From Essentialism to Constructivism: Philosophy of Technology at the Crossroads

by Andrew Feenberg

Introduction

What Heidegger called "The Question of Technology" has a peculiar status in the academy today. After World War II, the humanities and social sciences were swept by a wave of technological determinism. If technology was not praised for modernizing us, it was blamed for the crisis of our culture. Whether interpreted in optimistic or pessimistic terms, determinism appeared to offer a fundamental account of modernity as a unified phenomenon. This approach has now been largely abandoned for a view that admits the possibility of significant "difference," i.e. cultural variety in the reception and appropriation of modernity. Yet the breakdown of simplistic determinism has not led to quite the flowering of research in philosophy of technology one might hope for.

It is true that cultural studies and constructivist sociology and history have placed particular technologies on the agenda in new ways, but curiously, the basic questions of modernity posed by an earlier generation of theorists are rarely addressed in terms of the general problematic of technology. Where the old determinism over-estimated the independent impact of the artifactual on the social world, the new approaches have so disaggregated the question of technology as to deprive it of philosophical significance. It has become matter for specialized research (1). And for this very reason, most scholars in the humanities and social sciences now feel safe in ignoring technology altogether, except of course when they turn the key in the ignition. Meanwhile, those who continue the earlier interrogation of technology have hesitated to assimilate the advances of the new technology studies.

This is an unfortunate state of affairs. The currently fashionable multiculturalism cannot simply be taken for granted so long as the earlier tradition's expectation of convergence in a singular model of modernity is not persuasively refuted. According to that tradition technology will continue to affect more and more of social life, and less and less will remain free of its influence to constitute a cultural difference. Thus the demonstration, in the course of endlessly repeated case histories, that modern scientific-technical rationality is not the trans-cultural universal it was thought to be may advance the argument, but does not settle the question. The persistance of cultural particularity in this or that domain is not especially significant. Perhaps the Japanese and the Americans will disagree on the relative merits of sushi and hamburgers for generations to come, but if that is all that remains of cultural difference it has really ceased to matter.

The new picture emerging from social studies of science and technology gives us excellent reasons for believing that rationality is a dimension of social life more similar than different from other cultural phenomena. Nevertheless, it is implausible to dismiss it as merely a Western myth and to flatten all the distinctions which so obviously differentiate modern from premodern societies (2). There is something distinctive about modern societies captured in notions such as mod-

ernization, rationalization, and reification. Without such concepts, derived ultimately from Marx and Weber, we can make no sense of the historical process of the last few hundred years. Yet these are "totalizing" concepts that seem to lead back to a deterministic view we are supposed to have transcended from our new culturalist perspective. Is there no way out of this dilemma? Must we choose between universal rationality and cultural variety? Or more accurately, *can* we choose between these two dialectically correlated concepts that are each unthinkable without the other?

That is the underlying question I hope to address in this paper through a critique of the account of technical action in Heidegger, Habermas, and, as an instance of contemporary philosophy of technology, Albert Borgmann. Despite important differences I will discuss further on, for these thinkers modernity is characterized by a unique form of technical action and thought which threatens non-technical values as it extends itself ever deeper into social life. They propose substantive theories of technology in the sense that they attribute a more than instrumental, a substantive, content to technical mediation. According to these theories, technology is not neutral. The tools we use shape our way of life in modern societies where technique has become all pervasive. In this situation, means and ends cannot be separated. How we do things determines who and what we are. Technological development transforms what it is to be human.
Something like this view is implied in Max Weber's pessimistic conception of an "iron cage" of rationalization, although he did not specifically connect it to technology. Jacque Ellul, another major substantive theorist, makes that link explicit, arguing that the "technical phenomenon" has become the defining characteristic of all modern societies regardless of political ideology. "Technique," he asserts, "has become autonomous" (Ellul, 1964: 6). Or, in Marshall McLuhan's more dramatic phrase: technology has reduced us to the "sex organs of the machine world" (McLuhan, 1964: 46).

Recognition of the central importance of technical phenomena in the philosophies of Heidegger and Habermas promises a much more concrete social theory than anything possible in the past. However, neither fulfills the initial promise of their breakthrough. Both offer essentialist theories that fail to discriminate significantly different realizations of technical principles. As a result, technology rigidifies into destiny in their thought and the prospects for reform are narrowed to adjustments on the boundaries of the technical sphere. They hope that something—albeit a very different something—can be preserved from the homogenizing effects of the radical extension of technical systems, but they give us little reason to share their hope. In this talk I will attempt to preserve these thinkers' advance toward the critical integration of technical themes to philosophy without losing the conceptual space for imagining a radical reconstruction of modernity.

I could challenge substantivism's rather pessimistic view of modernity by simply denying that technical action has the broad significance attributed to it by Heidegger and Habermas, but I will not do so because on this point I believe they are right. I could also offer examples of culturally specific differences in the technical sphere, but these could easily be dismissed as trivial or as due to cultural lag or local circumstances. The problem is to show how such differences might be of fundamental significance and not merely minor accidents certain to be effaced or marginalized by the further course of progress. I will therefore argue that cultural difference can appear in the structure of modern technology itself, distinguishing peoples and social systems not only symbolically but also technically.

Let me begin now to present my argument with a brief reminder of Heidegger and Habermas's approach.

Technical Action in the Critique of Modernity

Heidegger

Heidegger claims that technology is relentlessly overtaking us (Heidegger, 1977a). We are engaged, he argues, in the transformation of the entire world, ourselves included, into "standing reserves," raw materials mobilized in technical processes. We have become little more than objects of technique, incorporated into the very mechanism we have created. The essence of this technology is the methodical planning of the future. Planning operates on a world tailored conceptually at the outset to the exercise of human power. The reordering of experience around a plan does inadmissible violence to human beings and nature. Universal instrumentalization destroys the integrity of all that is. An "objectless" heap of functions replaces a world of "things" treated with respect for their own sake as the gathering places of our manifold engagements with "being."

Translated out of Heidegger's own ontological language, he seems to be saying that technology constitutes a new type of cultural system that restructures the entire social world as an object of control. This system is characterized by an expansive dynamic which invades every pretechnological enclave and shapes the whole of social life. The instrumentalization of man and society is thus a destiny from which there is no escape other than retreat. The only hope is a vaguely evoked spiritual renewal that is too abstract to inform a new technical practice. As Heidegger explained in his last interview, "Only a god can save us" from the juggernaut of progress (Heidegger, 1977b).

This critique gains force from the actual perils with which modern technology threatens the world today. But my suspicions are aroused by Heidegger's tendentious contrast between the pious work of the Greek craftsman making a chalice and the destructive appropriation of the Rhine by a modern dam. The craftsman brings out the "truth" of his materials through the symbolically charged reworking of matter by form. The modern technologist obliterates the inner potential of his materials, "de-worlds" them, and "summons" nature to fit into his plan. Ultimately, it is not man, but pure instrumentality that holds sway in this "enframing" [*Ge-stell*]; it is no merely human purpose, but a specific way in which being hides and reveals itself *through* human purpose.

No doubt Heidegger is right to claim that modern technology is immensely more destructive than any other. And it is true that technical means are not neutral, that their substantive content affects society independent of the goals they serve. Thus his basic claim that we are caught in the grip of our own techniques is all too believable. Increasingly, we lose sight of what is sacrificed in the mobilization of human beings and resources for goals that remain ultimately obscure. If there is no sense of the scandalous cost of modernization, this is because the transition from tradition to modernity is judged to be a progress by a standard of efficiency intrinsic to modernity and alien to tradition. Heidegger's substantive theory of technology attempts to make us aware of this. The issue is not that machines are evil nor that they have taken over, but that in constantly choosing

to use them over every other alternative, we make many other unwitting choices. The overall effect of our involvement with technology cannot therefore be interpreted as a relation of means to ends.

So far so good. But there are significant ambiguities in Heidegger's approach. He warns us that the essence of technology is nothing technological, that is to say, technology cannot be understood through its functionality, but only through our specifically technological engagement with the world. But is that engagement merely an attitude or is it embedded in the actual design of modern technological devices? In the former case, we could achieve the free relation to technology which Heidegger demands without changing technology itself. But that is an idealistic solution in the bad sense, and one which a generation of environmental action would seem decisively to refute.
Heidegger's defenders point out that his critique of technology is not merely concerned with human attitudes but with the way being reveals itself. This means, roughly translated again out of Heidegger's language, that the modern world has a technological form in something like the way in which, for example, the medieval world had a religious form. Form in this sense is no mere question of attitude but takes on a material and institutional life of its own: power plants are the gothic cathedrals of our time. But this interpretation of Heidegger's thought raises the expectation that criteria for a reform of technology as a material and institutional reality might be found in his critique. For example, his analysis of the tendency of modern technology to accumulate and store up nature's powers suggests the superiority of another technology that would not challenge nature in Promethean fashion.

Unfortunately, Heidegger's argument is developed at such a high level of abstraction he literally cannot discriminate between electricity and atom bombs, agricultural techniques and the Holocaust. All are merely different expressions of the identical enframing, which we are called to transcend through the recovery of a deeper relation to being. And since he rejects technical regression while leaving no room for a modern alternative, it is difficult to see in what that relation would consist beyond a mere change of attitude. Surely these ambiguities indicate problems in his approach (3).

