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What do philosophers need to know about technology? What kind of knowledge do we need to have? And how much? Perhaps it is enough simply to have lived in a society in which a wide variety of technologies are in common use. Drawing upon an everyday understanding of such matters, one can move on to develop general perspectives and theories that may enable us to answer important questions about technology in general. The problem is that one's grasp may be superficial, failing to do justice to the phenomena one wants to explain and interpret. One may seize upon a limited range of vaguely understood examples of technical applications—a dam on a river, a robot in a factory, or some other typification—and try to wring universal implications from a sample that is perhaps too small to carry the weight placed upon it.

An alternative would be to focus one's attention more carefully, becoming expert in the technical knowledge of a specific field, attaining the deeper understanding of, say, a worker, engineer, or technical professional. Even that may prove limiting, however, because the experience available in one field of practice may not be useful in comprehending the origins, character, and consequences of technical practices in other domains. The sheer multiplicity of technologies in modern society poses serious difficulties for anyone who seeks an overarching grasp of human experience in a technological society.

Yet another strategy might be to study particular varieties of technology in a scholarly mode, drawing upon existing histories and contemporary social studies of technological change as one's base of understanding. And one

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might make the effort to expand this base of knowledge by contributing research of one's own. Noel Mostert's (1974) wonderful book, *Supership*, is such a work—a philosophical reflection upon the world of oil tankers in which the author takes care to examine details of the construction, economic context, and daily operation of these enormous vessels.

The use of colorful, substantive cases like Mostert's (1974) suggests an interesting question. *Where* does one go to learn what one needs to know to write confidently about philosophy and technology? For Mostert, it meant not only going to the library to study the history, engineering, and economics of supertankers but also living on a tanker himself during several voyages. An identifying mark of the different philosophical approaches to technology can be found in the typical locations that writers prefer to visit, if only in their minds. It is common for many Marxist thinkers, for example, to want to return to the scene of the crimes described by Marx himself, namely, to the industrial factory, to the shop floor, noticing the social relations and productive forces displayed there. By the same token, many feminist writers have turned their attention to technologies in the home, office, and hospital, places where technological designs and policies have historically affected the lives of women.

The list of typical locations in which a detailed understanding of technology might be gained is very large indeed. Where should a philosopher go to learn about technology? To a research and development laboratory? A farm? An electrical power plant? A communications center? An airport? An arsenal? A construction site? Offices of any agency that funds research? A toxic waste dump? An automated theme park? A school where computers are being introduced? What does one's understanding of a specific location and specific varieties of technical apparatus, knowledge, and practice contribute to one's ability to talk in penetrating, reliable ways about modern technology in general?

As studies in philosophy and technology mature, it will be increasingly important for us to think critically about the origins and relative quality of the knowledge that we draw upon as we address the key questions. There are bound to be disagreements about which strategies of inquiry are the best ones to follow. But it seems perfectly clear that, faced with the enormously diverse kinds of technology in the world, philosophers must somehow gain a well-developed understanding of at least a representative slice of them.

For those of us engaged in studies of philosophy and technology, this need is all the more crucial just now because those working in the various subdisciplines of contemporary science and technology studies are at work on roughly the same turf where philosophers commonly situate their inquiries. This flurry of activity in the social sciences poses both an opportunity

and a peril. The opportunity is that one can enter into discussion with persons who employ other approaches, learning from their results, sharing ideas about similar topics. The peril is that philosophers may find themselves outflanked by these developments because the rich, empirical detail of historical and social science studies of technology can make the abstract speculations of philosophers appear vacuous and armchair-bound by comparison.

Social Constructivism: Its Value

My purpose here is to look briefly at some recent work in the lively cross-disciplinary field of science and technology studies and ask: How well does it help orient our understanding of the place of technology in human affairs? The particular school of thought I shall briefly examine is one currently fashionable among historians and sociologists who study technology and society. Its most common label is the *social construction of technology*, or simply, *social constructivism*. It is of interest not only for the specific features of its approach to the study of technology and society but also for the way it regards past and present philosophical inquiries in technology and philosophy. To ignore the central claims of this important school of thought, to fail to examine its basic notions, would be to overlook an important challenge.

