The WHALE and the REACTOR

A Search for Limits in an Age of High Technology

LANGDON WINNER

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LANGDON WINNER is associate professor of political science at Rensselaer Polytechnic Institute and author of *Autonomous Technology*. He has written articles and reviews for many publications, including *The New York Times Book Review*, *Science*, *Village Voice*, *The Atlantic Monthly*, and *Rolling Stone*.

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To Gail and Matthew

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PREFACE

THE MAP OF the world shows no country called Technopolis, yet in many ways we are already its citizens. If one observes how thoroughly our lives are shaped by interconnected systems of modern technology, how strongly we feel their influence, respect their authority and participate in their workings, one begins to understand that, like it or not, we have become members of a new order in human history. To an ever-increasing extent, this order of things transcends national boundaries to create roles and relationships grounded in vast, complex instrumentalities of industrial production, electronic communications, transportation, agribusiness, medicine, and warfare. Observing the structures and processes of these vast systems, one begins to comprehend a distinctively modern form of power, the foundations of a technopolitan culture.

The significance of this state of affairs is by no means confined to its material success. When we use terms like "output," "feedback," "interface," and "networking" to express the transactions of everyday life, we reveal how thoroughly artificial things now shape our sense of human being. As we compare our own minds to the operations of a computer, we acknowledge that an understanding of technical devices has somehow merged with the most intimate levels of self-understanding. Seldom, however, are such matters the subject of critical reflection. For most people it is enough to know how technical systems are produced, how they are run, how they are best used, and how they contribute to that vast aggregate of blessings: economic growth.

My aim here is to go further, exploring the meaning of tech–

nology for the way we live. What appear to be nothing more than useful instruments are, from another point of view, enduring frameworks of social and political action. How can one look beyond the obvious facts of instrumentality to study the politics of technical objects? Which theoretical perspectives are most helpful in that attempt? In the three chapters of Part I, questions of that kind are examined and some initial steps taken toward developing a political philosophy of technology.

A number of modern social movements have chosen one technology or another as a focus of their hopes or fears. In Part II some of these movements are explored, noting the special opportunities and pitfalls that appear when technology is placed center stage. Appropriate technology, a form of radicalism characteristic of the 1970s, tried to reform society by suggesting we change our tools and our ways of thinking about them. What did the appropriate technologists accomplish? Where did they fall short? For more than a century utopian and anarchist critiques of industrial society have featured political and technical decentralization. While it has wonderful appeal, decentralization turns out to be a very slippery concept. How can it have any importance in a society thoroughly enmeshed in centralized patterns? Many of the passions that have inspired appropriate technology and decentralism have been reborn in the excitement surrounding the so-called computer revolution. Some computer enthusiasts believe that the coming of an information age will inevitably produce a more democratic, egalitarian society and that it will achieve this wonderful condition without the least bit of struggle. I will examine this romantic dream in detail.

A central theme throughout the book concerns the politics of language, a topic that Part III tackles explicitly. Choosing our terms, we express a vision of the world and name our deepest commitments. The quest for political consensus, however, sometimes leads to atrophy of the imagination. In debates about technology, society, and the environment, an extremely narrow range of concepts typically defines the realm of acceptable discussion. For most purposes, issues of efficiency and risk (or some variant of those) are the only ones to receive a thorough hearing. Any broader, deeper, or more perplexing questions are quickly pushed into the shadows and left to wither. How is it that we have gotten stuck packaging some of the important issues that face humanity in such conceptually impoverished terms? What would it take to open up the conversation about

technology to include a richer set of cares, categories, and criteria? In the final section we look at three concepts—"nature," "risk," and "values"—to see what light they shed on important choices before us.

In its approach to these matters, this is a work of criticism. If it were literary criticism, everyone would immediately understand that the underlying purpose is positive. A critic of literature examines a work, analyzing its features, evaluating its qualities, seeking a deeper appreciation that might be useful to other readers of the same text. In a similar way, critics of music, theater, and the arts have a valuable, well-established role, serving as a helpful bridge between artists and audiences. Criticism of technology, however, is not yet afforded the same glad welcome. Writers who venture beyond the most pedestrian, dreary conceptions of tools and uses to investigate ways in which technical forms are implicated in the basic patterns and problems of our culture are often greeted with the charge that they are merely "antitechnology" or "blaming technology." All who have recently stepped forward as critics in this realm have been tarred with the same idiot brush, an expression of the desire to stop a much needed dialogue rather than enlarge it. If any readers want to see the present work as "antitechnology," make the most of it. That is their topic, not mine.

