discourse on genetic diseases (Keller 1992*b*). The "right to normal genes" might well become the battle cry of an army of health experts and reformers deploying practices of biosocial transformation of a scope not witnessed since "the birth of the clinic" two centuries ago (Foucault 1975).

The corollary of these analyses is the need to pay attention to the social and cultural relations of science and technology as central mechanisms for the production of life and culture in the 21st century. Capital, to be sure, will continue to play a crucial role in the reinvention of life and society. The worldwide spread of value today, however, takes place not so much by the direct extraction of surplus value from labor or conventional industrialization as by the further capitalization of nature and society through scientific research and development, particularly in the areas of artificial intelligence and biotechnology. Even the human genome becomes an important area for capitalist restructuring and, thus, for contestation. The reinvention of nature and culture currently under way—effected by/within webs of meaning and production that link science and capital—must therefore be understood according to a political economy appropriate to the era of cyberculture. Anthropologists need to begin in earnest the study of the social, economic, and political practices related to the technologies through which life, language, and labor are being articulated and produced.

ETHNOGRAPHIC DOMAINS

As I have said, the general questions to be raised by the anthropology of cyberculture include the following: What new forms of social construction of reality and of negotiation of such constructions are being created or modified? How are people socialized by their routine experience of the constructed spaces created by the new technologies? How do people relate to their techno-worlds (machines, reinvented bodies, and natures)? If people are differently placed in technospaces (according to race, gender, class, geographical location, "physical ability"), how do their experiences of these spaces differ? Finally, would it be possible to produce ethnographic accounts of the multiplicity of practices linked to the new technologies in various social, regional, and ethnic settings? How do these practices relate to broader social issues such as the control of labor, the accumulation of capital, the organization of life-worlds, and the globalization of cultural production?

One can begin to think of these questions in terms of possible ethnographic domains and concrete research strategies. Some clues concerning these domains may be found in current research projects. Several domains of ethnographic investigation can be distinguished as an initial approximation, to be refined as the research advances:

1. The production and use of new technologies. Here anthropological research would focus on scientists and experts in sites such as genetic research labs, high-technology corporations, and virtual reality design centers, on the one hand, and the users of these technologies, on the other. Ethnographies in this domain would generally follow in the footsteps of the handful of ethnographies of modern science and technology conducted to date (Latour and Woolgar 1979, Martin 1987, Visvanathan 1985, Latour 1988, Traweek 1988, Kondo 1990), science and technology theorizing, particularly in relation to anthropology (Hakken n.d., Pfaffenberger 1992, Hess and Layne 1992, Hess 1993), and feminist studies of science and technology (Haraway 1989, 1991; Jacobus, Keller, and Shuttlewort 1990; Wajcman 1991; Keller 1992*a*), although they would have to be resituated within the conceptual space of the anthropology of cyberculture. A handful of ethnographic studies of this kind are already under way.[19]

19. These include Deborah Heath's study of a molecular biotech-

A salient aspect of research in this domain is the ethnographic study of the production of subjectivities that accompanies the new technologies. That the computer is "an evocative object," a projective medium for the construction of a variety of private and public worlds, has been shown by Sherry Turkle (1984). As the computer culture spreads, Turkle shows in a pioneering study, more and more people come to think of themselves in computer terms. Computers are changing notions of identity and the self in ways that are little understood. Cyberculture is indeed creating a host of veritable "technologies of the self" that go beyond the view of self as machine, and the cultural productivity of these notions can only be assessed ethnographically. Virtual worlds, for instance, such as the use of anonymous computer role-playing games (MUDs) as therapeutic media, can be a way of moving out of the self and into the world of social interactions. Although these media are frequently thought of negatively, Turkle's (1992) recent work indicates that they can become instruments for reconstructing identities in interactive ways and sources of knowledge about other cultures and the outside world. There is also a global component to the production of subjectivities that needs to be explored. What is the meaning of the globalization of Nintendo, for instance, in youth culture worldwide? How are computer games "consumed" in societies that have different cultural codes?

To the extent that the reconstruction of space entails the reconstruction of the body, this also needs to be theorized. How is the body being reconfigured and reimagined through inscriptions at the level of the relation between body and machine? What would be a poststructuralist understanding of the body in cyberspace, if this understanding is to avoid the trappings both of the frontier (the body that can or cannot be transcended) and of humanism (the body one can "remake")? A fruitful theorization of posthumanity might lie in this area of inquiry. If new technologies afford opportunities for the reproduction of life through machines, must the computer be included in the ensemble of reproductive technologies? What would "female body" mean from a feminist perspective on these matters?[20]

2. The appearance of computer-mediated communities, such as the so-called virtual communities and, generally, what one of the most creative computer environment designers has called "the vibrant new villages of activity within the larger cultures of computing" (Laurel 1990:93).[21] Anthropological analysis can be important not only for understanding what these new "villages" and "communities" are but, equally important, for imagining the kinds of communities that human groups can create with the help of emerging technologies. Again, research in this area is just beginning. We can anticipate active discussion on the proper methods for studying these communities, including questions of online/off-line fieldwork, the boundaries of the group to be studied, interpretation, and ethics.[22]

A variant of this line of research is what Laurel (1990: 91–93) has termed "interface anthropology." The creation of human-computer interfaces has been treated narrowly as a problem of engineering design which attempts to match the tasks to be performed with the tools at hand. Yet the key question of the distinct user populations for whom the technologies are intended is often ignored or inferred from statistical information, and the critical question of what the technology in question does to users and what it allows them to do is never raised. Children, teachers, computer game designers and users, fiction writers, architects, community activists, and others have different needs and approaches regarding these basic questions. An "interface anthropology" that addresses this lack would focus on user/context intersections, finding "informants" to guide the critical (not merely utilitarian) exploration of diverse users and contexts.[23]

3. Studies of the popular culture of science and technology, including the effect of science and technology on the popular imaginary (the set of basic elements that structure a given discourse and the relations among them) and popular practices. What happens when technologies such as computers and virtual reality enter the mainstream? The emergence of a "technobabble" (Barry 1992) is only the tip of the iceberg with regard to the

nology laboratory (1992), Barbara Joans's ethnography of virtual reality designers (1992), and David West's research in progress on virtual reality users (personal communication; for information on this project, contact David West at "dmwest@stthomas.edu", or at the WELL).

20. These thoughts on the body are Jennifer Terry's (personal communication).

21. Virtual communities are formed by groups of people who relate to each other mainly through a computer medium such as electronic mail and specialized networks such as Peacenet, Econet, and a large variety of academic, community, and business-based bulletin boards and conferencing systems, usually linked through Internet, Bitnet, and Usenet. A unique on-line community is the Whole Earth 'Lectronic Link (WELL), located in the San Francisco Bay area, with subscribers from many parts of the United States. The WELL maintains ongoing discussions on the meaning of virtual communities, virtual reality, multimedia, and the like. An ethnography of the WELL is in progress (Bessinger 1993).