Among the names of those involved in this project are a number of Europeans and Americans: H. M. Collins, Trevor Pinch, Wiebe Bijker, Donald MacKenzie, Steven Woolgar, Bruno Latour, Michel Callon, Thomas Hughes, and John Law. These and other scholars of similar persuasion are now very active doing research, publishing articles, and building academic programs. They are also openly proselytizing and even self-consciously imperial in their hopes for establishing this approach. It is clear they would like to establish social constructivism as the dominant research strategy and intellectual agenda within science and technology studies for many years to come.[1]

An important aim of the social constructivist mode of inquiry is to look carefully at the inner workings of real technologies and their histories to see what is actually taking place. It recommends that rather than employ such broad-gauged notions as technological determinism or technological imperatives, scholars need to talk more precisely about the dynamics of technological change. Rather than try to explain things through such loosely conceived notions as the trajectory of a technical field or technical momentum, we need to look very closely at the artifacts and varieties of technical knowledge in question and at the social actors whose activities affect their

development. In that light, their preferred locations for research so far have been contemporary research and development laboratories as well the archives that contain records of R&D accomplishments of the past.

The plea frequently voiced by the social constructivists is that we open "the black box" of historical and contemporary technology to see what is there (Pinch and Bijker 1987). The term *black box* in both technical and social science parlance is a device or system that, for convenience, is described solely in terms of its inputs and outputs. One need not understand anything about what goes on inside such black boxes. One simply brackets them as instruments that perform certain valuable functions.[2]

In my view, the social constructivists are correct in criticizing writers in the social sciences and humanities who have often looked upon technological developments as black boxes while neglecting any comprehensive account of their structures, workings, and social origins. To find more precise, detailed descriptions and explanations of the dynamics of technical change is a goal well worth pursuing.

As they go about opening the black box, the historians and sociologists in this school of thought follow methodological guidelines established during the past two decades within the sociology of science, in particular an approach that studies the sociology of scientific knowledge (Collins 1983). In this mode of analysis, there is a strong tendency to regard technology as the lesser relative of science. Because science deals with the fundamentals of human knowledge, it is considered the more evaluated and significant topic. In that light, for both historians and sociologists, the "turn to technology" is sometimes portrayed as a kind of intellectual slumming (Woolgar 1991). There is even some doubt that sociologists of scientific knowledge will benefit greatly from studying such grubby technological matters at all. Sociologists of science see social studies of technology as a new field in which to apply a powerful but as yet underutilized research apparatus that had been successful in studies of the sociology of scientific knowledge.

From that vantage point, most past and contemporary work in the philosophy of technology is greeted with scorn. As Pinch and Bijker (1987) conclude in their widely cited survey, "Philosophers tend to posit overidealized distinctions, such as that science is about the discovery of truth whereas technology is about the application of truth. Indeed, the literature on the philosophy of technology is rather disappointing. We prefer to suspend judgment on it until philosophers propose more realistic models of both science and technology (p. 19).[3]

In quest of "more realistic" models of their own, social constructivists employ a methodological posture, "the empirical programme of relativism," commonly used in the sociology of science. Adapting this stance to the study

of technology requires some modification. What social analysts do in this new focus is to study the "interpretive flexibility" of technical artifacts and their uses. One begins by noticing that people in different situations interpret the meaning of a particular machine or design of an instrument in different ways. People may use the same kind of artifact for widely different purposes. The meanings attached to a particular artifact and its uses can vary widely as well. In this way of seeing, sociologists and historians must locate the "relevant social groups" involved in the development of a particular technological device or system or process. They must pay attention to the variety of interpretations of what a particular technological entity in a process of development means and how people act in different ways to achieve their purposes within that process.

I want to emphasize that social constructivism is by no means an entirely unified viewpoint. There are some important differences among its leading practitioners.[4] For some who work in this perspective, the conventional distinction between technology and society has finally broken down altogether. In the approach of Michel Callon and Bruno Latour, for example, we find the methodological premise (eventually upheld as a basic social truth) that the modern world is composed of actor networks in which the significant social actors include both living persons and nonliving technological entities. Others like Trevor Pinch and Wiebe Bijker prefer to maintain the notion that society is an environment or context in which technologies develop. But despite such differences of emphasis, the basic disposition and viewpoint of social constructivism is fairly consistent.