What does interest me, however, is identified in the book's subtitle: A Search for Limits. In an age in which the inexhaustible power of scientific technology makes all things possible, it remains to be seen where we will draw the line, where we will be able to say, here are possibilities that wisdom suggests we avoid. I am convinced that any philosophy of technology worth its salt must eventually ask, How can we limit modern technology to match our best sense of who we are and the kind of world we would like to build? In several contexts and variations, that is my question throughout.

All of these are issues in public philosophy, and I have done my best to address them in an open, reasonable, public manner. But they are also extremely personal themes, a fact I do not try to conceal. When the whale surfaces in the final chapter, giving salute to a neighboring reactor, the reader will understand how I came to think about these matters in the first place.

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I

A PHILOSOPHY OF TECHNOLOGY

1

TECHNOLOGIES AS FORMS OF LIFE

FROM THE EARLY DAYS of manned space travel comes a story that exemplifies what is most fascinating about the human encounter with modern technology. Orbiting the earth aboard *Friendship* 7 in February 1962, astronaut John Glenn noticed something odd. His view of the planet was virtually unique in human experience; only Soviet pilots Yuri Gagarin and Gherman Titov had preceded him in orbital flight. Yet as he watched the continents and oceans moving beneath him, Glenn began to feel that he had seen it all before. Months of simulated space shots in sophisticated training machines and centifuges had affected his ability to respond. In the words of chronicler Tom Wolfe, "The world demanded awe, because this was a voyage through the stars. But he couldn't feel it. The backdrop of the event, the stage, the environment, the true orbit . . . was not the vast reaches of the universe. It was the simulators. *Who could possibly understand this*?"[1] Synthetic conditions generated in the training center had begun to seem more "real" than the actual experience.

It is reasonable to suppose that a society thoroughly committed to making artificial realities would have given a great deal of thought to the nature of that commitment. One might expect, for example, that the philosophy of technology would be a topic widely discussed by scholars and technical professionals, a lively field of inquiry often chosen by students at our universities and technical institutes. One might even think that the basic issues in this field would be well defined, its central controversies well worn. However, such is not the case. At this late date in the development of our industrial/technological civilization the most accurate observation to be made about the philosophy of technology is that there really isn't one.

The basic task for a philosophy of technology is to examine critically the nature and significance of artificial aids to human activity. That is its appropriate domain of inquiry, one that sets it apart from, say, the philosophy of science. Yet if one turns to the writings of twentieth-century philosophers, one finds astonishingly little attention given to questions of that kind. The six-volume *Encyclopedia of Philosophy*, a recent compendium of major themes in various traditions of philosophical discourse, contains no entry under the category "technology."[2] Neither does that work contain enough material under possible alternative headings to enable anyone to piece together an idea of what a philosophy of technology might be.

True, there are some writers who have taken up the topic. The standard bibliography in the philosophy of technology lists well over a thousand books and articles in several languages by nineteenth- and twentieth-century authors.[3] But reading through the material listed shows, in my view, little of enduring substance. The best writing on this theme comes to us from a few powerful thinkers who have encountered the subject in the midst of much broader and ambitious investigations—for example, Karl Marx in the development of his theory of historical materialism or Martin Heidegger as an aspect of his theory of ontology. It may be, in fact, that the philosophy is best seen as a derivative of more fundamental questions. For despite the fact that nobody would deny its importance to an adequate understanding of the human condition, technology has never joined epistemology, metaphysics, esthetics, law, science, and politics as a fully respectable topic for philosophical inquiry.