Habermas

It may appear strange to discuss Habermas and Heidegger in the same breath, and especially to compare their views on technology since Habermas has written practically nothing on the subject in his major works of the last 25 years. Yet I will argue that Habermas's whole project is rooted in a critique of the type of action characteristic of technology, which has provided him with a model for his later interpretation of the specific modes of "purposive-rational action" that do concern him focally. The evidence for this contention is primarily Habermas's early preoccupation with the positivist understanding of reason and its historical realization in a technocratic society. These arguments, developed especially in the essay "Technology and Science as Ideology," form the underlying structure of Habermas's theory despite the continual refinement and enrichment of his view of modern society over the years (Habermas, 1971). I believe there is enough similarity between this theoretical substructure and Heidegger's philosophy of technology to justify a comparison and contrast.

While Heidegger proposes a quasi-historical account of modern technology, Habermas offers a theory of the transhistorical essence of technical action in general. As Thomas McCarthy writes, "Habermas's own view is that while the specific historical forms of science and technology depend on institutional arrangements that are variable, their basic logical structures are grounded in the very nature of purposive-rational action" (McCarthy, 1981: 22). At first Habermas argued that "work" and "interaction" each have their own logic. Work is "success oriented;" it is a form of "purposive-rational action" aimed at controlling the world. On these terms, technological development is a "generic project" consisting in the substitution of mechanical devices for human limbs and faculties. By contrast, interaction involves communication between subjects in the pursuit of common understanding. The technocratic tendency of modern societies results from an imbalance between these two action-types.

In his later work, Habermas reformulated his approach in system-theoretic terms borrowed in part from Talcott Parsons. This "media theory" is designed to explain the emergence of differentiated "subsystems" based on rational forms of calculation and control such as business, law, and administration. The media concept is generalized from monetary exchange. Habermas claims that only power resembles money closely enough to qualify as a full fledged medium (Habermas, 1984, 1987: II, 274).

The media make it possible for modern individuals to coordinate their actions on a large scale while pursuing individual success in an instrumental attitude toward the world. Media steered interaction is an alternative to communicative understanding, to arriving at shared beliefs in the course of linguistic exchanges. Common understandings and shared values play a diminished role on a market because the market mechanism yields a mutually satisfactory result without discussion. Something similar goes on with the exercise of administrative power. Together, money and power "delinguistify" dimensions of social life by organizing interaction through objectifying behaviors.

This "media" theory supports a critique of welfare capitalism. Habermas distinguishes between *system*, media regulated rational institutions, such as markets and administration, and *lifeworld*, the sphere of everyday communicative interactions. The central pathology of modern societies is the colonization of lifeworld by system. This involves the over-extension of success oriented action beyond its legitimate range and the consequent imposition of criteria of efficiency on the communicative sphere. Habermas follows Luhmann in calling this the "technization of the lifeworld." But in fact technology drops from the discussion even though Habermas's analysis of system rationality continues to be shaped by the original contrast of work and interaction. Technology itself receives hardly a mention although it is obviously implicated somehow in the pathologies Habermas denounces.

The disappearance of technology as a theme is connected to a larger problem in the theory, the ambiguity of analytic and real distinctions between system and lifeworld. Habermas insists that the distinction between system and lifeworld is analytic. No institution is a pure exemplification of one or the other category. While the types of action coordination characteristic of each—media steered or communicative—are really distinct, they are always combined in various proportions in real situations. Thus the system is not itself an actual social institution, but merely refers to actual institutions, such as the market or the state, in which media steered interactions pre-

dominate. Similarly, the lifeworld is not an exclusively communicative institution, but describes those actual institutions, such as the family, in which communication predominates.

Although in principle Habermas avoids in this way a crude identification of system and lifeworld with actual institutions, in practice, the analytic distinctions tend to become indistinguishable from real ones. For instance, the state and the family end up exemplifying system and lifeworld despite Habermas's precautions. Perhaps this also explains why he does not consider technology to be a medium. Since there is no institutionally separate sphere, such as the market or the family, in which its influence is especially prominent, it seems to be ubiquitous. How then to identify it with an institutional base in which it would support a predominance of media-steered interaction? Habermas may have thought that technology's contribution to the problems of modern society could be adequately captured by analysis of its employment in the market and administrative structures through which the colonization process advances (4). However, the theoretical disadvantages of thus dissolving technology into economics and politics far outweigh the advantages.

More convincing is Habermas's critique of Weber, and by implication Heidegger as well, for identifying the rationalization process exclusively with the extension of technical control. He argues for the possibility of a communicative rationalization that would enhance human freedom, but which has been partially blocked in the course of modern development. While this seems right in a general way, in practice he is content to tinker with the boundaries of the system while minimizing the all too obvious valuative bias of what goes on within it. So long as the media remain limited to merely facilitating the complex interactions and institutional arrangements required by a modern society, they pose no problem. Indeed, to criticize technization in its proper place is anti-modern and regressive. The alternative he envisages is not reform of the media as such, but rather bounding them appropriately in order to give communicative rationality a chance to develop fully. As with Heidegger, the critique offers no concrete criteria for changing technology (5).

Essence and History

The comparison between Heidegger and Habermas reveals several interesting complementarities, but also a common problem. Both rely on the Weberian hypothesis that modern and premodern societies are distinguished by the degree of systematic differentation of domains such as technology and art that were united in earlier cultural forms. And both argue that this differentation has led to the reification of the object of technical action, its degradation to a lower plane of being than the subject which acts on it. Each emphasizes a different aspect of this process, Heidegger the object, Habermas the subject. As I will try to show, together, they provide the basis for a powerful theory of technology. Yet they each develop their contribution in an essentially unhistorical way which is no longer credible.

In Heidegger and Habermas, modernity is governed by a very abstract concept of the essence of technical action. I call this view "essentialist" because it interprets a historically specific phenomenon in terms of a transhistorical conceptual construction. Of course technical action systems and rationalities must have some core of common traits that enable us to distinguish them

from other relations to reality. But these thinkers want to get too much—a whole theory of history—out of the few abstract properties belonging to that core.

The weakness of this approach shows up most strikingly in problems with historical periodization. The construction of the distinction between the premodern and the modern in terms of the essential characteristics of technical action is unconvincing. The difficulty is inherent in the essentialist project: how to fix the historical flux in a singular essence? Two strategies are available: either deny all continuity and make of modern technology a unique phenomenon—Heidegger's solution, or distinguish earlier from later stages in the history of technical action in terms of the degree to which it has differentiated itself in its purity from other forms of action—Habermas's solution.

Heidegger represents modern technology as radically different from the one other model of technical action he recognizes, premodern craft. He emphasizes the reduction of the object of modern technology to a decontextualized, fungible matter cut off from its own history. This reduction is value charged, or more precisely in Heideggerian terms, it brings "value" into being by cancelling the intrinsic potentialities of the object, which craft respected, and delivering it over to alien ends. The process of differentiation in which modernity consists constitutes a sharp ontological break for Heidegger, a new dispensation, not a continuous social change. Modern technology is thus no merely contingent historical phenomenon but a stage in the history of being. Perhaps because of this ontologizing approach, Heidegger seems to allow no room for a future evolution of the basic form of modern technology which remains fixed in its eternal essence whatever happens next in history. Not technology itself but "technological thinking" will be transcended in a further stage in the history of being that we can only await passively. This essentializing tendency cancels the historical dimension of his theory.

For Habermas, on the contrary, modernity does not reveal being but human activity in a new and purer light. In premodern societies the various types of action are inextricably mixed together, with no clear distinction between technical, aesthetic, and ethical considerations. In modern societies, on the contrary, the truth of technical action, as objectivating and success oriented, is immediately accessible both practically and theoretically. Habermas explores this change from the side of the subject, arguing that the value implications of technical action appear where it interferes with human communication as, for example, in the substitution of mediated interaction for understanding in essential lifeworld domains such as the family or education. However, because Habermas continues to interpret technical action through the generic concept of instrumentality, he grants it a kind of neutrality in the limited sphere where its application is appropriate. Habermas's notion of history is less idiosyncratic than Heidegger's, but for him the culturally variable nature of technical design is not a question of rationality; he treats it as a minor sociological issue of the sort from which he routinely abstracts. His alternative thus offers an avowedly non-historical conception of technical rationality which effaces any *fundamental* difference between culturally distinct forms of technology. As a result the variability of technology, and with it technology itself, disappears as a theme from his work.

Heidegger and Habermas claim that there is a level at which technical action can be considered as a pure expression of a certain type of rationality. However, as such, it is merely an abstraction. Real technical action always has a socially and historically specific content. What, in fact, do

they actually mean by the enframing of being or the objectivating, success oriented relation to nature? Do these definitions have enough substance to serve the foundational purpose to which they are destined in these theories? Are they not rather mere classifications so empty of content as to tolerate a wide range of instances including some that embody quite different values from the ones these philosophers associate with the modern and the technical?

Unless, that is, one smuggles in a lot of social content. In the next section I shall attempt to show that this is how contemporary essentialist philosophy of technology actually proceeds.

A Contemporary Critique

Technology and Meaning

Both Heidegger and Habermas hold that the restructuring of social reality by technical action in modern times is inimical to a life rich in meaning. The Heideggerian relation to being, the Habermasian process of reaching understanding are incompatible with the overextension of technological thinking and system rationality. It seems, therefore, that identification of the structural features of enframing and the media can found a critique of modernity. I intend to test this approach through an evaluation of some key arguments in the work of Albert Borgmann, arguably the leading American representative of philosophy of technology in the essentialist vein (6).

Borgmann's social critique is based on a theory of the essence of technology. What Borgmann calls the "device paradigm" is the formative principle of a technological society which aims above all at efficiency. In conformity with this "paradigm," modern technology separates off the good or commodity it delivers from the contexts and means of delivery. Thus the heat of the modern furnace appears miraculously from discreet sources in contrast with the old wood stove that stands in the center of the room and is supplied by regular trips to the woodpile. The microwaved meal emerges effortlessly and instantly from its plastic wrapping at the command of the individual in contrast with the laborious operations of a traditional kitchen serving a family's needs.