22. Questions of ethics are significant in virtual communities, including the possibility of assuming different personas, the relationship between "virtual" and "real" personas, the disclosure of one's social markers, such as one's gender, race, and class, and the possibility of "lurking" (observing a community without making one's presence known to those observed). There is a rich set of concerns to be explored here by anthropologists (see Bessinger 1993). Questions of exchange of information between anthropologists from various parts of the world and between anthropologists and those they work with in the field take on a novel dimension with the advance of electronic networks. In some situations, virtual communities become part of "the field" rather than merely an extension of it. An effort to connect anthropologists and others throughout the world electronically to discuss the kinds of questions, ideas, books, conferences, etc., that are most relevant for anthropology is under way under the direction of Arjun Appadurai and Carol Breckenridge of the journal *Public Culture*.

23. Walker (1990) distinguishes five phases in the history of user interfaces: (1) knobs and dials, (2) batch (a specialist computer operator running a stack of jobs on punched cards), (3) time sharing, (4) menus, (5) graphics, windows. The next phase will take the user directly "inside" the computer, through the screen to cyberspace, so to say. This will be a three-dimensional space such as the one achieved by virtual reality today. The hope of designers is that it will replace more passive viewing with active participation.

changes that are taking place at this level. For the Argentinian cultural critic Beatriz Sarlo (1992), the principal need in this regard is to examine the aesthetic and practical incorporation of technology into daily life. At the level of the popular sectors, the technological imaginary elicits a reorganization of popular knowledges and the development of symbolic contents that, while undeniably modern, differ significantly from those intended by scientists. This has to be taken into account in the study of the technoliterate practices that enable people to relate actively to new technologies (Penley and Ross 1991). Since the mid-1980s, ethnographic studies of popular culture (Fiske 1989, Willis 1990) have been grappling with some of these issues. The imbrication of cultural forms with social questions can be studied ethnographically; it can also be gleaned from literature and other popular productions, as the work of Sarlo (1992), Seltzer (1992), and Jenkins (1992) demonstrates.[24]

4. The growth and qualitative development of human computer-mediated communication, particularly from the perspective of the relationship between language, communication, social structures, and cultural identity. While computer-mediated communication shares many features with other forms of mediated communication well studied by linguists and linguistic anthropologists, such as telephone and answering machine messages, it also differs in important respects. Human interaction through computers must be studied not only from the perspective of the transcultural/transsituational principles and discourse strategies (Gumperz 1983) governing any type of human interaction but also in terms of the specificity of the communicative and linguistic practices that arise from the nature of the media involved. Three dimensions of the process of construction of computer-mediated communicative communities are particularly relevant in this regard (Celso Alvarez, personal communication, 1992): (*a*) the relationship between machines and social subjects as producers of discourse at the threshold of the birth of an international "cyberliterate" society; (*b*) the question of the creation and distribution of and access to the "authorized" or "legitimate" computer-mediated communication codes and languages whose mastery and manipulation grants particular groups of practitioners symbolic authority and control over the circulation of cyberculture; (*c*) the role of computer-mediated communication in establishing links between, giving cohesion to, and creating continuities in the interactional history of group members, side by side with telephone conversations, regular mail, and face-to-face interaction. This might include research on talk, interaction, and technology in work (Goodwin and Harness Goodwin 1992) and leisure contexts and on the shaping and reshaping of social and cultural boundaries both between a given computer-mediated community and other communities and within such communities. A particular aspect of this area of research is hypertext—a computer text designed to be recreated or transformed through collaborative acts involving one person and an original database or many users performing operations upon a given text or texts—to the extent that it is the virtual environment of the hypertext that allows a "matrix" of knowledgeable users to interact (Barrett 1989, Piscitelli 1991).[25]

A barely explored question in this domain is the hypothesized transition to a postscriptural society effected by information technologies. If writing and its associated logical modes of thought replaced orality and its associated situational ways of thinking, the information age would be marking the abandonment of writing as the dominant intellectual technology. In the same way that writing incorporated orality, information would incorporate writing—but only after an important cultural mutation. Theoretical and hermeneutical knowledge—so closely linked to writing—would likewise enter into a period of decline or, at least, of conversion to a secondary form. New ways of thinking determined by the operational needs of information and computation would be instituted. Time would no longer be circular (as in orality) or linear (as with the historical societies of writing) but punctual. Punctual time and the acceleration of information would entail that knowledge be not fixed, as in writing, but evolving, as in an expert system (Lévy 1991). Were these momentous changes to take place, they would pose difficult questions for anthropology, so dependent on writing and hermeneutical interpretation. One thing seems certain: despite widespread arguments to the contrary, electronic communication has effected basic changes in language experiences and the construction of events. "What is at stake are new language formations that alter significantly the network of social relations, that restructure those relations and the subjects they constitute" (Poster 1990:8). The understanding of these changes demands venturing into unexplored domains of analysis.

5. The political economy of cyberculture. Anthropologists have paid close attention in recent decades to the analysis of communities in historical and global contexts (Wolf 1982, Roseberry 1992). Cyberculture presents new challenges for the continued articulation of an anthropological political economy. What has been variously called "the silicon order," "microchip capitalism," and "the information economy" entails profound

24. Seltzer's book examines "the anthropology of boyhood and adolescence at the turn of the century and the social and cultural technologies for 'the making of men'" (p. 5) from the Foucaultian perspective of the production of subjectivities and docile bodies. Sarlo's book deals with the introduction of modern technologies in Argentina in the 1920s and 1930s. One of Sarlo's strongest points is that, in historical moments at which new technologies are introduced, as in the present, there is the possibility of a certain *original* popular construction in connection with them. Penley and Ross's book examines the enabling practices of groups such as hackers and science-fiction fans. Jenkins's advocacy of the study of "textual poaching" by science-fiction writers and by computer users points in the same direction.

25. Alvarez claims that the characterization of computer-mediated communicative groups as "virtual" communities is a misnomer, since from the perspective of linguistic interaction, they are "real" communities. A question about the adequacy of the model of conversation for dealing with computers has been posed by Walker: "When you are interacting with a computer you are not conversing with another person. You are exploring another world" (1990:443). Here might lie some challenges for linguistic anthropology.

changes in capital accumulation, social relations, and divisions of labor at many levels.

What is the relationship between "information" and "capital"? Is it appropriate to postulate, as some do (Poster 1990), the existence of a "mode of information" akin to a mode of production? How can we theorize the articulation between information, markets, and cultural orders? The shift to new information technologies marked the appearance of more flexible, decentralized labor processes highly stratified by gender, ethnic, class, and geographic factors. This "post-Fordist regime" (Harvey 1989) elicits novel articulations of global capital with local cultures; we are witnessing "the production of cultural difference within a structured system of global political economy" (Pred and Watts 1992:18). In what specific ways are these global processes mediated and constituted locally? What happens to local notions of development and modernity as new mechanisms of local-global interaction take shape?