Engineers have shown little interest in filling this void. Except for airy pronouncements in yearly presidential addresses at various engineering societies, typically ones that celebrate the contributions of a particular technical vocation to the betterment of humankind, engineers appear unaware of any philosophical questions their work might entail. As a way of starting a conversation with my friends in engineering, I sometimes ask, "What are the founding principles of your discipline?" The question is always greeted with puzzlement. Even when I explain what I am after, namely, a coherent account of the nature and significance of the branch of engineering in which they are

involved, the question still means nothing to them. The scant few who raise important first questions about their technical professions are usually seen by their colleagues as dangerous cranks and radicals. If Socrates' suggestion that the "unexamined life is not worth living" still holds, it is news to most engineers.[4]

Technological Somnambulism

Why is it that the philosophy of technology has never really gotten under way? Why has a culture so firmly based upon countless sophisticated instruments, techniques, and systems remained so steadfast in its reluctance to examine its own foundations? Much of the answer can be found in the astonishing hold the idea of "progress" has exercised on social thought during the industrial age. In the twentieth century it is usually taken for granted that the only reliable sources for improving the human condition stem from new machines, techniques, and chemicals. Even the recurring environmental and social ills that have accompanied technological advancement have rarely dented this faith. It is still a prerequisite that the person running for public office swear his or her unflinching confidence in a positive link between technical development and human well-being and affirm that the next wave of innovations will surely be our salvation.

There is, however, another reason why the philosophy of technology has never gathered much steam. According to conventional views, the human relationship to technical things is too obvious to merit serious reflection. The deceptively reasonable notion that we have inherited from much earlier and less complicated times divides the range of possible concerns about technology into two basic categories: *making* and *use*. In the first of these our attention is drawn to the matter of "how things work" and of "making things work." We tend to think that this is a fascination of certain people in certain occupations, but not for anyone else. "How things work" is the domain of inventors, technicians, engineers, repairmen, and the like who prepare artificial aids to human activity and keep them in good working order. Those not directly involved in the various spheres of "making" are thought to have little interest in or need to know about the materials, principles, or procedures found in those spheres.

What the others do care about, however, are tools and uses.

This is understood to be a straightforward matter. Once things have been made, we interact with them on occasion to achieve specific purposes. One picks up a tool, uses it, and puts it down. One picks up a telephone, talks on it, and then does not use it for a time. A person gets on an airplane, flies from point A to point B, and then gets off. The proper interpretation of the meaning of technology in the mode of use seems to be nothing more complicated than an occasional, limited, and nonproblematic interaction.

The language of the notion of "use" also includes standard terms that enable us to interpret technologies in a range of moral contexts. Tools can be "used well or poorly" and for "good or bad purposes"; I can use my knife to slice a loaf of bread or to stab the next person that walks by. Because technological objects and processes have a promiscuous utility, they are taken to be fundamentally neutral as regards their moral standing.

The conventional idea of what technology is and what it means, an idea powerfully reinforced by familiar terms used in everyday language, needs to be overcome if a critical philosophy of technology is to move ahead. The crucial weakness of the conventional idea is that it disregards the many ways in which technologies provide structure for human activity. Since, according to accepted wisdom, patterns that take shape in the sphere of "making" are of interest to practitioners alone, and since the very essence of "use" is its occasional, innocuous, nonstructuring occurrence, any further questioning seems irrelevant.[5]

If the experience of modern society shows us anything, however, it is that technologies are not merely aids to human activity, but also powerful forces acting to reshape that activity and its meaning. The introduction of a robot to an industrial workplace not only increases productivity, but often radically changes the process of production, redefining what "work" means in that setting. When a sophisticated new technique or instrument is adopted in medical practice, it transforms not only what doctors do, but also the ways people think about health, sickness, and medical care. Widespread alterations of this kind in techniques of communication, transportation, manufacturing, agriculture, and the like are largely what distinguishes our times from early periods of human history. The kinds of things we are apt to see as "mere" technological entities become much more interesting and problematic if we begin to observe how broadly they are involved in conditions of social and moral life.

It is true that recurring patterns of life's activity (whatever their origins) tend to become unconscious processes taken for granted. Thus, we do not pause to reflect upon how we speak a language as we are doing so or the motions we go through in taking a shower. There is, however, one point at which we may become aware of a pattern taking shape—the very first time we encounter it. An opportunity of that sort occurred several years ago at the conclusion of a class I was teaching. A student came to my office on the day term papers were due and told me his essay would be late. "It crashed this morning," he explained. I immediately interpreted this as a "crash" of the conceptual variety, a flimsy array of arguments and observations that eventually collapses under the weight of its own ponderous absurdity. Indeed, some of my own papers have "crashed" in exactly that manner. But this was not the kind of mishap that had befallen this particular fellow. He went on to explain that his paper had been composed on a computer terminal and that it had been stored in a time-sharing minicomputer. It sometimes happens that the machine "goes down" or "crashes," making everything that happens in and around it stop until the computer can be "brought up," that is, restored to full functioning.