The device paradigm offers obvious gains in efficiency, but at the cost of distancing us from reality. Let us consider the example of the substitution of "fast food" for the traditional family dinner. On the common sense or "engineering" view of technology, well prepared fast food appears to supply nourishment without needless social complications. Functionally considered, eating is a technical operation that may be carried out with more or less efficiency. It is a matter of ingesting calories, a means to an end, while all the ritualistic aspects of food consumption are secondary to this biological need. But what Borgmann calls "focal things" that draw people together in meaningful activities that have value for their own sake cannot survive this functionalizing attitude.

The unity of the family, ritually reaffirmed each evening, no longer has a comparable locus of expression today. One need not claim that the rise of fast food "causes" the decline of the traditional family to believe that there is a significant connection. Simplifying personal access to food scatters people who need no longer construct the rituals of everyday interaction around the necessities of daily living. Focal things require a certain effort, it is true, but without that effort, the

rewards of a meaningful life are lost in the vapid disengagement of the operator of a smoothly functioning machinery (Borgmann, 1984: 204ff).

Borgmann would willingly concede that many devices represent an advance over traditional ways of doing things, but the generalization of the device paradigm, its substitution for simpler ways in every context of daily life, has a deadening effect. Where means and ends, contexts and commodities are strictly separated, life is drained of meaning. Individual involvement with nature and other human beings is reduced to a bare minimum, and possession and control become the highest values.

Borgmann's critique of technological society usefully concretizes themes in Habermas and Heidegger. His dualism of technology and meaning is also characteristic of Habermas, with his distinction of work and interaction, and Heidegger, with his distinction of enframing and being. This dualism seems always to appear where the essence of technology is in question (7). It offers a way of theorizing the larger philosophical significance of the process of modernization. And, it reminds us of the existence of dimensions of human experience that are suppressed by a facile scientism and an uncritical celebration of technology.

However, Borgmann's approach suffers from both the ambiguity of Heidegger's original theory and the limitations of Habermas's. We cannot tell for sure if he is merely denouncing the modern attitude toward technology or technology as such, and in the latter case, his critique is so broad it offers no criteria for the constructive reform of technological design. He would probably agree with Habermas's critique of the colonization of the lifeworld, although he does improve on that account by discussing the all important role of technology in the social pathologies of modern society. What is lacking is a concrete sense of the intricate connections of technology and culture, beyond the few essential attributes on which his critique focusses. Since those attributes have largely negative consequences, we get no sense from the critique of the many ways in which the pursuit of meaning is intertwined with technology. And as a result, the critic imagines no significant restructuring of modern society around culturally distinctive technical alternatives that might preserve and enhance meaning.

But is this objection really persuasive? After all, neither Russian nor Chinese communism, neither Islamic fundamentalism nor so-called "Asian values" have been capable of producing a fundamentally distinctive stock of devices. Why *not* just reify the concept of technology and treat it as a singular essence? The problem with such an approach is that smaller but still significant differences do exist, and these may become more important in the future rather than less so as essentialist theory assumes. What is more, those differences often concern precisely the issues identified by Borgmann as central to a humane life. They determine the nature of community, education, medical care, work, our relation to the natural environment, the functions of devices such as computers and automobiles in ways either favorable or unfavorable to the preservation of meaning and focal things. Any theory of the essence of technology which forecloses the future therefore begs the question of difference in the technical sphere.

Interpreting the Computer

I would like to pursue this contention further with a specific example that illustrates concretely my reasons for objecting to this approach to technology. The example I have chosen, human communication by computer, is one on which Borgmann has commented fairly extensively. While not everyone who shares the essentialist view will agree with his very negative conclusions, I believe his position adequately represents that style of technology critique, and that, therefore, it is worth evaluating here at some length.

Borgmann introduces the term "hyperintelligence" to refer to such developments as electronic mail and the Internet (Borgmann, 1992: 102ff). Hyperintelligent communication offers unprecedented opportunities for people to interact across space and time, but, paradoxically, it also distances those it links. No longer are the individuals "commanding presences" for each other; they have become disposable experiences that can be turned on and off like water from a faucet. The person as a focal thing has become a commodity delivered by a device. This new way of relating has weakened connection and involvement while extending its range. What happens to the users of the new technology as they shift from face-to-face contact toward hyperintelligence?

" Plugged into the network of communications and computers, they seem to enjoy omniscience and omnipotence; severed from their network, they turn out to be insubstantial and disoriented. they no longer command the world as persons in their own right. Their conversation is without depth and wit; their attention is roving and vacuous; their sense of place is uncertain and fickle" (Borgmann, 1992: 108) (8).

There is a large element of truth in this critique. On the networks, the pragmatics of personal encounter are radically simplified, reduced to the protocols of technical connection. Correspondingly, the ease of passage from one social contact to another is greatly increased, again following the logic of the technical network that supports ever more rapid commutation. However, Borgmann's conclusions are too hastily drawn. A look, first, at the history of computer communication, and, second, at its innovative applications today refutes his overly negative evaluation.

In the first place, the computer was not destined by some inner techno-logic to serve as a communications medium. In fact, the major networks, such as the French Teletel or the Internet were originally conceived by technocrats and engineers as instruments for the distribution of data. So precious were the computing resources being put at the disposal of ordinary users that this seemed the appropriate use for them. The engineers imagined a virtual space of communication, paralleling the real world of everyday interaction, where only valuable information would circulate.

What actually happened in the course of the implantation of these networks? Users appropriated them very early for unintended purposes and converted them into communications media. Soon they were flooded with messages that were considered trivial or offensive by those who created the networks. Teletel quickly became the world's first and largest electronic singles bar (Feenberg, 1995a: chap. 7). The Internet is overloaded with political debates dismissed as "trash" by unsympathetic critics.

Here we have a dramatic case of what Pinch and Bijker have called the "interpretive flexibility" of technology (Pinch and Bijker, 1989: 40-41). A concatenation of devices configured by its designers as the solution to one problem—the distribution of information—was perceived by an-

other group of actors, its users, as the solution to quite another problem—human communication. The new interpretation of the technology was soon incorporated into its structure through design changes and, ultimately, through a change in the very definition of the technology. Today, it would not occur to someone describing the principal functionalities of the computer to omit its role as a communications medium although this particular application was regarded as quite marginal by most experts only a decade ago.

How does Borgmann's critique fare in the light of this history? It seems to me there is an element of ingratitude in it. Because Borgmann takes it for granted that the computer is useful for human communication, he neither appreciates the process of making it so, nor the hermeneutic transformation the computer underwent in that process. He therefore also overlooks the political implications of the history sketched above. The networks constitute a fundamental scene of human activity in the world today. To impose a narrow regimen of data transmission, to the exclusion of all human contact, would surely be perceived as totalitarian in any ordinary institution. Why is it not a liberation to break such limitations in the virtual world that now surrounds us?

In the second place, Borgmann's critique ignores the variety of communicative interactions mediated by the networks. No doubt he is right to argue that human experience is not enriched by much of what goes on there. But a full record of the face-to-face interactions occurring in the hallrooms of his university would likely be no more uplifting. The problem here is that we tend to judge the face-to-face at its memorable best and the computer mediated equivalent at its transcribed worst.

Borgmann ignores more interesting uses of computers, such as the original research applications of the Internet, and teaching applications, which show great promise (Harasim, et. al., 1995). It might surprise Borgmann to find the art of reflective letter writing reviving in this context. I would like to conclude this brief review of significant applications with a discussion of the emerging culture of on-line medical support groups. Consider for example the ALS (Lou Gehrig's Disease) discussion group on the Prodigy Medical Support Bulletin Board. In 1995, when I studied it, there were about 500 patients and caregivers reading exchanges in which some dozens of participants were actively engaged (Feenberg, et. al., 1996).

Much of the conversation consisted in exchanges of feelings about dependency, illness, and dying. There was a long running discussion of problems of sexuality. Patients and caregivers wrote in both general and personal terms about the persistence of desire and the obstacles to satisfaction. The frankness of this discussion may owe something to the fact that it was carried on in writing between people whose only connection was the computer. Here is a case where the very limitations of the medium open doors that might have remained closed in a face-to-face setting.

The larger implications of these online patient meetings have to do with their potential for changing the accessibility, the scale, and the speed of interaction of patient groups. Selfhelp groups, after all, are small and localized. With the exception of AIDS patients they have wielded little political power. If AIDS patients have been the exception, it is not because of the originality of their demands: patients with incurable illnesses have been complaining bitterly for years about the indifference of physicians and the obstacles to experimental treatments. What made the difference was that AIDS patients were "Networked" politically by the gay rights movement even before they were caught up in a network of contagion. Online networks may have a similar im-

pact on other patient groups. In fact, Prodigy discussion participants established a list of priorities they presented to the Amyotrophic Lateral Sclerosis Society of America. Computer networking may thus feed into the rising demand by patients for more control over their own medical care.

It is difficult to see any connection between these applications of the computer and Borgmann's critique of "hyperintelligence." Is this technologically mediated process by which dying people come together despite paralyzing illness to discuss and mitigate their plight a mere instance of "technological thinking?" Certainly not. But then how would Heidegger incorporate an understanding of it into his theory, with its tone of reproach toward modern technology? Because of his emphasis on communication, Habermas might have more to say about this example, however, I have argued elsewhere that he would have to include technology in a revised media theory for such purposes (Feenberg, 1996).