The appearance of a "society of control" (Deleuze 1993*b*) and of cyberocracy, or "rule by way of information" (Ronfeldt 1991), calls for institutional ethnographies conducted from the perspective of the political economy of information. What are the major institutional sites within which and from which key informational categories and flows are created and circulated? What perspectives of the world do these categories represent, and how do they enact mechanisms of ruling that depend on certain groups' relation to the mode of production of information? These ethnographies would move from computer-mediated production of information to its reception and use, investigating at each level the cultural dynamics and politics that "information" sets in motion.

As is information, science and technology have become crucial to capitalism in that the creation of value today depends largely on scientific and technological developments. The concrete forms of the scientific appropriation of life and labor by capital exhibit novel features such as the ever-tighter imbrication of academy and industry in the biotechnological field (Rabinow 1992*b*). These new forces are bringing about a "biorevolution" in the Third World: "New technical forms . . . will significantly change the context within which technological change in the Third World is conceptualized and planned. We suggest that the cluster of emergent techniques generically called 'biotechnology' will be to the Green Revolution what the Green Revolution was to traditional plant varieties and practices" (Buttel, Kenney, and Kloppenburg 1985:32). Plant genetics, industrial tissue culture, and the use of genetically manipulated microorganisms represent unprecedented interventions in the context of Third World development. Corporations are already in the lead with regard to research and development. As the analysis of corporate behavior by these researchers shows, the prospects for the Third World are ominous, because corporations simply do not care about Third World interests.

In the case of regions with high biological diversity, the biophysical milieu (nature) is increasingly represented as a reservoir of value in itself to be exploited by biotechnology in the name of efficient and rational use. Local communities and social movements are enticed to participate in these schemes as "stewards" of natural and social capital. Communities (or their survivors) are finally acknowledged as rightful owners of "the environment" only to the extent that they agree to treat it (and themselves) as capital (O'Connor 1993). The whole issue of "intellectual property rights" linked to Third World natural resources—including the patenting by multinational corporations of seeds and plant varieties and substances derived from stocks used by Third World "traditional" societies—is emerging as one of the most disturbing aspects of the ecological phase of capital (Shiva 1993, Kloppenburg 1991). What are the implications of these developments for studies of material culture and biological anthropology? Anthropologists have maintained that the transformation of ecosystems by capital is mediated by the cultural practices of the specific societies in which such appropriation takes place (Godelier 1986). Today, genetic engineering, molecular biology, and the new sciences of natural products qualify the concept of "mediation" in such a way as to make established anthropological insights no longer sufficient.[26]

Finally, the restructuring of the macroeconomic and political relations between rich and poor countries in the wake of cyberculture must be considered. As some argue, high technology is resulting in a "new dependency" of technology-poor countries on the leaders in the innovation of computer, information, and biological technologies (Castells 1986, Castells and Laserna 1989, Smith 1993). Third World countries, according to these writers, must negotiate this dependency through aggressive technological modernization coupled with social reform. From an anthropological perspective, this suggestion is problematic; it amounts to the continuation of the post–World War II policies of "development" which have had for the most part deleterious effects on the economies and cultures of the Third World (Escobar 1994). Like development, technologies are not culturally neutral.

Are there different possibilities for Third World societies—other ways of participating in the technocultural conversations and processes that are reshaping the world? How can social movements in Asia, Africa, and Latin America articulate policies that allow them to participate in cybercultures without fully submitting to the rules of the game? Will most social groups in the Third World be in a position even to know about the possibilities afforded by the new technologies? An especially important question is whether Third World governments will be interested in constructing the technological

26. It is no coincidence that the World Bank, through its Global Environment Facility (GEF), is leading efforts for the conservation of biological diversity. In Latin America, Colombia, Brazil, and Mexico already have GEF projects for their tropical rain forests. Other GEF projects are in the making in the most biodiverse environments of the world (all of them in the Third World). The struggle between corporations, social movements, and states over the resources of these areas is intense; it is the basis for a multibillion-dollar industry. So is the struggle over the patenting of genes and life-forms.

"imaginaries" that will be required for access to the new technologies from the perspective of more autonomous design (Sutz 1993): "there will not be a genuine social transformation without transforming the relation between society and the technologies it incorporates" (p. 138). To start paying attention to Third World technological innovation is a first step towards gaining "technological self-esteem." A more general question is whether the new technologies can be conceptualized in ways that do not reduce them to their role in economic development, and another is what cybercultures mean from different Third World perspectives.

Of special importance in discussing these issues in the Third World is the role of women in the electronics industry worldwide. The development of cyberculture rests, in many ways, on the labor of young women in North American, Japanese, and European electronic enclaves in Southeast Asia, Central America, and other parts of the Third World (Ong 1987, Mies 1986). There is every reason to believe that electronics will continue to be favored in industrial schemes in the Third World under the aegis of multinational corporations, and there is also every reason to believe that young women will continue to be seen as the "ideal" labor force by these industries. The effects of this process on the dynamics of gender and culture are enormous, as the few studies of *maquiladoras* and sweatshops conducted to date have shown. Feminist anthropology and political economy have a great deal to contribute to this fundamental aspect of the construction of cyberculture.

Anthropologists can contribute to in-depth studies of the class, gender, and race aspects of the making of cyberculture and challenges to it, including analyses of technoscientific elites, on the one hand, and of the potential of individuals, groups, and social movements to articulate parallel or alternative technologies, ways of knowing, and social relations of science and technology (Darnovsky, Epstein, and Wilson 1991). Anthropological studies of cybercultures can help us to imagine contexts in which possibilities for relating to technoculture that do not exacerbate the power imbalances in society might emerge.

Rethinking Technology? Anthropology and Complexity

Technological innovations and dominant world views generally transform each other so as to legitimate and naturalize the technologies of the time. Nature and society come to be explained in ways that reinforce the technological imperatives of the day, making them appear the most rational and efficient form of social practice. In the modern age, this mutual reinforcement has resulted in the universalization of the European technoscientific imaginary. For some, the visualization of a post-technoscientific society would depend on the ability to set limits to this technological imperative; it should be a matter of studying closely the reach of technoscience, deciding which domains should be defended from it, and demarcating appropriate technical domains and styles of competence (Medina 1992). Whether or not this position is viable or even useful, new languages are needed that allow different groups of people (experts, social movements, citizens' groups) to reorient the dominant understanding of technology. Some of these languages are being crafted within science itself (ecology, feminist science, non-Western scientific traditions). One such new language which is rapidly achieving prestige is the language of complexity.