As a way of studying the dynamics of technological change, this approach does offer some interesting advantages. It offers clear, step-by-step guidance for doing case studies of technological innovation. One can present this method to graduate students, especially those less imaginative graduate students who need a rigid conceptual framework to get started, and expect them to come up with empirical studies of how particular technologies are "socially constructed." Indeed, the social constructivists promise to deliver a veritable gold mine of those most highly valued of academic treasures: case studies. They have studied the development of Bakelite, missile guidance systems, electric vehicles, expert systems in computer science, networks of electrical power generation and distribution, and several other corners of technological development.[5] Research results usually indicate that technological innovation is a multicentered, complex process, not the unilinear progression depicted in many earlier writings. Another useful contribution of this approach is to reveal the spectrum of possible technological choices, alternatives, and branching points within patterns sometimes thought to be necessary. Social constructivist interpretations of technology emphasize

contingency and choice rather than forces of necessity in the history of technology.

Although they are not alone in doing so, the social constructivists have been quite helpful at calling into question the sometimes highly arbitrary distinctions between the social sphere and the technical sphere. In my view, the ability to break down such arbitrary distinctions opens up some interesting possibilities for those who want to understand the place of technology in human experience. For that reason alone, the literature in the new sociology of technology is well worth a philosopher's attention.

As they proceed with their work, social constructivists are eager to call attention to the inadequacies of their predecessors, identifying their accomplishments as a clear advance over earlier ways of thinking about technology and society. Theirs is said to be a more rigorous, methodologically refined, and clear-sighted vision of technology and society than what came before.

What are the significant points of comparison? Among the cast of characters, one would certainly have to include the whole range of thinkers who have written about the origins and significance of modern technology. Among those explicitly or implicitly criticized are sociologists of technology like William Ogburn, historians of technology like Lynn White, and a variety of economists who have written on the economic correlates of innovation. Not far in the background are the likes of Lewis Mumford, Jacques Ellul, Ivan Illich, members of the Frankfurt school of critical theory, and any number of Marxist social theorists, not to mention Marx and Engels themselves.

As they refer to earlier generations of sociologists, the social constructivists often appear to be saying, "Yes, these were, indeed, great thinkers, but they were wrong and we are right." Whether or not this judgment comes to be accepted by the scholarly community as a whole, only time will tell. But the aspirations of social constructivism are fairly evident. Part of what is going on here is a social construction of knowledge that seeks to depict earlier and contemporary approaches as outmoded or dead. Clearly, one of the ways in which this approach can be said to be "more complex" than previous ones has something to do with the Oedipus complex.

Before we join the swelling applause for social constructivism and anoint this school as the cutting edge in technology studies, we must pause to ask whether or not their approach does amount to an improvement over other approaches. Before we forget our Marx or our Mumford, Ellul, or Heidegger, it is important to notice what one gives up as well as what one gains in choosing this intellectual path to the study of technology and human affairs.

I hope I have made clear the aspects of this work that I find valuable: its conceptual rigor, its concern for specifics, its attempt to provide empirical

models of technological change that better reveal the actual course of events. But as I read the works of the social constructivists and ponder the character of their research program, I am increasingly struck by the narrowness of this perspective. Advances along this line of inquiry take place at a significant cost: a willingness to disregard important questions about technology and human experience, questions very much alive in other theoretical approaches.

Left out of View

Consequences

The most obvious lack in social constructionist writing is an almost total disregard for the social consequences of technical choice. This is a social theory and method geared to explaining how technologies arise, how they are shaped through various kinds of social interaction. One tries to show why it is that particular devices, designs, and social constituencies are the ones that prevail within the range of alternatives available at a given time. But the consequences of prevailing are seldom a focus of study. What the introduction of new artifacts means for people's sense of self, for the texture of human communities, for qualities of everyday living, and for the broader distribution of power in society—these are not matters of explicit concern.[6]

The commitment to study the origins of technology rather than the consequences of technological choices stems in part from the belief, a woefully mistaken one in my view, that the consequences or effects or "impacts" of technological change have already been studied to death by earlier generations of humanists and social scientists. As Donald MacKenzie and Judy Wajcmam (1985) put the matter, the urgent but neglected question is, "What has shaped the technology that is having 'effects'? What has caused and is causing the technological change whose 'impact' we are experiencing?" (p. 2).