Instrumentalization Theory

The Irony of Parmenides

Heidegger, Habermas, and Borgmann have undoubtedly put their fingers on significant aspects of the technical phenomenon, but have they identified its "essence?" They seem to believe that technical action has a kind of unity that defies the complexity and diversity, the profound socio-cultural embeddedness, that twenty years of increasingly critical history and sociology of technology have discovered in its various forms. Yet to dissolve it into the variety of its manifestations, as constructivists sometimes demand, would effectively block philosophical reflection on modernity. The problem is to find a way of incorporating these latter advances into a conception of technology's essence, rather than dismissing them, as philosophers tend to do, as merely contingent social "influences" on a reified technology "in itself" conceived apart from society (9). The solution to this problem I propose is a radical redefinition of technology that crosses the usual line between artifacts and social relations assumed by common sense and philosophers alike.

The chief obstacle to this solution is the unhistorical understanding of essence to which most philosophers are committed. I propose, therefore, a kind of compromise between the philosophical and the social scientific perspective. In what follows, I will attempt to construct a concept of the essence of technology that provides a *systematic* locus for the socio-cultural variables that actually diversify its historical realizations. On these terms, the "essence" of technology is not simply those few distinguishing features shared by all types of technical practice that are identified in Heidegger, Habermas, and Borgmann. Those constant determinations are not an essence prior to history, but are merely abstractions from the various historically concrete stages of a process of development (10).

In the remainder of this paper, I will attempt to work out this alternative concept of essence as it applies to technology. Is the result still sufficiently "philosophical" to qualify as philosophy? In claiming that it is, I realize that I am challenging a certain prejudice against the concrete that is an occupational hazard of philosophy. Plato is usually blamed for this prejudice, but in a late dia-

logue Parmenides mocks the young Socrates' reluctance to admit that there are ideal forms of "hair or mud or dirt or any other trivial and undignified objects" (Cornford, 1957: 130C-E) (11). Surely the time has come to let the social dimension of technology into the charmed circle of philosophical reflection. Let me now offer, if only schematically, a way of achieving this.

Primary Instrumentalization(12)

Substantivist philosophies of technology drew attention away from the practical question of what technology does to the hermeneutic question of what it means. This question of meaning has become defining for philosophy of technology as a distinct branch of humanistic reflection. More recently, constructivism has sharpened reflection on a third range of questions concerning who makes technology, why and how. My strategy here will consist in incorporating answers to the substantivist and constructivist questions into a single framework with two levels. The first of these levels corresponds more or less to the philosophical definition of the essence of technology, the second to the concerns of social sciences. However, merging them in a single framework transforms both, as we will see in the next sections.

On this account, the job of describing the essence of technology has not one but two aspects, an aspect which explains the *constitution* of technical objects and subjects, which I call the "primary instrumentalization," and another aspect, the "secondary instrumentalization," focussed on the *realization* of the constituted objects and subjects in actual technical networks. Heidegger and Habermas offer insight only into the primary instrumentalization of the technical by which a function is separated from the continuum of everyday life. Primary instrumentalization characterizes technical relations in every society, although its emphasis, range of application and significance varies greatly. Technique includes those constant features in historically evolving combinations with a secondary instrumentalization that includes many social aspects of technology. The most characteristic distinctions between different eras in the history of technology result from different structurings of these various dimensions.

As we have seen, the problem of periodization is central to the essentialist conception. Heidegger's ontological account of the distinction between premodern and modern technology is no more plausible than Habermas's epistemological one. This new approach offers a solution to the difficulties. In contrast with Heidegger, I will distinguish premodern from modern historically, rather than ontologically. I will break with Habermas as well in arguing that the differentiation of modern technology from other world orientations is relatively superficial and does not reveal the truth of the technical.

The primary instrumentalization can be summarized as four reifying moments of technical practice. The first two correspond roughly with important aspects of Heidegger's notion of enframing, and the latter two describe the form of action implied in Habermas's notion of the media.
1. *Decontextualization*

To reconstitute natural objects as technical objects, they must be "de-worlded," artificially separated from the context in which they are originally found so as to be integrated to a technical system. Once isolated they can be analyzed in terms of the utility of their various parts, and the technical schemas these contain can then be released for general application. For example, inven-

tions such as the knife or the wheel take qualities such as the sharpness or roundness of some natural thing, such as a rock or tree trunk, and releases them as technical properties from the role they play in nature. Technology is constructed from such fragments of nature that, after being abstracted from all specific contexts, appear in a technically useful form.

2. *Reductionism*

Reductionism refers to the process in which the de-worlded things are simplified, stripped of technically useless qualities, and reduced to those aspects through which they can be enrolled in a technical network. I will call these latter "primary qualities," primary that is from the standpoint of the technical subject for whom they are a power base. These are the dimensions of the object which can be reorganized around an alien commanding interest, while "secondary qualities" are vestiges of untransformable stuff tying the object to its pretechnical history and its potential for self-development. The tree trunk, reduced to its primary quality of roundness in becoming a wheel, loses its secondary qualities as a habitat, a source of shade, and a living, growing member of its species. To the extent that all of reality comes under the sign of technique, the real is progressively reduced to such primary qualities.

3. *Autonomization*

The subject of technical action isolates itself as much as possible from the effects of its action on its objects. This suggest a metaphoric application to society of Newton's third law: "for every action there is an equal and opposite reaction." In mechanics, actor and object belong to the same system and so every effect is simultaneously a cause, every object simultaneously a subject. This is not a bad description of ordinary human relations. A friendly remarks is likely to elicit a friendly reply, a rude one, a correspondingly unpleasant response. But technical action autonomizes the subject through dissipating or deferring feedback from the object of action to the actor. The subject is largely unaffected by the object on which it acts, thus forming an apparent exception to Newton's law. The hunter experiences a slight pressure on his shoulder as the rabbit dies; the driver hears a faint rustling in the wind as he hurtles a ton of steel down the highway. Administrative action too, as a technical relationship between human beings, presupposes the autonomization of the subject.

4. *Positioning*

Francis Bacon wrote that "Nature to be commanded must be obeyed." The technical subject does not modify the basic "law" of its objects, but rather uses that law to advantage. The law of gravity is present in the clock's pendulum, the properties of electricity in the design of the circuit, and so on. In dealing with complex systems, such as markets, that cannot be reduced to artifacts, Baconian obedience means adopting a strategic position with respect to the object. Location, as they say in real estate, is everything: fortunes are made by being in the right place at the right time. The management of labor and the control of the consumer through product design have a similar structure. One cannot "operate" workers or consumers as one would a machine, but one can position oneself strategically with respect to them so as to influence them to fulfill pre-existing programs they would not otherwise have chosen. In a sense all technical action is navigation, falling in with the object's own tendencies to extract a desired outcome. By positioning itself strategically with respect to its objects, the technical subject turns their inherent properties to account.

Secondary Instrumentalization

The primary instrumentalization does not exhaust the meaning of technique but merely lays out in skeletal fashion the basic technical relations. Far more is necessary for those relations to yield an actual system or device: technique must be *integrated* with the natural, technical, and social environments that support its functioning. The process of integration compensates for some of the reifying effects of the primary instrumentalization. Here technical action turns back on itself and its actors as it is realized concretely. In the process, it reappropriates some of the dimensions of contextual relatedness and self-development from which abstraction was originally made in establishing the technical relation. The underdetermined character of technological development leaves room for social interests and values to intervene in the process of realization. As decontextualized elements are combined, these interests and values assign functions, orient choices and insure congruence between technology and society at the technical level itself.

On the basis of this concept of integration, I argue that technique is fundamentally social. Its "essence" must include a secondary instrumentalization that works with dimensions of reality from which abstraction is made at the primary level. This level of technique includes the following four moments:

1. *Systematization*

To function as an actual device, isolated, decontextualized technical objects must be combined with other technical objects and re-embedded in the natural environment. Systematization is the process of making these combinations and connections. Thus such individual technical objects as wheels, a handle, a container, must be brought together to form a device such as a wheelbarrow. Add paint to protect the wheelbarrow from rust and the device has been embedded in its natural environment as well (13). The process of technical systematization is central to designing the tightly coupled networks of modern technological societies but plays a lesser role in traditional societies where technologies may be more loosely related to each other but correspondingly better adapted to the natural environment.

2. *Mediation*

In all societies, ethical and aesthetic mediations supply the simplified technical object with new secondary qualities that seamlessly reinsert it into its new social context. The ornamentation of artifacts and their investment with ethical meaning is integral to production in all traditional cultures. The choice of a type of stone or feather in the making of an arrow may be motivated not only by sharpness and size, but also by various ritual considerations that yield an aesthetically and ethically formed object. Only modern industrial societies distinguish production from aesthetics through indifference to the social insertion of their objects and the substitution of packaging for aesthetic elaboration. From this results the artificial separation of technique and aesthetics characteristic of our societies, artificial, I would argue, because no one denies that the prevailing ugliness of so much of our work and urban environment is bad for the people who must live with it. Ethical limits too are overthrown in the breakdown of religious and craft traditions, although medical technology and environmental crisis have inspired new interest in the moral limitation of technical power. These limitations are eventually embodied in modified designs which condense

considerations of efficiency with ethical values. A similar condensation appears in aesthetic functionalism. Thus mediations remain an essential aspect of the technical process even in modern societies.

3. *Vocation*

The autonomization of the technical subject is overcome in the recognition of the human significance of vocation, the acquisition of craft. In vocation, the subject is no longer isolated from objects, but is transformed by its own technical relation to them. This relation exceeds passive contemplation or external manipulation and involves the worker as bodily subject and member of a community in the life of its objects. The individual of our earlier example, who fires a rifle at a rabbit, will become a hunter with the corresponding attitudes and dispositions should he pursue such activities professionally. "Vocation" is the best term we have for this reverse impact on users of their involvement with the tools of their trade. The idea of vocation or "way" is an essential dimension of even the most humble technical practices in some traditional cultures, such as the Japanese (at least until recently), but tends to be artificially reserved for professions such as medicine in most industrial societies. Perhaps this is an effect of wage labor, which substitutes temporary employment under administrative control for the lifelong craft of the independent producer, thereby reducing both the impact of any particular skill on the worker and the individual responsibility for quality implied in vocation.