According to those devoted to this enterprise, developments in thermodynamics and mathematics during the past 20 years (the thermodynamics of irreversible phenomena and the theory of dynamical systems) forced scientists to recognize that the separation between the physicochemical and the biological worlds, between the "simple" and the "complex," and between "order" and "disorder" is neither as sharp nor as great as was once thought. The discovery that "inert" matter has properties that are remarkably close to those of life-forms led to the postulate that life is a property not of organic matter per se but of the organization of matter and hence to the concept of nonorganic life (de Landa 1992). In a similar vein, scientists began to pay attention to the fact that simple systems such as a simple chemical reaction and a mechanical pendulum can generate extremely complex behaviors, while extremely complex systems can give rise to simple and easily quantifiable phenomena.[27] The realization that events previously considered outside the purview of science because they could not be described by systems of linear equations were in fact central to the universe led this group of scientists to launch the theorization of complexity as the crucial scientific research program for the last decades of the 20th century and many decades to come.[28]

Much as the designers of the new technologies believe that they are changing the world, so the scientists working on the development of the science of complexity have no doubt that they are on the threshold of a great scientific revolution. Instead of emphasizing stability in nature and societies, they emphasize instabilities and fluctuations; in lieu of reversible linear processes, nonlinearity and irreversibility are placed at the heart of scientific inquiry. Similarly, "conservative systems" (physical systems considered in isolation from their surroundings) have given way to "self-organizing" systems, static equilibrium to dynamic equilibrium and nonequilibrium, order to chaos, fixed elements and quantities to patterns and possibilities, and prediction to explanation.

27. The examples most commonly given are the so-called chemical clock for the first type of system and solitons and tsunamis for the second.

28. Research on complexity has been spearheaded by the Santa Fe Institute, established mostly by physicists and economists in the mid-1980s. However, some of the basic ideas go back several decades to work done in systems science and systems philosophy in the 1950s and 1960s, ecology, biology, mathematics, and the early theories of self-organization (such as Prigogine and Stengers 1983). Most of these precursors are overlooked in the otherwise informative account of the history and work of the Santa Fe Institute by Waldrop (1992). An introduction to complexity for readers with some years of college science is found in Nicolis and Prigogine (1989). Useful introductions to chaos and self-organization are de Landa (1992), Hayles (1991), and Kauffman (1991).

The science of complexity has also replaced 19th-century physics with modern biology as a model; it studies physical phenomena as complex biological processes and employs kinds of analysis that are based on the concrete and the heterogeneous rather than on the abstract, the homogeneous, and the general. Whereas Cartesian epistemology and Newtonian science sought to model the order of things according to laws, the science of complexity—although still searching for a general law of pattern formation for all nonequilibrium systems in the universe—espouses a pluralistic view of the physical world, webs rather than structures, and connections and transgressions instead of neat boundaries isolating pristine systems.

The popularity achieved by fractals and chaos theory (a relatively small subset of complexity) in the mid-1980s helped immensely to put these developments on the map for the larger public. Chaos became the signifier for many things, few of which perhaps had to do with the actual scientific work going on. This popularity raises an important question recently taken up by a group of literary theorists: the extent to which science and culture intertwine in the production of popular imaginaries. Chaos theory, according to these theorists (Hayles 1991*a*, *b*), echoes and participates in cultural currents such as poststructuralist theory and postmodernism. The birth of chaos and complexity is not independent of the historical ferment which gave rise to "the postmodern condition": a world that was becoming at once more chaotic and more totalized, with small events having great effects on the economy and the social order and with the worldwide spread of information. "Chaos" must then be seen as a force that is negotiated at diverse sites within the culture, including science, poststructuralism, and postmodernism; it is part of the postmodern condition, whether reflected in literature, the human sciences, or the science of complexity.[29]

Be that as it may, the science of complexity has already developed an impressive vocabulary and theoretical corpus (Nicolis and Prigogine 1989:5–78). At the heart of complexity is the idea of self-organizing phenomena generated by complex systems under certain conditions.[30] The idea of self-organization is not restricted to complexity. Maturana, Varela, and coworkers (Maturana and Varela 1987, Varela, Thompson, and Rosch 1991) have made self-organization (the *autopoiesis* of the living) the cornerstone of their theoretical biology and epistemology. Foucault's (1972) conceptualization of discursive formations can likewise be seen as a theory of the self-organizing character of knowledge systems. Perhaps the most thorough view of the pervasive character of self-organizing processes is the work of Deleuze and Guattari (1987; Deleuze 1993*a*). Whether it is in the domains of inert matter (geology), the sciences, political economy, or the self, what these researchers find at work is "machinic" processes, stratifications and territorializations that develop into the structures we know.[31]

Technology has been essential to the appearance and consolidation of modern structures. Modern structures belong with the line, boundary-making, disciplinarity, unity, and hierarchical control. Fractals, chaos, complexity, nomadology would perhaps dictate a different dynamics and arrangement of life: fluidity, multiplicity, plurality, connectedness, segmentarity, heterogeneity, resilience; not "science" but knowledges of the concrete and the local, not laws but knowledge of the problems and the self-organizing dynamics of nonorganic, organic, and social phenomena. There is some awareness among scientists of complexity that they are reversing a centuries-old dualistic attitude of the West, the binary logic, the reductionist and utilitarian drive. Some have attempted a link with Eastern thought (Varela, Thompson, and Rosch 1991). These scientists (in contrast to the poststructuralist philosophers) still, however, place too much emphasis on order and general laws and have perhaps too quickly joined in the intellectual game of applying the ideas of complexity to social phenomena such as economies, social orders, evolution, and the rise and fall of civilizations. Their tendency to produce overencompassing theories that would link the physical, biological, social, and cultural worlds without making explicit the epistemological processes and assumptions involved in this endeavor is troubling (see Winner 1993*b*).[32]

Complexity, in other words, needs to be anthropologized, but at the same time it may offer insights to an-

29. Another attempt at relating complexity (particularly chaos) to the human sciences is Argyros's (1991) critique of deconstruction.

30. The concept of self-organization is intuitively simple and theoretically complex. An initial perturbation might lead certain systems into a type of nonequilibrium and chaotic behavior which is not, however, total disorder. In fact, recurrent patterns and self-organizing behavior may appear around certain states (attractors), turning part of the system's energy into an ordered behavior of a new type (a dissipative structure). This structure is characterized by the breaking down of previous symmetry and the appearance of multiple choices. In other words, self-organizing systems can develop different patterns out of the same initial conditions. Beyond a certain point, these systems can undergo bifurcations towards multiple states or solutions; a given solution is dictated by chance and cannot be predicted beforehand. Any subsequent evolution of the system, however, will depend on the choice made at a bifurcation point. Bifurcation points mark the system's passage towards complexity: they represent innovation and diversification, since they entail new solutions or pathways for change. Self-organizing systems thus have a historical dimension (an "ontogeny," in Maturana and Varela's terminology).

31. Deleuze and Guattari oppose the tree—the master trope of the modern world—to the rhizome. In contrast to the tree, the rhizome assumes diverse forms, branches in all directions, and forms bulbs and tubers. It has different principles of connection and heterogeneity; it is multiple, giving rise to its own structure but also breaking down that structure according to the "lines of flight" it contains. "We are tired of trees," they write. "We should stop believing in trees, roots, and radicles. They've made us suffer too much. All of arborescent culture is founded on them, from biology to linguistics" (1987:15).