Another reason that social constructivists have turned away from the study of consequences, in my reading, springs from their basic orientation: an application of ideas and methods employed in the sociology of science to what they regard as a new and less important field of inquiry, namely, technology. In the sociology of science, the primary issues are ones that have to do with the origins of knowledge about natural phenomena. Translating this approach to the study of technology, the focus tends to become the closest corresponding phenomenon that the sociologist can identify, namely, the origins and dynamics of technological innovation.

In a peculiar way, then, this is a sociology of technology that has little concern for the ways in which technologies transform personal experience and social relations. The object of fascination is social construction of technical artifacts and processes. But why such innovations matter in the broader context is no longer of any great concern.

"Irrelevant" Social Groups

A second variety of narrowness can be seen in the social constructivists' favored conception of social process. Here, as I have noted, one usually finds a field of what are called *relevant social actors* who are engaged in a process of defining technical problems, seeking solutions, and having their solutions adopted as authoritative within prevailing patterns of social use. As a student of politics examining this approach, I am struck by the ways in which it echoes the conceptual and theoretical commitments of theories of political pluralism and of bureaucratic politics. Proposed as a way of understanding the workings of modern democracy, pluralist theories point to the complex interactions of interest groups within society as a whole and within and around particular organizations. Decisions and policies emerge as a vector outcome of the combined pushes and pulls within an essentially pluralist framework.

But there is an annoying question for political pluralism that can be posed for social constructivism as well. Who says what are relevant social groups and social interests? What about groups that have no voice but that, nevertheless, will be affected by the results of technological change? What of groups that have been suppressed or deliberately excluded? How does one account for potentially important choices that never surface as matters for debate and choice?

As critics of pluralist theory in political science have argued, it is important to notice not only which decisions are made and how but also which decisions never land on the agenda at all; which possibilities are relegated to the sphere of nondecisions (Bachrach 1980). By noticing which issues are never (or seldom) articulated or legitimized, observing which groups are consistently excluded from power, one begins to understand the enduring social structures upon which more obvious kinds of political behavior rest. Failing to do this, social scientists offer an account of politics and society that is implicitly conservative, an account that attends to the needs and machinations of the powerful as if they were all that mattered.

The corresponding problem for social constructivism is that its ways of modeling the relationship between social interests and technological innovation will conceal as much as they reveal. Looking at contemporary research

and development in manufacturing technology in the United States, for example, it is remarkable how thoroughly the interest and perspectives of labor have simply been eliminated as a focus of any serious concerns. In research models of computer-integrated manufacturing (CIM), the traditional roles of blue-collar workers are simply no longer present. Can research in the social construction of technology succeed if its map of the relevant social groups does not indicate which social groups have finally been sandbagged out of the laboratories and which social voices effectively silenced?

As a program of inquiry, social constructivism is careful to avoid the technological version of the "Whig theory of history," in which the past is read as a sequence of steps leading inevitably to the accomplishments of today. But although social constructivism escapes the bind of Whig history, it seems not to have noticed the problem of elitism, the ways in which even a broad, multicentered spectrum of technical possibilities is skewed in ways that favor some social interests while excluding others. Although this approach rejects the "great man theory" of technological development, it still attends to the needs and problems of the powerful persons and groups: those with the resources to enter the game and define its terms. Although it succeeds in finding contingency rather than necessity in the course of technological change, it seems so far to have little to say about the deep-seated political biases that can underlie the spectrum of choices that surface for relevant social actors.

Structure and Culture

This point leads to my third problem with social constructivism, namely, that it disregards the possibility that there may be dynamics evident in technological change beyond those revealed by studying the immediate needs, interests, problems, and solutions of specific groups and social actors. One of the key claims in philosophical writings is that, if one looks closely, one sees basic conditions that underlie the busy social activities of technology making. Marxists, for example, argue that a key condition is the phenomenon of social class. In this view, the structural relationships between classes are fundamental conditions that underlie all economic institutions, government policies, and technological choices.

Other thinkers have pointed to a basic metaphysical disposition that establishes the split between human beings and nature and the attitude of mastery and domination that characterizes modern technics, whatever its particular forms may be. Others still have pointed to the form of un-

derdimensioned rationality that plays itself out in all modern technological projects.

The possibility that the ebb and flow of social interaction among social groups may reflect other, more deeply seated processes in society is not an idea that the social constructivists choose to explore. They usually find it sufficient to gather evidence of social activities most clearly connected to technological change. Insofar as there exist deeper cultural, intellectual, or economic origins of social choices about technology or deeper issues surrounding these choices, the social constructivists choose not to reveal them.