4. *Initiative*

Finally, to positioning as the basis of strategic control of the worker and consumer there correspond various forms of initiative on the part of the individuals submitted to technical control, for example, the praxis of voluntary cooperation in the coordination of effort and user appropriation of devices and systems for unintended purposes. In precapitalist societies, cooperation was often regulated by tradition or paternal authority, and the uses of the few available devices so loosely prescribed that the line between producer programs and user appropriations was often blurred. Collegiality is an alternative to bureaucratic control in modern societies with widespread if imperfect applications in the organization of professionals such as teachers and doctors. Reformed and generalized, it has the potential for reducing alienation through substituting self-organization for control from above. In the sphere of consumption, we have numerous examples, such as the computer, where informal appropriations by users result in significant design changes. As we have seen, this is how human communication became a standard functionality of a technology that was originally conceived by computer professionals as a device for calculating and storing data.

Secondary instrumentalizations support the reintegration of object with context, primary with secondary qualities, subject with object, and leadership with group through a *reflexive metatechnical practice* that treats technical objects and the technical relation itself as raw material for more complex forms of technical action. There is of course something paradoxical about this association of reflexivity with technology; in the framework Heidegger and Habermas share technical rationality is supposed to be blind to itself. Reflection is reserved for another type of thought competent to deal with such important matters as aesthetics and ethics. We have here the familiar thesis of the split between nature and *Geist*, and their corresponding sciences. What is the origin of this split?

Capitalism and Substantive Theory of Technology

Substantivism identifies technique in general with the specific technologies that have developed in the last century in the West. These are technologies of conquest that pretend to an unprecedented autonomy. The exemplary modern "maestro" of technology is the entrepreneur, single-mindedly focussed on production and profit. The enterprise is a radically decontextualized platform for action, without the traditional responsibilities for persons and places that went with technical power in the past. Ultimately, it is the autonomy of the enterprise that makes it possible to distinguish so sharply between intended and unintended consequences and to ignore the latter. Capitalism is thereby freed to extend technical control to the labor force, the organization of work, and aspects of the natural environment that were formerly protected from interference by custom and tradition (14). To define technology on these terms is ethnocentric.

What does a broader historical picture of technology show? Contrary to Heideggerian substantivism, there is nothing unprecedented about our technology. Its chief features, such as the reduction of objects to raw materials, the use of precise measurement and plans, the management of some human beings by others, large scales of operation, are commonplace throughout history. It is the exorbitant role of these features that is new, and of course the consequences of that are truly without precedent.

Those consequences include obstacles to secondary instrumentalization wherever integrative technical change would threaten the maximum exploitation of human and natural resources. These obstacles are not merely ideological but are incorporated into technological designs. Only a critique of those designs is adequate to the problems, and only such a critique can uncover technology's hopeful potential. The privileged dimensions of modern technology must therefore be viewed in a larger context which includes many currently marginalized practices that were of great importance in former times and may someday return to center stage. For example, until the generalization of Taylorism, the technical experience was essentially about the choice of a vocation. Technology was associated with a way of life, with specific forms of personal development and virtues. It was the success of capitalist deskilling that finally made workers objects of technique like raw materials or machines. Here, not in some mysterious dispensation of being, lies the source of the "total mobilization" of modern times.

Similarly, modern management has replaced the traditional collegiality of the guilds with new forms of control. Just as vocational investment in work continues in certain exceptional settings, so collegiality survives in a few professional or cooperative workplaces. Numerous historical studies show that these more democratic forms are not so much incompatible with the "esssence" of technology as with capitalist economics. Given a different social context and a different path of technical development, it should be possible to recover these traditional technical values and organizational forms in new ways in a future evolution of modern technological society. Thus reform of this society would involve not merely limiting the reach of the technical, but building on its intrinsic potential for democratic administration.

Because its hegemony rests on extending technical control beyond traditional boundaries to embrace the labor force, capitalism tends to identify technique as a whole with the instrumentalizations through which that control is secured. Meanwhile, other aspects of technique are forgotten

or treated as non-technical. It is this capitalist technical rationality that is reflected in the narrow essentialism of Heidegger, Habermas, and Borgmann. Because their characterization of technology is confined to the privileged instrumentalizations of capitalist modernity, they are unable to develop a socially and historically concrete conception of its development and potential. They take their own labor of abstraction, by which they eliminate the sociohistorical dimensions of technical action, for evidence of the nonsocial nature of technology.

In the next section I will explore in more detail the constitution of that abstraction, and offer a very different way of understanding the social nature of technology.

Hermeneutic Constructivism

Technological Fetishism

The error of essentialism is not arbitrary but is a consequence of the very sociohistorical dimensions of technical action it denies. I will argue here that this error reflects the reified form of objectivity of technology in modern societies. By "form of objectivity" I mean a socially necessary illusion with real consequences. Such illusions become an aspect of social reality insofar as we constantly act on them (15). The concept is roughly comparable to the notion of a culturally determined frame of reference so long as the culture is understood not merely as a way of seeing but also as a way of doing, a system of practices.

Marx offered the original analysis of this phenomenon. In Marx's usage, the fetishism of commodities is not the love of consumption but the practical belief in the reality of the prices attached to goods on the market. As he points out, price is not in fact a "real" (physical) attribute of goods but the crystallization of a relation between manufacturers and consumers; yet the movement of goods from seller to buyer is determined by price just as though it were real. What is masked in the fetishistic perception of technology is, similarly, its relational character: it appears as a nonsocial instanciation of pure technical rationality rather than as the social nexus that it is. It is this form and not the reality of technology which essentialism theorizes.

Hence the ambiguity of the Heideggerian critique of technology, which cannot decide whether what is needed is a change in attitude or in technological design. The problem is located somehow in between these determinations, in the form of objectivity in which technology reveals itself. This is also the ambiguity of Borgmann's device paradigm, which hovers uncertainly between a description of how we encounter technology and how it is made.

A critique of technology developed from this standpoint pursues the larger connections and social implications masked by the "paradigm." To this extent it is genuinely dereifying. But insofar as it fails to incorporate these hidden social dimensions into the concept of technology itself, it remains still partially caught in the very way of thinking it criticizes. Technology, i.e. the real world objects so designated, both is and is not the problem, depending on whether the emphasis is on its fetish form as pure device or our subjective acceptance of that form. In neither case can we change technology "in itself." At best, we can hope to overcome our attitude toward it through a spiritual movement of some sort.

I have proposed a very different conceptualization that includes the underdetermined integration of technologies to larger technical systems and nature, and to the symbolic orders of ethics and aesthetics, as well as their relation to the life and learning processes of workers and users, and the social organization of work and use. On the essentialist account, one could still admit the existence of these aspects of technical life, but they would be extrinsic social influences. Essentialism proposes to treat all these dimensions of technology as merely contingent, external to technology "in itself," and to hand them over to sociology while retaining the unchanging essence for philosophy.

What explains the persistance of the reified concept of technology even in a critical context? As I have argued above, the answer to this question lies in the social structure of a technologically developed capitalist society. That structure shapes both practical and theoretical relations to technology.

In everyday practical affairs, technology presents itself to us first and foremost through its function. We encounter it as *essentially* oriented toward a use. Of course we are aware of devices as physical objects possessing many qualities that have nothing to do with function, for example, beauty or ugliness, but we tend to see these as inessential. What distinguishes technology from other types of objects is the fact that it appears always already split into what I have called primary and secondary qualities. We do not have to make that split as we would in the case of a natural object since it belongs to the very form of the technical device.

Thus an initial abstraction is built into our immediate perception of technologies. That abstraction, it seems obvious to us, sets us on the path toward an understanding of the nature of technology. However, it is important to note that this is an assumption, based on the form of objectivity of technology in our society. The function of technical artifacts is not necessarily privileged in this way in other types of society. The functional point of view may coexist peacefully with other points of view—religious, aesthetic, etc.—none of which are essentialized. To the Western observer this eclecticism may appear as mere confusion but it has its rationale, as we will see. And indeed, even Westerners are capable of fall-ing into the same confusion with respect to certain richly signified technical artifacts, such as houses, which we must strain to perceive as mere "machines for living," in Le Corbusier's phrase.

In any case, when we moderns consider technologies theoretically we find that they possess "structures" corresponding to the everyday practical evidence of function. Technology is social only insofar as it is used "for" something, leaving the structure of technology "in itself" as a non-social residue. That residue can either be approached technically, for example, by engineers concerned only with the inner workings of a device, or philosophically in terms of the essential nature of technology as such. But once social aspects of technology have been stripped away, what remains are the primary instrumentalizations: technology, in essence, decontextualizes and manipulates its objects. And that, no amount of change at the social level can alter.

Technical structures consist in the systems of "parts" that enable technologies to perform their functions. Insofar as structures have an internal causal logic, they can be abstracted from their social surround as an instance of scientific or empirical principles. All systematic knowledge of technology rests on this type of abstraction. Professional technical disciplines arise to explain and perfect the stuctures of technologies. As the prestige of these disciplines spreads, their ap-

proach to technology becomes the model for common sense and philosophy alike. Eventually, it seems obvious that technology *is* its structure. Function is a kind of hinge between that logico-causal reality and the subjective intentions of users, hence also between artifact and society.