32. See the Santa Fe Institute Studies in the Sciences of Complexity and, for an application of complexity theory to economics, Anderson, Arrow, and Pines (1988). Work in complexity continues at a rapid pace, including areas such as artificial life, adaptive computational models, autocatalysis, neural networks, cellular automata, emergence, and coevolution.

thropology. Anthropological questions have hardly been tackled within the science of complexity, with the exception of a reformulation in progress of the theory of evolution to account for the role of learning and self-organization (in addition to natural selection) and the articulation of a more complex concept of adaptation. In fact, the Santa Fe Institute sees a good part of its work as the understanding of complex adaptive systems. Although there is some interest in cultural complexity, the question has not been broached to any significant degree. Anthropologists, it can be argued, have generally been attuned to the complexity of life and have resisted reducing it to magical formulas and laws. Nevertheless, from the 19th century through Malinowski, Boas, Benedict, and Lévi-Strauss to Geertz, the tendency to reduce the manifold complexity of cultural reality to neat descriptions of institutions, patterns, structures, or exemplars has persisted. Only in recent years has this tendency been modified with the development of forms of analysis that emphasize partiality, finally abandoning any pretense at general laws or objective accounts.

Can the complexity enterprise—seemingly so different from conventional science, yet so clearly entrenched in scientific culture—help to reorient the prevailing understanding of technology? The perspective that complexity scientists are attempting to bring to the scientific community and the public is indeed powerful, and its influence is likely to grow. Its implications for the reorientation of technoscience have yet to be explored, and this is true of poststructuralist theory at this level as well. Is it possible to destabilize (destratify, deterritorialize) modern technosocial, politicoeconomic, and biosocial systems as Deleuze and Guattari (1987) propose? The widespread articulation and adoption of technological understandings and policies that might contribute to people's autonomous lives and self-organizing experiences are at best many years in the future. If we are to believe those working on new ways of understanding the universe and social life—whether in science or in the humanities—a social "nomadology" of technology may be possible. Perhaps the language of complexity signals that it is possible for technoscience(s) to contribute to the design of forms of living that avoid the most deadening mechanisms for structuring life and the world introduced by the project of modernity. It is not a question of bringing about a technosocial utopia—decentralized, self-managed, empowering—but one of thinking imaginatively whether technoscience cannot be partially reoriented to serve different cultural and political projects.

Anthropology without Primitives?

Anthropology, it continues to be said (e.g., Trouillot 1991), is still enframed within the order of the modern and the savage, the civilized self and the uncivilized other. If it is to "reenter the real world" and "work in the present" (Fox 1991), it will have to deal with the steady advance of cyberculture. Cyberculture, moreover, offers a chance for anthropology to renew itself without again reaching, as in the anthropology of this century, premature closure around the figures of the other and the same. These questions, and cyberculture generally, concern what anthropology is about: the story of life as it has been lived and is being lived at this very moment. What is happening to life in the late 20th century? What is coming in the next?

Comments

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Escobar's essay is a welcome addition to the rapidly growing field of anthropological/cultural/feminist/antiracist/anticolonialist/etc. studies of science and technology. In just a few short years, studies of science and technology within American anthropology have gone from a somewhat backwater status to something of a fad. At any moment, the predictable backlash/critique will probably appear, perhaps in this journal. So far, the field seems to be in the phase of programmatic statements and introductory edited volumes, both of which are probably helpful at this point because they serve to connect and position what is still not even, to use the STS phrase, a "cocitation cluster."

Escobar is in an especially good position to contribute to the process of mapping because of his expertise in global political economy and development politics. I find the sections of his essay on those topics the most exciting, and I look forward to reading his forthcoming book. He has also done a credible job of pointing anthropologists to some of the useful (although, as he and others have noted, simultaneously problematic) theoretical developments in the more general field of science and technology studies beyond anthropology. Those interested in exploring this area in more detail might want to consult, in addition to reviews already listed, those by Hakken (1993), Heath et al. (1993), Hess (n.d.), and Traweek (1993).

I wish to build on Escobar's paper by focusing on the question of labels, institutionalization, and boundaries/exclusions. As I understand it, the various versions of "cyborg anthropology" or the "anthropology of cyberspace" emerged in a historical context in which panels on science and technology were being rejected by AAA program committees. The renaming and repositioning of the field via the cyberpanels, together with legitimation from increasing numbers of senior people, helped change that situation. My understanding from discussions with the panel organizers is that the term "cyborg" was meant not only as an ironic oxymoron (an anthropology of the post- or technohuman) but also as a pointer toward affiliation with feminist, ethnic, and cultural studies perspectives on contemporary technoscience. In other words, the term was meant to broaden disciplinary

horizons rather than to exclude voices and limit fields of discourse. I think most participants in this rather spirited dialogue on the nature of cyborology would agree that a narrow focus on cutting-edge science and technology (especially when it is defined in disciplinary terms such as computers and biotechnologies) runs the risk of leaving out of the discussion other related areas of crucial importance: to name a few, the environment and the environmental justice movement, religion-science-medicine hybrids, appropriations and counterappropriations in the flows of cosmopolitan culture and local knowledge (including areas covered in the classical anthropological studies of ethno-knowledges and material culture), reconstructions and new uses of conventional technologies (especially in the development context, the so-called low-tech cyborgs), new managerial technologies in the workplace, and new reproductive technologies (perhaps included under biotechnologies). Furthermore, discourse on the new can easily eclipse much-needed studies on the very old social technologies of exclusion that continue to operate throughout the patriarchal, Eurocentric world of cyberspace and technoscience. As all of us know only too well, for many people in the world most of Cyberia is a distant Siberia located well above the global glass ceiling.

Largely out of a concern for questions of exclusion, I have tended to use more inclusive terms such as "the anthropology/cultural studies of science and technology," sometimes even "of knowledge and artifacts." I have also helped connect researchers by joining with others in subdisciplinary institution building, which in the arcane virtual kinship terminology of the new AAA now seems to be at a "General Anthropology Division committee" level rather than a bonafide subdisciplinary "section" level. For many of the people who have been involved in the effort, the development of a disciplinary site is a troubled but welcome forum for the exchange of ideas. Yet, although people may speak in terms of an "anthropology of X" or an "X anthropology" or work on subdisciplinary committees, they are not necessarily advocating a specific subdisciplinary program. Many of us are more interested in cross-disciplinary coalition building and theorizing, including working as/alongside technoscience activists. I am especially interested in the activist/engaged component in some of the recent projects, and I hope this direction will continue to receive prominence in any discussion of the field (e.g., Downey, Dumit, and Traweek n.d.). Escobar, as an engaged, Latin American intellectual with an interest in development and political economy issues, promises to play an important role in the ongoing dialogue.