The notion of autonomous technology, for example, they reject as a now-discredited determinism, eclipsed by their models of a dynamic, multicentered process of social selection. But in more subtle versions of the autonomous technology, determinism is not the central issue at all. As people pursue their interests, socially constructing technologies that succeed at some level of practice, they sometimes undermine what are or ought to be key concerns at another level. Each technically embodied affirmation may also count as a betrayal, perhaps even self-betrayal. The same devices that have brought wonderful conveniences in transportation and communication have also tended to erode community. In the maxim of theologian Richard Penniman, "They got what they wanted, but they lost what they had."

In that light, the interesting questions have nothing at all to do with any alleged self-generating properties of modern technology. Instead they have to do with the often-painful ironies of technical choice. Although the social constructivists are energetic researchers, they always seem not to be careful readers. Thus they simply overlook aspects of philosophical discussion about autonomous technology that do not fit their preferred conceptual straw man: technological determinism.

What It All Means

A fourth and final quality of this mode of inquiry that deserves comment is one to which I have already alluded, namely, its lack of and, indeed, apparent disdain for anything resembling an evaluative stance or any particular moral or political principles that might help people judge the possibilities that technologies present. The empirical program of relativism in the sociology of science becomes the methodology of interpretive flexibility in the new sociology of technology. Rather than attribute any particular meaning to a technical device or its uses, social research tries to understand how it is that some people see a developing artifact in one way while others see it quite differently.

This strategy seems to me well worth using—up to a point. It helps reveal the broad range of demands and desires that are packed into technical developments of various kinds. Some welcomed the modern safety bicycle with its balloon tires and foot brakes because it was fast and stable; others liked it because it presented fewer riding hazards than its predecessors; and so on. The premise of interpretive flexibility works especially well in cases in which social consensus is achievable, where all or most parties can say at the end of the process, "Thank God we came together around this set of design features." In that way, the underlying leitmotif of the sociologist's composition is still (implicitly) that of progress—kudos all around. But what about circumstances in which there are serious disagreements about the design or use of an artifact or technological system? How will the social analysis evaluate the terms of the disagreement?

As regards the analysis of scientific knowledge, the epistemological program of relativism in the sociology of science remains neutral as regards judgments about whether or not the proclaimed discoveries or theories of scientists are true or not. Extrapolating to technology, social constructivists choose to remain agnostic as regards the ultimate good or ill attached to particular technical accomplishments. As a feature of a purely descriptive, explanatory project in sociology, this may make sense. A researcher may even suggest that, at some later point and in a different setting, it may be possible to offer well-considered judgments about values associated with a particular technology. But, in fact, researchers in the social construction of technology programs have neither made such promises nor, to my knowledge, taken such steps. As far as I can tell, they have no theoretical or practical position on technology and human well-being at all. In fact, to announce such a position seems forbidden on methodological grounds. And because purity of social science methodology is of such preeminent concern, it is likely that social constructivists will continue their research without taking a stand on the larger questions about technology and the human condition that matter most in modern history.

In this way, the methodological bracketing of questions about interests and interpretations amounts to a political stance that regards the status quo and its ills and injustices with precision equanimity. Interpretive flexibility soon becomes moral and political indifference. In my view, the frequency with which technology looms as a crucial issue for commitment in modern society makes this posture an extremely vain and unhelpful one. Sometimes it matters what a thing is, what name it has, and how people judge its properties. For example, was the structure in Iraq photographed during the Gulf War of 1991 a baby food factory or chemical weapons plant? It is true that some people claimed the building was one thing while others said it was

something else. But noticing the diversity and flexibility of interpretations in such cases is of little help. Ultimately, one has to decide what one is dealing with and why it matters.

But the methodological posture of social constructivism is characteristically unwilling to engage in argument about the aspects of technology that now weigh heavily in key debates about the place of technology in human affairs. Such concerns are now deleted from historical accounts of how technologies arise, as well as from contemporary descriptions of technological and social change. There is, similarly, no willingness to examine the underlying patterns that characterize the quality of life in modern technological societies. There is also no desire to weigh arguments about right and wrong involved in particular social choices in energy, transportation, weaponry, manufacturing, agriculture, computing, and the like. Even less is there any effort to evaluate patterns of life in technological societies taken as a whole. All the emphasis is focused upon specific cases and how they illuminate a standard, often repeated hypothesis, namely, that technologies are socially constructed.