Theory and Reality: The Limits of Differentiation

Now, there is no point in denying the existence of structure. It is real enough. The question is, what kind of reality does it possess? Is its rational coherence sufficient warrant for positing it as an independent object? Or is it merely an aspect, an artificial if useful cross-section, of a more complex object that includes many other dimensions? This is the ontological question implicit in the critique of essentialism. This ontological question is linked to a sociological one. In the Weberian tradition, modernity is characterized by the differentiation of social spheres. The splitting off of technical rationality from other dimensions of social life is a particularly important case. The absolute differentiation of technical disciplines from social and religious sciences is the very index of effective modernization. Purified objects, such as the economy of economics and the technology of engineering precipitate out of this process in their truth. Here, in a new sense, the rational is the real.

But how plausible is this identification? Aren't these rational models too good to be true? Aren't they just ideal-types, only loosely linked to actual objects in the world? But then the essence of those real objects will not coincide with their rational "core." An essentialism of rational structure will fail to reach beyond the limits of the disciplines that conceptualize it.

An example from economics will clarify the issues. Both modern economic science and the modern economy developed through differentiation from an earlier less differentiated social magma. The science had to distinguish its object from the vaguely defined "political economy" analyzed by Adam Smith and Marx. Similarly, the capitalist economy differentiated itself from institutions such as the state and religion. But economics achieves much higher levels of differentiation from sociology and political science than do markets from social and political life. Long after economic science is constituted independently as a pure logic of markets, actual markets in real economies remain thoroughly intertwined with all sorts of sociological and political influences about which modern economics has nothing to say. The "real" abstraction of the actual capitalist market is nowhere near as total as the highly idealized abstractions of economic science.

In a sense, then, Smith and Marx were more realistic than modern economics because they incorporated more of the relevant contexts into the object of their science. However, modern economics does not pretend to offer a social philosophy that would explain the origins, development and social relations of capitalism; it is dedicated more modestly to the study of quantitative aspects of a completely stabilized, fully capitalist economy. Where these narrow conditions are met, it provides a powerful approach to understanding and predicting economic behavior. Where they are not met, its explanatory power is small, smaller perhaps than the class and institutionally oriented methods of its predecessors.

Of course modern economics takes account of the broader array of factors those predecessors recognized, but it does so in an impoverished way designed to protect the idealization which

founds it. Thus some of these factors enter the science as background assumptions about constraints on economic behavior. For example, the political struggle over the length of the working day belonged to Marx's science but modern economic theory simply takes its results for granted as a condition of economic activity. Other so-called non-economic factors are recognized as "imperfections" with respect to a logical model of the perfect market that has, of course, never actually existed.

This difference between the degree and type of differentation characteristic of theories and the real world objects they study gives rise to serious confusion. Should markets be defined simply as the object of economic science, leaving aside as does economics everything that does not fit the theory, or should they be defined in terms of their real structure, including all the aspects from which economic sciences abstracts? But then the essence of the market will no longer correspond exactly to the object of economics. Should we, as social thinkers, care? Only to the extent that the prestige of economics delegitimates every other reflection on the economy. But that is a provocation to debate, not an argument in the debate.

With technology, similar problems arise. The differentiation of technical disciplines opens cognitive access to rational structures like those economics discovers in markets. But, again like economics, those structures are abstractions from a far more complex and far less differentiated reality. That reality lies in the background of disciplines such as engineering, laying out the framework within which they define and solve problems, but it is not an object of engineering science. The typical engineering illusion, (followed uncritically by modern common sense), is to assume that the technical device is actually identical with what the engineer makes of it and relates only externally to the society in which it is found; in fact it is a rich manifold that incorporates engineering parameters along with many others. This point might be put in another way: the selfsame device is subject to description in many discourses (engineering, artistic, ethical, etc.) none of which is "fundamental " (16).

Although philosophy of technology has often attacked the narrow horizons of engineering from a humanistic standpoint, paradoxically, its concept of technology is equally narrow. Its key mistake has been to assume that technical disciplines reveal the boundaries of their objects, not just in a certain respect for certain purposes, but generally, fundamentally. Thus limitations of those disciplines and particularly of their explicit self-understanding tend to be transferred to their objects and real technology comes to be seen as non-social, non-reflective, indifferent to values, power oriented, and so on. But as we have seen, an adequate definition of real technology, as opposed to the narrow, idealized cross-section studied by engineering, involves much besides the formal-rational properties of devices.

System, Network, Lifeworld

To get at that surplus of meaning, we need to return to the problem of function once again. What is the reality of this all too obvious concept that emerges spontaneously from our daily technical practice? As noted above, function resembles price as a fetishistic form of objectivity. Like price, function is a relational term which we attribute to the object as a real quality. In reality, the function of any technology is relative to the organizations that create and control it and assign it a purpose. It thus has a function as part of a "system" in the systems-theoretic sense of the term.

The concept of system is surely one of the slipperier ones in social science. Systems are generally defined as complexes of interacting elements. In the biological and social world, these appear as self-reproducing structures, such as organisms or corporations. In nature, the criteria that delimit the structure appear to be objective. We can identify internal processes, such as immunological response, that effectively distinguish an organism from its environment and even from parasites that attack it internally. (But of course cancer poses a problem for this model.) But the boundaries between social systems and their environments are not so objective and unambiguous.

For example, officially the stockholders own the company and appoint a management responsible to themselves. The company as system would seem to be constituted around the intentions of its owners, embodied in system maintenance procedures by its managers. However, the official system is not the only "self-reproducing complex of interacting elements" in play. What of the workers and their union which may treat the company as a very different kind of system? What of the community in which the company is located, which may consider the company as a subsystem of a larger urban system? Are workers and community leaders mere "environment" or are they competing systematizers operating on the same terrain as management?

Of course management would like to achieve complete autonomy. It may try to sharpen the system boundaries, as it understands them, by fighting the union and the local politicians. But in the end the system is more like a spinning whirlpool than a solid object. To whom does its wealth legitimately belong? Its shareholders, the victims of its products, its workers, the community? And is it the same system, independent of the answer to this question? Laws and courts, not natural processes, decide the outcome (17).

But this is to say that social systems are very much in the eye of the beholder. Systems, as self-reproducing wholes, are fragile subsets of much more loosely organized complexes of interacting elements that may support several overlapping systemic projects. I call this latter type of system a "network" (18). Social systems belong to larger networks with which they are involved in many uncontrolled and unintended interactions. To call these networks "environment" in the systems-theoretic sense of the term is to prejudge the issue of system boundaries. So long as system managers are successful, this prejudgement appears reasonable. But among the elements of the networks are human beings whose involvement has a symbolic as well as a causal dimension. They belong to the lifeworld within which the system is situated. They may prey on the system and destroy it like bacilli in the bloodstream, but they are also capable of reorganizing the network in conflict with system managers, of producing a new configuration of the resources it contains. They are, in other words, *involved* in a way that makes nonsense of the organic metaphor of living creature and environment (19).

System managers become aware of that wider background through unintended consequences and system breakdowns that highlight incompletely controlled or integrated elements of the network. The translation of the problems revealed in these breakdowns into functional terms is essential for restructuring the system. Success in this enterprise tends to obscure the fact that any given function is a selection from the full range of possibilities and demands revealed in the breakdown, including some which contradict system maintanence.

This wider range, the "potentialities" of the technical lifeworld, may include positive elements that can only be systematized through new technological designs, as in the case of computer communications, or even through the creation of new organizations with new leaders and goals. Such radical transitions cannot be conceptualized from a purely functional point of view, always relative to a given system and its line of development. The essentialist philosopher who finds confirmation of his or her theses in the limits of the technologist's self-understanding thus also loses sight of the relativity of function.

This is not to say that the concept of function is a useless abstraction. On the contrary, it orients users toward devices suited to their needs and has an important role in the technical professions which must focus their efforts on narrowly defined goals. But both users and technologists act against a background of assumptions that belong to a lifeworld of technology which need not be thematized in the ordinary course of events. A hermeneutic of technology must clarify that background.
I have therefore proposed a different type of model based not on the distinction of the social and the technical, but cross-cutting the customary boundaries between them. In this conception, technology's essence is not an abstraction from the contingencies of function, a structure that remains the same through the endless uses to which devices are subjected in the various sytems that incorporate them. Rather, the essence of technology is abstracted from the whole network within which functionality plays a specific limited role.

The reified form of objectivity of technology privileges the system managers' point of view over the decentered complexity of the network. Similarly, the very possibility of scientific idealization rests on the emergence of a system standpoint that selects out a narrowly defined domain of objects and tasks. But as we have seen, the less differentiated world of real technology includes elements excluded by theory and the device paradigm. That real world of technology is a network, not a system, but a network that encompasses a system within it.

Concretization and Technical Change

The Question of Technical Change

I complained earlier that essentialism fails to grasp the historical dimension of technology. It is now time to make good on the promise of an alternative approach implicit in that complaint. At issue is the explanation of social change in the technical sphere, and whether such change is ontologically significant. The question has two parts, only one of which can be discussed here. The first part concerns the reconceptualization of technical change from the standpoint of instrumentalization theory. That task involves a fundamental break with the system standpoint in order to develop a broader view of progress as more than an accident of technology's essence. The second part of the question concerns whether such a reconceptualization could ever itself become a part of the lifeworld of technology, i.e., whether technology's form of objectivity might change and the everyday understanding of it conform with the sophisticated findings of philosophy rather than the naive self-understanding of the technical professions. That question is the subject of another essay (20).