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The major achievement of this article is the overview that the author has constructed of the kinds of anthropological analysis now being undertaken in the field of social studies of new technologies. Escobar appropriately points to the paramount importance of inquiry into the nature of modernity as the background for the current understanding and practice of technology. He identifies a set of important questions in the political economy of cyberculture, for example, the articulation of global capital with local cultures, local notions of development and modernity, new mechanisms of local and global interaction, and the restructuring of macroeconomic and political relations between rich and poor countries in the wake of cyberculture. In particular, he calls attention to the various possible ways in which Third World societies may participate in the technocultural process that is reshaping the world and asks whether social movements in Asia, Africa, and Latin America can develop strategies that will allow them to participate in cyberculture without submitting to the rules of the game imposed by the developing countries. In highlighting these questions, so rarely attended to in the field of social studies of science and technology, especially in Latin America, Escobar suggests that research be undertaken to answer them. From a broader perspective, Escobar remarks that technoscience is increasingly a point of articulation of power and knowledge and therefore new concepts are needed to make clear its historical and cultural specificity. His ideas on what might constitute an anthropology of cyberculture are suggestive and insightful.

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My comments in response to Escobar's elegantly encyclopedic article must be viewed as only a modest and homely complement. The article greatly expands my understanding of recent research and findings by anthropologists. Since I find myself in agreement with the major thrusts of the article, my remarks will reflect the small part that my own career development may represent in the direction of goals Escobar proposes.

Escobar notes that until recently few cultural and social anthropologists have interested themselves much in how technology shapes and is shaped by the societal and cultural context in which it develops and changes. I agree, surmising that the stronger interest in technology on the part of archaeologists is in part, at least, a reflex of the fact that the archaeological assemblage reveals much about technology but often much less about the societies and cultures carried by the persons making the material remains.

Looking backward, I regret now that I did not pursue more aggressively in print some of my own interests in technology, beginning three decades ago with my study in Page, Arizona, of dam builders at the Glen Canyon site. In a paper presented during the annual meeting of the American Anthropological Association (Sibley 1961) I described the ways in which the technologies involved

in building a major dam influenced the social relationships developed by the dam builders. The purposive manner in which dam workers built and maintained critical social relationships with key individuals spread over the broad geographical landscape for dam work was quite contrastive with the construction of social nets by, for example, urban workers with the same skills.

In the late 1970s I worked for more than a year in the Facilities Requirements Division of the U.S. Environmental Protection Agency (EPA) in Washington, D.C., as a "sewer anthropologist." The Division managed a $5 billion fund for assisting municipalities in rebuilding their sewer systems under the provisions of the Clean Water Act. In my work for the EPA (described in part in Sibley 1979) I was made aware of the reciprocal linkages between the development of sewer systems and conduits and the residential demography of human populations. I was also introduced to the political side of sewers—the political problems and processes entailed in putting such technological products in place and into use. Somewhat later, I presented a paper (Sibley 1982) on the retention in a Midwestern county of a "low-tech" system (septic tanks) to achieve social goals (exclusiveness, segregation, exclusion of industry and high-density housing). More "modern" conventional gravity sewers were being promoted both by developers and by public health officers concerned with threats to health resulting from a high rate of failure of septic systems already in place.

One other incident may exemplify the recency of cultural anthropologists' interest in technology—an interest which I believe is related to and a reflex of the legitimating of research within our domestic frontiers. The manifold barriers to research abroad have brought anthropologists now doing research at home closely in contact with their fellow humans in a society constantly confronted by potent and rapidly changing technologies—for example, the computer-based technologies which Escobar discusses at length. The legitimacy of domestic research as a route to the Ph.D. is really quite recent. In 1970 I guided and encouraged a Ph.D. candidate in his study of Alaskan carpenters' social adaptations to carpentry work in a physical environment which caused their work to be intermittent. Had I not been a senior faculty member in the department involved, I think it would have been difficult if not impossible for the student to pursue this dissertation research. Today, only two decades later, many students in the most prestigious graduate schools pursue domestic work.

Finally, I offer a comment on a complex set of issues touched upon gently by Escobar: should anthropological research about technology simply theorize and describe, or should it be prescriptive? Anthropologists complain from time to time that their findings are not listened to by decision makers. Is this not in part because they have failed to resolve for themselves the question of whether they remain "pure" and "scientific" or enter the policy arena, offering both their findings and the implications of those findings for public policy and social change? While there is danger in overselling one's wisdom, I believe that anthropologists should risk participating more fully in public and policy debates about technology and its potent role in organizing and shaping human life. Not all anthropologists need to involve themselves in public engagements and missionizing, but we should hold those who choose such a route in esteem equal to that which we have traditionally accorded to "pure researchers."

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I welcome this plea for an anthropologisation of complexity. It carries with it the acknowledgement that complexity need be neither denigrated nor praised. Both happen. Anthropologists are castigated for being complicated (when they should be simple), obscure (when they should be clear), and thus in a world of their own (when they should be in "the real world"). At the same time, anthropologists would often wish to be subtle (rather than crass), to have plural perspectives (rather than unitary ones), and to follow through interrelations between phenomena (rather than rely on stereotype). There is rhetoric attached to the concept of complexity that perhaps a "science" of it would clarify.

However, and this is Escobar's intriguing tale, a science of complexity already exists, and it is that he would see anthropologised. Certainly there is an aspect of such already formulated concerns that anthropologists would do well to play back. My own plea would be to reinforce the message that we not confuse complexity with scale or, if we wish to preserve the hybrid, that we observe the different workings of each.

There is nothing necessarily trivialising or aggrandising about being complicated/subtle. Yet we are accustomed to imagining the complex as itself one end of a scale. To think that one can move "from" the simple to the complex (as in developmental theories) or that one can reduce the complex "to" the simple (as in appeals for communicational clarity) belong to the same modernist rhetoric as imagining a historical move from status to contract in the organisation of relationships (anthropologists talk of simple and complex societies) or reducing society to the behaviour of individuals (where it is society itself that is complex and individuals seem less so). This is not of course to say that scale has no significance. As John Law has observed (personal communication), the interesting question is the point at which scale is made significant and thus works to sort phenomena/knowledge by their different implications. It is one of the important clarifying devices which Latour (1993) ascribes to a world that thinks itself modern.

But were we to locate complexity not in its effects (how the world appears) but in the instrument that produces that effect (human perception), then the anthropologist would comment that there is no social life that is not complex, as indeed might others (see Munro n.d.).

We would be dealing with a general organisational faculty for the production and disposal of detail. Indeed, to introduce my own clarification, I would prefer to deploy the concept of "complexity" for that property of perception which conserves the detail of phenomena regardless of scale. We see it in being able to see things close to hand and far away at the same time. We inscribe it in the effort it takes to write an ethnography, an effort that cannot be measured by whether the society under study is allegedly small-scale or large-scale.