Answering Woolgar

To give an example of how the constructivist orientation seeks to sidestep questions that require moral and political argument, I want to look briefly at an article written by one of the leading proponents of this view, Steven Woolgar (1991). Woolgar examines "the turn to technology," deploying familiar constructivist moves to build his point of view. Along the way, he takes on an argument that I made several years ago about the politics of technology. The case in point involves some bridges on the Long Island expressway built decades ago by the powerful New York planner, Robert Moses. My claim is that Moses deliberately built the overpasses on the expressway fairly low to the ground so that buses would not be able to pass under them. I see this as an expression of Moses' desire to separate different social class and racial groups in New York City. Blacks and poor tended not to have cars and would have to take buses if they wanted to get to places like Jones Beach on Long Island. Thus the height of the bridge was a political statement—inequality in built form—that became an enduring part of both the physical infrastructure and social landscape of New York (Winner 1986).

Woolgar looks at this finding with amusement. In the style of social constructivism, he notes that the bridges could be flexibly interpreted in a variety of ways. He says that Langdon Winner can interpret them as political artifacts "if you like." But, he says, "the interpretist response espouses a

measure of impartiality by proposing that analysis deals with the ways in which readings are done, without prejudice to their relative truth" (Woolgar 1991, p. 41).

Woolgar is certainly justified in asking, "What is it that makes one reading of the text (technology) more persuasive than another?" However, he is wrong to suggest that the issue is simply not decidable. I agree that all structures, including Moses' bridges, can be interpreted in a variety of different ways; in fact, my analysis presupposes exactly that. What makes the conclusion that Moses' bridges are inegalitarian political artifacts a strongly defensible proposition is not difficult to grasp. It can be seen in the role that the bridges play in the social and political history of a particular community at a particular time, as well as in the personal history of a power broker notorious in his willingness to use all possible means, including public works projects, to shape social patterns to match with his vision of what was desirable. To avoid this conclusion through the use of postmodernist interpretive irony is, in my view, politically naive.

In situations in which there are admittedly a variety of points of view that matter in making choices about technology, I believe it is necessary for social theorists to go beyond what positivists used to call *value neutrality* and what social constructivists resurrect as *interpretive flexibility*. One must move on to offer coherent arguments about which ends, principles, and conditions deserve not only our attention but also our commitment. At that point, one ceases interpreting interpretations of interpretations and, for better or worse, takes a stand on choices to develop or limit the technologies available to humankind.

Power holders who have technological megaprojects in mind could well find comfort in a vision like that now offered by the social constructivists. Unlike the inquiries of previous generations of critical social thinkers, social constructivism provides no solid, systematic standpoint or core of moral concerns from which to criticize or oppose any particular patterns of technical development. Neither does it show any desire to move beyond elaborate descriptions, interpretations, and explanations to discuss what ought to be done. Robert Moses, for example, might well have applauded such an approach. For it implicitly affirms what he eventually came to believe: that what matters in the end is simply the exercise of raw power.

Conclusion

My conclusion is, then, that, although the social constructivists have opened the black box and shown a colorful array of social actors, processes,

and images therein, the box they reveal is still a remarkably hollow one. Yes, they regularly succeed in tracking a great deal of intense activity around technological developments of various kinds. They also show us the fascinating dynamics of conflict, disagreement, and consensus formation that surround some choices of great importance. But as they survey the evidence, they offer no judgment on what it all means, other than to notice that some technological projects succeed and others fail, that new forms of power arise and other forms decline.

Unlike other approaches, those of Marx, Ellul, Heidegger, Mumford, and Illich, for example, this perspective does not explore or in any way call into question the basic commitments and projects of modern technological society. The attitude of the social constructivists seems to be that it is enough to provide clearer, well-nuanced explanations of technological development. As compared to any of the major philosophical discussions of technology, there is something very important missing here, namely, a general position on the social and technological patterns under study.

In contrast, the corresponding inquiries of traditional Marxists have always shown a concern for the condition of the working class and the world's downtrodden, expressing suspicion of the manipulations of capital and a hope that the dynamics of history would produce human liberation.

With liberal theorists, similarly, there is a fundamental conviction that expanding technology and economic growth will eventually make everyone relatively wealthy.