As we have seen, for essentialism the primary and secondary instrumentalizations are more or less differentiated depending on the stage of technical and social development. In a premodern society there may be no very clear distinction between narrowly conceived technical ends, which flow from the mastery of natural causality, and such spiritual mediations as aesthetic or ethical values. The shape of a chalice is not ornamentation in our sense, but belongs integrally to its design. In our society, on the contrary, these different aspects of technical work are not only clearly distinguished but often embodied in different institutions.

Once technology is differentiated from other social domains, its interaction with them appears to be external. This is particularly clear in the case of mediations. Art is no longer an intrinsic part of technical practice but something added on aposteriori. Ethical values regulate technology from without, through laws, and are not internal to technical practices. Heidegger and Habermas have taken such differentiation to be the essence of modernity. In the course of it the mediations lose their concrete links to technical reality and become increasingly rarefied and ineffectual ideals.

Of course, in many case such external relations do prevail, at a definite cost in efficiency. The existence of such costs seems to validate the essentialist conviction that technology does not change in essence with modifications in its historical forms. What changes is only the extent of its differentiation. Movement is either forward toward higher levels of differentiation or backward, through dedifferentiation to more primitive conditions. The more societies emphasize aesthetic and ethical values, the more these values are allowed to interfere with pure technical considerations, the poorer they will be. Whether such virtuous poverty is treasured or reviled, the consequences of value based technological change are similar. But instrumentalization theory implies a two way interaction in which differentiation is continually overcome not through regression but through another type of change essentialism lacks the means to theorize.

This is the process in which social constraints are embodied internally by design. In that case technical and social relations are condensed in the device. We can still make an analytic distinction between, for example, the aesthetic form and the technical function of a streamlined vehicle, but no *real* distinction exists, any more than in the case of Heidegger's famous chalice. This is not a question of mere packaging or extrinsic influences; design itself is affected. Here the social is not differentiated from the technical but merged with it. The distinction is purely analytic and corresponds to no specifically technical or social structures.

But surely, where the very design and structure of technology is socially relative and not merely its appearance or use, differentiation is not the defining characteristic of modernity the sociological tradition takes it to be. Insofar as such cases persist and even proliferate, technology must be conceived as fundamentally implicated in social change. In some cases, such as environmental impacts or skill levels associated with production, the very nature of life in modern societies is at stake. In such cases we cannot say apriori, on the basis of an essentialist preconception, that the problems are an expression of technology as such, nor can we decide whether technology is or is not inherently destructive of nature and humane ways of living and working.

Concretization

The fact that primary and secondary instrumentalizations are sometimes only analytically distinguishable while at other times they are institutionally differentiated is another important source of confusion in the philosophy of technology. The confusion is compounded by the fact that there is a constant transition from the second case to the first through what the French philosopher of technology, Gilbert Simondon, called the "concretization" process (Simondon, 1958). (See Chart I.)

Simondon's concept of concretization refers to the condensation of various functions in a single technical structure oriented toward efficiency. Technologies are adapted to their multiple milieux by concretizing advances: a car's metal skin must protect it from the weather while also reducing air drag to increase effective power; the base of a light bulb must seal it for operation within a certain range of temperatures and pressures while also fitting in standard sockets. Energy efficient housing design offers another example of a technical system which is not simply compatible with environmental constraints, but which internalizes them, making them in some sense part of the "machinery." In this case, factors that are usually only externally related, such as the direction of sunlight and the distribution of glass surfaces, are purposefully combined to achieve a desired effect. The house operates in a niche it itself creates by the angle it occupies with respect to the sun.

CHART I

differentiation

———————————————————————>

primary instrumentalization	***secondary instrumentalization***
decontextualization	**systematization**
reduction	**mediation**
autonomy	**vocation**
positioning	**initiative**

<———————————————————————

concretization

All developed technologies exhibit more or less elegant condensations aimed at achieving compatibilities of this sort. Concretization is the discovery of synergisms between the various functions technologies serve and between technologies and their various environments. Here the instrumentalization of the object is reconciled with wider contextual considerations through a special type of technical development.

Where that context is social, I will refer to a specifically social form of concretization. Such social concretization is a special case of what Bruno Latour (1992) calls the "delegation" of a social rule to a device; it reorders the internal structure of the device to optimize its functioning even as it fulfills a social demand. Here a goal is not merely assigned to a device but actually becomes technically productive in a positive sense.

Once a social constraint is internalized in this way, there is a tendency to lose sight of it. Technical devices are then seen as pure of social influences, which are conceived as essentially external, as values, functions, ideologies, rules. The internalized social constraints concretized in design are read off the reconfigured device as its inevitable technical destiny, as in the example of human communication by computer (Feenberg, 1995b: 14-15) . The concretizing process is thus a *technological unconscious*, present only in the sedimented form of technical codes that are interpreted as purely rational and separate from society (Feenberg, 1991: 79ff) .

Technology and Values

The process of concretization has a progressive character: designs can be ordered in a sequence going from the most abstract to the most concrete according to technical criteria. Concretization thus involves the general type of cognitive advance usually associated with technology and to that extent it founds progress in rationality. But unlike a simple developmental criterion such as growth in productivity, concretization is involved in the reflexive accommodation of technologies to their social and natural environment. It describes a complex trajectory of progress, richer than simple growth. It is this higher order complexity which makes it significant for the issues under discussion here in a way mere quantitative growth is not. Here is an example of the sort of thing I have in mind.

Simondon claims that the craftsman is actually the most important milieu of traditional tools, all of which are adapted primarily to their human users. Collegial forms of work organization were associated with the use of these tools. By contrast, the deskilling of industrial labor went hand in hand with the imposition of hierarchical management. Here the "device paradigm" operates with a vengeance, alienating the worker from the work process itself.

Although modern machines do not depend to the same degree as the craftsman's tools on human operators, it is still possible to design them to take advantage of an environment of human intelligence and skill. There is an extensive literature in management theory (going back to Marx) which argues that integration of human and machine, drawing on the full range of workers' intellectual as well as physical capacities, implies more participatory forms of organization. But the capitalist technical code militates against solutions to technical problems that place workers once again at the center of the technical system. Such concretizing innovations in work organization are nevertheless becoming more and more common as information technology reveals its full potential. This is a case where one might judge between several competing models of industrial society and their associated technological designs in terms of their ability to reconcile the pursuit of efficiency with democratic values and the human need for interesting and fulfilling work (Hirschhorn, 1984).

The idea of a "concrete technology," which includes human beings and nature in its very structure, contradicts the commonplace notion that technique "conquers" its objects. In Simondon's theory the most advanced forms of progress consist in the creation of complex synergies of technical and natural forces through advances that incorporate the wider contexts of human and environmental needs into the structure of technical systems. While there is no strictly technological imperative dictating such an approach, strategies of concretization could embrace these contexts as they do others in the course of technical development. Where these contexts include environmental considerations, the technology emerges as reintegrated or adapted to nature; where they include the capacities of the human operators, the technology progresses beyond deskilling to become the basis for vocational self-development and participatory management. Demands for environmentally sound technology, and humane, democratic and safe work, are thus not extrinsic to the logic of technology, but respond to the reflexive tendency of technical development to construct synergistic totalities of natural, human, and technical elements.

These considerations allow us to identify a type of directional development that is both technically and normatively progressive. The normative standards of that development are immanently derived from the resistances evoked by the technical process itself. That connection is clear where technical advance suppresses contextual features of nature and social life that the individuals mobilize to defend or to incorporate into improved designs through secondary instrumentalizations.

The theory of concretization offers a better account of the bias of technology than that proposed by substantivism. This bias is not determined once and for all by the essentialized primary instrumentalization as in Heidegger and Habermas, but also has a complex social dimension. To be sure, technology may enframe and colonize; but it may also liberate repressed potentialities of the lifeworld that would otherwise have remained submerged. It is thus essentially ambivalent, available for very different types of development (21).

The evidence of this is all around us. It has taken a certain theoretical obstinacy to ignore that evidence and to abstract from the emancipatory implications of technology in construing its essence. That obstinacy nevertheless had its justification as a reaction against the dystopian politics of technology of the postwar period. As technological issues are increasingly contested today, the dystopian risk fades. It is no longer sufficient to challenge the "one-dimensionality" of "technological thinking;" what is needed is an account of technology's ambivalence as a locus of social change.

Conclusion: Technology as Place

Essentialist theories of technology define the technical in terms of the primary instrumentalization alone. At that level it seems possible to abstract technology from society, while the secondary instrumentalizations are transparently social, with the exception of some types of systematization. They lie at the intersection of technique and the other action systems with which it is inextricably linked insofar as it is a social enterprise. As a result, socially specific configurations of the secondary instrumentalizations are as variable as the contexts to which technique is integrated, subject to transformations corresponding to distinct eras in the history of technical systems and technical rationalities. For example, a dimension of technology such as vocation may

be central to technical life in one era and eliminated as much as possible through deskilling in another.

From this anti-essentialist standpoint, our form of modern society cannot be the untranscendable horizon of technical possibilities, defining for modernity in general. But neither can we conceive of a general deglobalization of modern societies, a splitting up of modernity into incommunicable varieties. The shared technical heritage provides what might be called a "practical universality" that has imposed itself on a planetary scale. No modern society can forego basic technical discoveries such as antibiotics, plastics or electricity, and none can withdraw from worldwide communication networks. The cost of an entirely independent path of development is just too high. But both in the advanced and the developing countries, significant innovations are possible with respect to what has been the main line of progress up to now.

The terrain of practical universality is accessible from many standpoints for many purposes. It is not a destiny, but the *place* on which destinies can be worked out. It first emerged in the capitalist West around a particular panoply of technologies and rational systems. These intentionally deemphasized most secondary instrumentalizations with consequences we now experience as cultural homogenization, social anomie and environmental crisis. The threat of technology is due to this particular realization of its potential.