As I listened to the student's explanation, I realized that he was telling me about the facts of a particular form of activity in modern life in which he and others similarly situated were already involved and that I had better get ready for. I remembered J. L. Austin's little essay "A Plea for Excuses" and noticed that the student and I were negotiating one of the boundaries of contemporary moral life—where and how one gives and accepts an excuse in a particular technology-mediated situation.[6] He was, in effect, asking me to recognize a new world of parts and pieces and to acknowledge appropriate practices and expectations that hold in that world. From then on, a knowledge of this situation would be included in my understanding of not only "how things work" in that generation of computers, but also how we do things as a consequence, including which rules to follow when the machines break down. Shortly thereafter I got used to computers crashing, disrupting hotel reservations, banking, and other everyday transactions; eventually, my own papers began crashing in this new way.

Some of the moral negotiations that accompany technological change eventually become matters of law. In recent times, for example, a number of activities that employ computers as their operating medium have been legally defined as "crimes." Is unauthorized access to a computerized data base a criminal offense? Given the fact that electronic information is in the strictest sense intangible, under what conditions is it "property" subject to theft? The law has had to stretch and reorient its traditional categories to encompass such problems, creating whole new classes of offenses and offenders.

The ways in which technical devices tend to engender distinctive worlds of their own can be seen in a more familiar case. Picture two men traveling in the same direction along a street on a peaceful, sunny day, one of them afoot and the other driving an automobile. The pedestrian has a certain flexibility of movement: he can pause to look in a shop window, speak to passersby, and reach out to pick a flower from a sidewalk garden. The driver, although he has the potential to move much faster, is constrained by the enclosed space of the automobile, the physical dimensions of the highway, and the rules of the road. His realm is spatially structured by his intended destination, by a periphery of more-or-less irrelevant objects (scenes for occasional side glances), and by more important objects of various kinds—moving and parked cars, bicycles, pedestrians, street signs, etc., that stand in his way. Since the first rule of good driving is to avoid hitting things, the immediate environment of the motorist becomes a field of obstacles.

Imagine a situation in which the two persons are next-door neighbors. The man in the automobile observes his friend strolling along the street and wishes to say hello. He slows down, honks his horn, rolls down the window, sticks out his head, and shouts across the street. More likely than not the pedestrian will be startled or annoyed by the sound of the horn. He looks around to see what's the matter and tries to recognize who can be yelling at him across the way. "Can you come to dinner Saturday night?" the driver calls out over the street noise. "What?" the pedestrian replies, straining to understand. At that moment another car to the rear begins honking to break up the temporary traffic jam. Unable to say anything more, the driver moves on.

What we see here is an automobile collision of sorts, although not one that causes bodily injury. It is a collision between the *world* of the driver and that of the pedestrian. The attempt to extend a greeting and invitation, ordinarily a simple gesture, is complicated by the presence of a technological device and its

standard operating conditions. The communication between the two men is shaped by an incompatibility of the form of locomotion known as walking and a much newer one, automobile driving. In cities such as Los Angeles, where the physical landscape and prevailing social habits assume everyone drives a car, the simple act of walking can be cause for alarm. The U.S. Supreme Court decided one case involving a young man who enjoyed taking long walks late at night through the streets of San Diego and was repeatedly arrested by police as a suspicious character. The Court decided in favor of the pedestrian, noting that he had not been engaged in burglary or any other illegal act. Merely traveling by foot is not yet a crime.[7]