From that point of view, the vocabulary that imagines the instability and pluralisms to which decriptive effort gives rise as "transgressions" belongs to an older purificatory impulse, as of course does the very dichotomising of two kinds of science ("sorting" science into new and old). I would rather pursue Escobar's other formula for analysis. Insofar as complexity is evident in the concrete and heterogeneous, then it is ubiquitous, as ordinary as it is extraordinary. We simply make it visible in those descriptions/interventions that point to "the concrete" and to "heterogeneity." Technology is one of the devices (making the world present for us) that Euro-Americans currently use. Technology makes explicit the nature of the lived world precisely in terms of the concrete (technology works) and the heterogeneous (it brings together different orders of knowledge, mixes of materials and personnel, and so forth [see Mol and Law n.d.]). Thus the new reproductive technologies make explicit a conceptualisation of kinship as founded in both nature and culture (see Franklin 1993). Escobar's paper raises the question of the cultural specificity of such devices.

Now that we see hybrids everywhere (Latour 1993:43), it was probably inevitable to see hybridisation as a higher-order fusing of technology and culture as such. My only concern about Escobar's otherwise fascinating conceptualisation of cyberculture, a concern he himself raises with regard to scientists of complexity, is that it is scaled-up. That is, the neologism is presented as an encompassing summary of concrete and heterogeneous events—a gathering together of everything that appears new. Hence his hortation: "Anthropologists must venture into this world." Of course, except that, as he also implies, they are already there. They do not have to buy into the anticipatory effect of imagining that a culture is about to be "created" by science and technology. That is a real-world fantasy (like the real world, culture is always elsewhere). Rather they might recognise in "technology" (an apparatus that at once makes the workings of things explicit and is identifiable by how it works) the same figure they are familiar with in (say) the "participant observer": simultaneously the register of the social life that he/she makes visible and an interventionist in it, for every participant observer must make social relations work. There is nothing "posthuman" about this complex figuration.

Escobar argues that the issue is "the realization that we increasingly live and make ourselves in technobiocultural environments structured by novel forms of science and technology." Absolutely. But the *realisation* can only come from existing organisational complexities, from the cyborgs persons everywhere already make out of their dealings with one another; social relations are hybrid phenomena. Indeed, of the many reasons for anthropology to engage with what Euro-Americans perceive as science and technology, one is to query the ethnocentric rhetoric that celebrates the joining of life (body) and technology (machine) as though humanity were thereby to be transcended.

This paper takes up an important critique, but to the democratising move of asking what effect cyberculture will have on "the Third World" I would add a further one: that we do not turn this into another from-simple-to-complex game. Social life, as Haraway (1988) might have said, only ever moves from the complex to the complex (from the concrete and heterogeneous to the concrete and heterogeneous). Cyberculture might make this newly evident; but by the same token, and for the sake of argument, it would follow that there was never any pre-cyberculture.

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Perhaps the most valuable contribution of Escobar's "Welcome to Cyberia" is its understanding of technology in general and new technology in particular as a cultural construction. This provides good grounds for a general anthropological approach to the evolution of technology and to the way in which society, through community power, popular concerns, and prevailing values, shapes the production of technology. This point of departure is particularly important with regard to underdeveloped countries. When it comes to new technologies the underdeveloped world imports almost everything—from devices to needs, from technical systems to systems of thought. Nevertheless, cultural invention plays a determinant role in the concrete way in which technology is perceived and used.

Many of the questions Escobar raises can be seen as crucial ones for a research program attempting to understand the relationship between society and particular social groups and the intellectual and practical devices that permanently alter their routines, their acquired wisdom, their hopes, and their sense of belonging to a community. It is not easy to foresee whether the answers to them will be universal or highly specific or whether they will at least clearly distinguish between development and underdevelopment. For some technologies, some features of the recipient society, and some questions, the answers for a highly industrialized country and an underdeveloped one will probably be remarkably similar. For others they will probably be very different.

For example, the discourses generated around/by computers are probably almost identical around the world while practices differ. Elites and bureaucracies—

private and public—everywhere deeply believe that computers are the very embodiment of rationality and truth. Their discourse of infallibility—ultimately winning the battle against chaos—is universal. But the practice of these same elites could not be more different. In developed situations, computers involved an advance from a fairly high level of manual complexity to an automated one. Entry into the information era was quite smooth, prefigured by social, economic, and technical evolution. In situations of underdevelopment, none of these types of evolution heralded the new informatics, and therefore practice carries a heavy burden reflected in the inefficiency and irrationality that persist alongside an impressive amount of computer technology. When Escobar asks about the implications of the political economy of cyberculture and the transformation of values associated with the emergence of information technologies for a cultural politics of science and technology, he is in fact asking us to explore with anthropological tools two types of situation. Perhaps after the questions have been answered for each a synthesis could be produced showing an underlying identity. Surely, however, wide differences would remain. From the particularly appealing perspective of the construction of a cultural politics of science and technology, one can guess what these differences might be.

When people are too proud, too self-confident, too close to blind faith in their own technological omnipotence, a cultural politics of science and technology must stress the assessment side, reject the motto "What can be done must be done," and raise consciousness about the need for social meaning and usefulness in the activities of science and technology. When people combine blind admiration for information technologies with a deep conviction that there is no room for any creative exercise of them, cultural politics must stress technological self-esteem, foster the capacity for innovation wherever it can be found, and encourage precisely the belief that "What can be done must be done" as opposed to "What has been done elsewhere must be bought here."

Escobar's challenge, primarily addressed to anthropologists, can be taken up by anyone involved in research, reflection, and action on science, technology, and society in this time of vertiginous change, blurring of the boundaries between nature and artifact, and shifts in the social actors capable of decisively influencing the "common wisdom." It is a work program, and if it is carried out the answers may suggest an alternative way of being welcomed to cyberculture.

Reply

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One of the features of "Welcome to Cyberia" is its emphasis on looking at new technologies in an integrated fashion. This is done at several levels: geographical (First World and Third World; regional variations and intensities), technological (information, computer, and biological technologies), and disciplinary (social and human sciences approaches, with anthropology somewhere in between). This approach has advantages (identifying connections, effects, and mechanisms that might otherwise remain invisible) and drawbacks (overgeneralization, lack of depth). Strathern is right, however, when she points out that my account of cyberculture is "scaled up," too encompassing, thus undermining the very principle of complexity it seems to invoke. The paper does not, however, try to make a statement about a "total truth"; it is an attempt to come to terms with new technologies from the perspective of the historical and geographical effects of present-day capitalism and modernity. It is impossible to neglect the universalizing force of modern knowledge and of the accumulation and circulation of capital. This force is reflected in technological arrangements as well as in the structuring of social labor. The challenge is to theorize such effects without overlooking the manifold forms they take and the endless variations in which they operate.

As one of a handful of participants in the collective effort to articulate an anthropology of science and technology, Hess is in an excellent position to contextualize any contribution to this enterprise. Since I have not participated in the meetings of this group during the past few years, I welcome his clarifying remarks on my brief account of them. These early efforts, he says, were meant to broaden disciplinary horizons rather than create new fields, and this is still the state of affairs today. He also warns us not to overlook the need for continued studies of well-known technologies, particularly in the Third World. I agree. I am less in agreement about the dangers he sees in focusing on cutting-edge technologies. On the one hand, a number of computer and biological technologies are already vastly dispersed; on the other, there is a cultural particularity about these technologies that is important to signal. As he insists, however, this focus should not be at the expense of anthropological studies of technologies of other kinds.