With Heideggerians, one always has the sense that there might someday be a "turning" within the history of being to save humanity from the perils of modernity.

With Mumford, there is always an underlying hope that the abstract, mechanistic obsessions of the modern age would be replaced by a more humane, organic sense of technical possibilities.

With Ellul, there remains the possibility that, even as the technological system reaches its maturity, humanity will renew its covenant with a forgiving God.

What are the corresponding prospects envisioned by social constructivism? The answer is by no means clear. To this point, the dreams and projects of social constructivists have been primarily academic ones, carefully sanitized of any critical standpoint that might contribute to substantive debates about the political and environmental dimensions of technological choice.

Perhaps the helpful insight they want to offer is simply that choices are available, that the course of technological development is not foreordained by outside forces but is, instead, a product of complex social interactions. If

that is the point of their inquires, then constructivists are now repeating it ad nauseam. Alas, this increasingly redundant theme has not been incorporated into anything like a program for positive change or a theoretical perspective that anticipates anything better than the current course of events. We do not find, for example, arguments by social constructivists to justify expanded democratic participation in key technological choices. Neither are there suggestions to illuminate processes of technological design in ways that might serve the ends of freedom and justice. Indeed, several social constructivists appear much more concerned to gaze at themselves within that endlessly enchanting hall of mirrors—sociological reflexivity.

In the manner in which it now presents itself, social constructivism offers a very limited purchase on the issues that surround technology. In its own distinct manner, the accomplishments that it recommends are largely technical ones, ways of enriching increasingly specialized sociological and historical research. As such, social constructivism now appears content to define itself as a narrow academic subfield—innovation studies. At present, it shows no inclination to reach further, to fashion conceptual links to the larger question about technology and the human condition that have engaged social and political thinkers throughout the 19th and 20th centuries.

The intellectual vogue of social constructivism arises at a crucial time. In the late 20th century, a great many people—scholars and ordinary citizens alike—have begun to realize that the key question is not how technology is constructed but how to come to terms with ways in which our technology-centered world might be reconstructed. Faced with a variety of social and environmental ills, there is growing recognition that what is needed is a process of redirecting our technological systems and projects in ways inspired by democratic and ecological principles. How that reconstruction might occur is an open question, one ripe for widespread study, debate, and action. I believe it to be the great challenge for cross-disciplinary thinking during the next several decades. How tragic it would be to find that, at the moment of greatest challenge, many leading scholars of technology and society had retreated into a blasé, depoliticized scholasticism.

Fortunately, this need not happen. It turns out that the very questions that the social constructivists typically ignore are the ones a good number of contemporary philosophers, political theorists, and social activists are still interested in posing. Although there is much we can learn from the new sociology of technology, there is also much in this way of thinking that needs to be criticized, reformulated, and refocused around a clearer understanding of what the aims of our thinking ought to be.

In sum, the search for a meaningful theory of technology has by no means achieved "closure." It must begin anew.

Notes

1. The best statement of the general aims and approaches of this school of thought is presented in *The Social Construction of Technological Systems* (Bijker, Hughes, and Pinch 1987).

2. The use of black boxes is a common engineering practice, a way of abbreviating complex technical processes so that the work of design can proceed. Textbooks, lectures, and problem sets employed in engineering education are also filled with black boxes that students are taught to view as convenient "plug-ins" for problem solving.

3. Pinch and Bijker (1987) show little awareness of the literature in philosophy and technology, past or present. That does not prevent them from delivering a peremptory judgment on the matter.

4. I do not wish to conflate works to the sociology and history of technology that have important distinguishing traits. Each published study by the scholars I mention here could well stand on its own merits alone. Some of the writers I have mentioned may even object to being classified within this category at all. Nevertheless, there has been a concerted push to affirm social constructivism as a coherent mode of analysis and to include or exclude writers according to their degree of adherence to this new canonical standard. It is that push to which I am responding here.

5. Probably the most complete application of this approach to date is Donald MacKenzie's (1990) study of missile guidance systems.

6. There are, of course, exceptions. One is the work of Ruth Schwarz Cowan, a historian sometimes included in social constructivist conferences and anthologies. Cowan's work is steadfast in its desire to show the connection between specific technological choices and how social life is affected as a consequence. The work of Brian Martin and his colleagues at the University of Wollongong also satisfies several of the criticisms I offer here (Cowan 1983).

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