This conclusion invites us to consider the possibility of an alternative form of technical rationality that would integrate the secondary instrumentalizations more fully through new concretizations. On this basis, I have argued elsewhere for a reform of modern technology to incorporate workers' skills, human communication, and environmental limits into its very structure (Feenberg, 1991: chap. 8). Similar arguments could be made with respect to the possibility of culturally specific technological configurations (Feenberg, 1995: chap. 9).

The scope and significance of such change is potentially enormous. Technical choices establish the horizons of daily life. These choices define a "world" within which the specific alternatives we think of as purposes, goals, uses, emerge. They also define the subject who chooses among the alternatives: we make ourselves in making the world through technology. Thus fundamental technological change is self-referential. At issue is *becoming*, not *having*. The goal is to define a way of life, an ideal of abundance, and a human type, not just to obtain more goods in the prevailing socio-economic system. As Terry Winograd argues, technological designing is ontological designing (Winograd and Flores, 1987: 163).

Unexpected struggles over issues such as nuclear power, access to experimental treatment for AIDS patients, and user participation in computer design remind us that the technological future is by no means predetermined. To the extent that such struggles spread, we can hope to inhabit a very different future from the one projected by essentialist critique. In that future technology is not a fate one must chose for or against, but a challenge to political and social creativity.

Notes

1 See, for examples, Pinch, Hughes, and Bijker (1989).

2 Latour seems to want to have it both ways. On the one hand, he claims "we have never been modern" because modernity is an impossible notion, and on the other hand, he attempts to reconstruct on his own terms a certain discontinuity between modern and premodern societies (Latour, 1993). The argument might be less provocatively, but more clearly formulated to say that we have been modern, but not in the way we thought. I could agree with this and in fact offer reasons in support of such a position here.

3 I would of course be willing to revise this view if shown how Heidegger actually envisages technological change. What I have heard from his defenders is principally waffling on the attitude/device ambiguity described here. Yes, Heidegger envisages change in "technological thinking," but how is this change supposed to effect the design of actual devices? The lack of an answer to this question leaves me in some doubt as to the supposed relevance of Heidegger's work to ecology. One enthusiastic defender informed me that art and technique would merge anew in a Heideggerian future, but was unable to cite a text. That would indeed historicize Heidegger's theory, but in a way resembling Marcuse's position in An Essay on Liberation (1968) with its eschatological concept of an aesthetic revolution in technology. It is not clear how the case for Heidegger is fundamentally improved by this shift, which would not make much difference to the substantive arguments presented here. For an interesting defense of Heidegger's theory of technology that eschews mystification, see Dreyfus (1995).

4 This argument was suggested to me by Thomas Krogh. I address it in Feenberg (1996).

5 Am I unfair to Habermas? He too has his defenders, who gesture at a Habermasian philosophy of technology that goes well beyond the limits I attribute to his position here. However, to my knowledge no Habermasian has ever tried to develop that philosophy. So far it is only invoked as a theoretical potential in response to criticism, not to do the work we expect of a philosophy of technology. Note, however, that Habermas's lapsus is almost universally shared by those who reflect philosophically on modernity. (Among the main exceptions, of course, are Heideggerians.) I have discussed these problems in more detail in Feenberg (1996).

6 For another interesting contemporary approach that complements Borg-mann's, see Simpson (1995).

7 In the next part of this paper I will attempt to resituate this dualism within technology itself, to avoid the ontologized distinctions characteristic of essentialism.

8 This negative evaluation of computer communication can be extended back to other forms of mediated communication. In fact Borgmann does not hesitate to denounce the telephone as an early form of hyperintelligence which substituted trivial chat for the more deeply reflective interactions made possible by written correspondence (Borgmann, 1992: 105).

9 Like the turtles in Feynman's famous story, the hermeneutics of technology "goes all the way down."

10 The approach I suggest here bears a certain resemblance to Habermas's interpretation of modernity in terms of a structural model encompassing a variety of forms of rationalization that would receive differing emphases in different types of modern society (Habermas 1984, 1987: I,

238). However, I extend this approach downward into technology, which is only one component of Habermas's model, in order to introduce variety at the technological level. I believe this is a condition for the appearance of variety in fact, and not just theoretically, at the level at which Habermas works.

11 Compare Latour's account of a similar episode involving Heraclitus, Latour (1993), pp. 65-66.

12 Many of the ideas in this section and the next were first worked out in discussion with Robert Pippin.

13 Strange as it may seem, underdetemination applies even to wheelbarrows. Today they are designed for use by working adults, but they were made small to serve as children's toys among the Aztecs, who did not use wheels for transportation.

14 It is important to resist the temptation to say that capitalism is irrelevant to the issues under discussion here since Soviet communism and its imitators did no different and no better. These regimes never constituted an alternative; they followed the capitalist example in essential respects, importing technology and management methods, in some cases, such as protection of the environment, carrying its irresponsibility even further. I have discussed this problem in more detail in Feenberg (1991), chap. 6.

15 The concept of form of objectivity is derived from Lukacs' early History and Class Consciousness (1971). See Feenberg (1986: 70-71).

16 Of course many reflective engineers are aware of this, particularly since their practice constantly involves them with other dimensions of technology.

17 Very different outcomes are possible; witness the social charter of the European Community which grants rights to workers and communities unheard of in the United States.

18 The implicit reference to actor network theory is intended, although I do not follow that approach closely.

19 Menenius Agrippa's myth of the dysjecta membrae is thus the original systems-theoretic ideology.

20 This second question is also connected to another important problem that is discussed elsewhere, the democratization of technology.

References

Borgman, Albert (1984). *Technology and the Character of Contemporary Life*. Chicago: Univ. of Chicago Press.

Borgman, Albert (1992). *Crossing the Postmodern Divide*. Chicago: Univ. of Chicago Press.

Conford, Francis (1957). *Plato and Parmenides*. New York: Liberal Arts Press.

Ellul, Jacques (1964). *The Technological Society*, J. Wilkinson, trans. New York: Vintage.

Dreyfus, Hubert (1995). "Heidegger on Gaining a Free Relation to Technology," in Feenberg, A., and Hannay, A., eds. (1995). *Technology and the Politics of Knowledge*. Bloomington and Indianapolis: Indiana University Press.

Feenberg, Andrew (1986). *Lukacs, Marx, and the Sources of Critical Theory.* New York: Oxford Univ. Press.

—(1991). *Critical Theory of Technology.* New York: Oxford Univ. Press.

—(1995a). *Alternative Modernity: The Technical Turn in Philosophy and Social Theory.* Los Angeles: Univ. of California Press.

—(1995b). "Subversive Rationalization: Technology, Power, and Democracy," in Feenberg, A., and Hannay, A., eds. (1995). *Technology and the Politics of Knowledge*. Bloomington and Indianapolis: Indiana University Press.

—(1996). Marcuse or Habermas: Two Critiques of Technology, in *Inquiry,* 39.

Feenberg, Andrew, J. Licht, K. Kane, K. Moran, and R. Smith, (1996) "The Online Patient Meeting," *Journal of the Neurological Sciences,* 139.

Habermas, Jurgen (1970). Technology and Science as Ideology, in *Toward a Rational Society*, J. Shapiro, trans. Boston: Beacon Press.

Habermas, Jurgen (1984, 1987). *The Theory of Communicative Action: Lifeworld and System: A Critique of Functionalist Reason*, T. McCarthy, trans. Boston: Beacon.

Harasim, Linda, S. R. Hiltz, L. Teles, and M. Turoff (1995). *Learning Networks: A Field Guide to Teaching and Learning Online*. Cambridge, MA: MIT Press.

Heidegger, Martin (1977a). *The Question Concerning Technology*, W. Lovitt, trans. New York: Harper and Row.

Heidegger, Martin (1977b). "Only a God Can Save Us Now," trans. D. Schendler. *Graduate Faculty Philosophy Journal,* 6(1).

Hirschhorn, Larry (1984). *Beyond Mechanization: Work and Technology in a Postindustrial Age*. Cambridge, Mass.: MIT.

Latour, Bruno (1992). Where Are the Missing Masses? The Sociology of a Few Mundane Artifacts, in Bijker, W. and Law, J., eds., *Shaping Technology/Building Society: Studies in Sociotechnical Change*. Cambridge, Mass: MIT Press.

Latour, Bruno (1993). *We Have Never Been Modern*. Trans. C. Porter. Cambridge, MA: Harvard University Press.

Lukacs, George (1971). *History and Class Consciousness*. R. Livingstone, trans. Cambridge, Mass.: MIT Press.

Marcuse, Herbert (1969). *An Essay on Liberation*. Boston: Beacon.

McCarthy, Thomas (1981). *The Critical Theory of Jurgen Habermas*. Cambridge, Mass.: MIT Press.

McLuhan, Marshall (1964). *Understanding Media*. New York: McGraw Hill.

Pinch, Trevor and Bijker, Wiebe (1989). "The Social Construction of Facts and Artefacts: or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other." In Pinch, T., Hughes, T, and Bijker, W, *The Social Construction of Technological Systems*. Cambridge, MA: MIT Press.

Pinch, Trevor, Hughes, Thomas, and Bijker, Wiebe (1989). *The Social Construction of Technological Systems*. Cambridge, MA: MIT Press.

Simondon, Gilbert (1958). *Du Mode d'Existence des Objets Techniques*. Paris: Aubier.

Simpson, Lorenzo (1995). *Technology, Time, and the Conversations of Modernity.* New York: Routledge.

Winograd, Terry and Flores, Fernando (1987). *Understanding Computers and Cognition*. Reading, Mass.: Addison-Wesley.