We also need, for instance, more thorough retrospective looks at anthropological studies of science and technology. This is one of Sibley's strong points. The example he gives of how sewer systems contribute to the shaping of population dynamics in cities raises a more general question: the relationship between technology and modernity. Rabinow (1989) has demonstrated how planning practices in French and North African cities shaped the social production of space, populations, and subjectivities, becoming instrumental in creating modernity as a cultural order. To what extent should the study of "practices of reason"—practices combining truth and power—be incorporated into the anthropology of science and technology? Does a physicist, for instance, constitute a more legitimate focus of science and technology studies than, say, the planner of a World Bank–sponsored development project? What view of science and technology would underlie such a belief? There

is a relation between the anthropology of modernity and the anthropology of science and technology that needs to be worked out.

One of the stronger preoccupations that emerges from the various comments is the differential treatment of science and technology in First World as opposed to Third World societies. Hess's notion of "low-tech" cyborgs is a way of giving form to this difference; people in the Third World also "make cyborgs" out of their dealings with one another, as Strathern reminds us. This, of course, takes place through multiple technologies, "high" and "low" (by which I do not mean more and less complex). The most general point in this regard is made by Sutz. Again, she is in an excellent position to speak on this issue as the coordinator of a Latin America–wide research project on technology. The historical context, she says, requires that we develop different ways of looking at technology in the Third World in accordance with the specificity of Latin American modernity. Latin American subjectivities and structures—from government and business groups to the popular classes—dictate different relations to technology. The conclusion is that critical studies of science and technology will have to develop different politics in First and Third World contexts. The dominance of modern technological imaginaries in the first case calls for critical studies and diagnoses; in the latter case, studies might reveal the technological creativity that is always associated with global technologies as a way of fostering more autonomous technocultures.

Strathern elaborates her comments around the questions raised in the last part of the paper—the scientific discourse on complexity. One of the features that I find most appealing in Strathern's work is her remarkable ability to expose the ground on which anthropologists stand. Every anthropological inquiry, as she puts it in *The Gender of the Gift,* should be accompanied by "an ethnography of Western knowledge practices" (1988:xi). This endeavor requires approaching creations such as the science of complexity "through an appreciation of the cultures of Western social science and its endorsement of certain interests in the description of social life" (p. 4). Her writings remind us with unusual cogency that our ethnographic and scientific efforts are constructions of the world. Hence her definition of complexity as "that property of perception which conserves the detail of phenomena regardless of scale. . . . We simply make it visible in those descriptions/interventions that point to 'the concrete' and to 'heterogeneity.'"

This is a needed corrective for both scientists of complexity (many of whom are still committed to realist epistemologies) and anthropologists who persist in a modernist understanding of complexity, with its anachronistic tales of simple and complex societies. It is this anthropological tradition that Strathern invites us to discard once and for all by rethinking the relationship between ethnography and complexity—a theme she apparently develops in her latest book, *Partial Connections* (1992), which I have not had the pleasure of reading. From this perspective, anthropology teaches us that there never was a precyberculture, that social life has always been complex and technology has been part of that complexity—which is not the same as saying that the new technologies are not fostering important cultural transformations. As scholarly constructions, the discourse on complexity and the anthropology of science and technology are attempting to catch up with the vibrant creativity of social and natural life. In perhaps unprecedented ways, the new technologies are facilitating this new look into life.

This latter possibility is adumbrated in the last writings of Guattari (1993), particularly in his notion of a postmedia society. Although he acknowledges that information, computer, and biological technologies still for the most part reinforce the alienating and retrograde systems of capitalist modernity, he sees them as also providing grounds for new creative, self-referential subjectivities. This, for Guattari, is a historical possibility that has to be fought for; to become real, it requires the actualization of rights to singularity and alterity, new types of North-South relations, and a radical democratization of gender relations. What he calls "ecosophical practices" include a profound transformation of economies, urban and rural ecologies, science, and ways of thinking—a question not of simple-minded self-management and autonomy but of a social complexity that undermines the hegemony of techno-capitalist valorization.

The development of this complexity can be advanced by deterritorializations that make possible bifurcations of existing and potential singularities and the formation of diverse collective subjectivities. Here may lie yet another way of being welcomed to cyberculture.

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Calendar

June 12–15. 9th Inuit Studies Conference, Iqaluit, N.T., Canada. Write: Inuit Studies Oranizing Committee, c/o Arctic College, P.O. Box 600, Iqaluit, N.T., Canada XoA oHo.

July 4–9. Threatened Peoples and Environments in the Americas: 48th International Congress of Americanists, Stockholm, Sweden. Write: Institute of Latin America Studies, S-106 91 Stockholm, Sweden.

July 11–16. 1st World Congress on African Languages and Linguistics, Johannesburg, South Africa. Write: R. K. Herbert, Department of African Languages, University of the Witwatersrand, Private Bag 3, 2050 Johannesburg, South Africa.

July 15–18. The Social and Cultural Origins of Language, a conference in association with the Language Origins Society, Berkeley, Calif., U.S.A. Write: Bruce Richman, conference coordinator, 2200 Oakdale Rd., Cleveland Heights, Ohio 44118, U.S.A.

September. Texts and Images of People, Politics, and Power: Representing the Bushman People of Southern Africa, Symposium and Exhibitions, Johannesburg, South Africa. Write: T. A. Dowson and J. D. Lewis-Williams, Rock Art Research Unit, Department of Archaeology, University of the Witwatersrand, Johannesburg 2050, South Africa.

October 3–7. 2d International Congress for the Study of Modified States of Consciousness, Lerida, Spain. Theme: Ethnocognition, Shamanism, Plants and Cultural Context. Write: Institut de Prospectiva Antropologica, Av. Gran Via de les Corts Catalanes, 457, 4rt., 08015 Barcelona, Spain.

November. The Pleistocene/Holocene Boundary and Human Occupations in South America, International Symposium, Mendoza, Argentina. Write: Marcelo Zárate, International Symposium The Pleistocene/Holocene Boundary, Centro de Geología de Costas y del Cuaternario, UNMP, Casilla de Correo 722-Correo Central, 7600 Mar del Plata, Argentina.

November 10–13. American Society for Ethnohistory, Annual Meeting, Tempe, Ariz., U.S.A. Write: Peter Iverson, Department of History, Arizona State University, Tempe, Ariz. 85287-2501, U.S.A.

November 17–19. Second United Nations Decade Conference on International Development, Children, and Women, Washington, D.C., U.S.A. Write: Mekki Mtewa, Association for the Advancement of Policy, Research, and Development in the Third World, P.O. Box 70257, Washington, D.C. 20024-0257, U.S.A.