Knowing how automobiles are made, how they operate, and how they are used and knowing about traffic laws and urban transportation policies does little to help us understand how automobiles affect the texture of modern life. In such cases a strictly instrumental/functional understanding fails us badly. What is needed is an interpretation of the ways, both obvious and subtle, in which everyday life is transformed by the mediating role of technical devices. In hindsight the situation is clear to everyone. Individual habits, perceptions, concepts of self, ideas of space and time, social relationships, and moral and political boundaries have all been powerfully restructured in the course of modern technological development. What is fascinating about this process is that societies involved in it have quickly altered some of the fundamental terms of human life without appearing to do so. Vast transformations in the structure of our common world have been undertaken with little attention to what those alterations mean. Judgments about technology have been made on narrow grounds, paying attention to such matters as whether a new device serves a particular need, performs more efficiently than its predecessor, makes a profit, or provides a convenient service. Only later does the broader significance of the choice become clear, typically as a series of surprising "side effects" or "secondary consequences." But it seems characteristic of our culture's involvement with technology that we are seldom inclined to examine, discuss, or judge pending innovations with broad, keen awareness of what those changes mean. In the technical realm we repeatedly enter into a series of social contracts, the terms of which are revealed only after the signing.

It may seem that the view I am suggesting is that of technological determinism: the idea that technological innovation is the basic cause of changes in society and that human beings have little choice other than to sit back and watch this ineluctable process unfold. But the concept of determinism is much too strong, far too sweeping in its implications to provide an adequate theory. It does little justice to the genuine choices that arise, in both principle and practice, in the course of technical and social transformation. Being saddled with it is like attempting to describe all instances of sexual intercourse based only on the concept of rape. A more revealing notion, in my view, is that of technological somnambulism. For the interesting puzzle in our times is that we so willingly sleepwalk through the process of reconstituting the conditions of human existence.

Beyond Impacts and Side Effects

SOCIAL SCIENTISTS have tried to awaken the sleeper by developing methods of technology assessment. The strength of these methods is that they shed light on phenomena that were previously overlooked. But an unfortunate shortcoming of technology assessment is that it tends to see technological change as a "cause" and everything that follows as an "effect" or "impact." The role of the researcher is to identify, observe, and explain these effects. This approach assumes that the causes have already occurred or are bound to do so in the normal course of events. Social research boldly enters the scene to study the "consequences" of the change. After the bulldozer has rolled over us, we can pick ourselves up and carefully measure the treadmarks. Such is the impotent mission of technological "impact" assessment.

A somewhat more farsighted version of technology assessment is sometimes used to predict which changes are likely to happen, the "social impacts of computerization" for example. With these forecasts at its disposal, society is, presumably, better able to chart its course. But, once again, the attitude in which the predictions are offered usually suggests that the "impacts" are going to happen in any case. Assertions of the sort "Computerization will bring about a revolution in the way we educate our children" carry the strong implication that those who will experience the change are obliged simply to endure it. Humans must adapt. That is their destiny. There is no tampering with the source of change, and only minor modifications are possible

at the point of impact (perhaps some slight changes in the fashion contour of this year's treadmarks).

But we have already begun to notice another view of technological development, one that transcends the empirical and moral shortcomings of cause-and-effect models. It begins with the recognition that as technologies are being built and put to use, significant alterations in patterns of human activity and human institutions are already taking place. New worlds are being made. There is nothing "secondary" about this phenomenon. It is, in fact, the most important accomplishment of any new technology. The construction of a technical system that involves human beings as operating parts brings a reconstruction of social roles and relationships. Often this is a result of a new system's own operating requirements: it simply will not work unless human behavior changes to suit its form and process. Hence, the very act of using the kinds of machines, techniques, and systems available to us generates patterns of activities and expectations that soon become "second nature." We do indeed "use" telephones, automobiles, electric lights, and computers in the conventional sense of picking them up and putting them down. But our world soon becomes one in which telephony, automobility, electric lighting, and computing are forms of life in the most powerful sense: life would scarcely be thinkable without them.

My choice of the term "forms of life" in this context derives from Ludwig Wittgenstein's elaboration of that concept in *Philosophical Investigations*. In his later writing Wittgenstein sought to overcome an extremely narrow view of the structure of language then popular among philosophers, a view that held language to be primarily a matter of naming things and events. Pointing to the richness and multiplicity of the kinds of expression or "language games" that are a part of everyday speech, Wittgenstein argued that "the speaking of language is a part of an activity, or of a form of life."[8] He gave a variety of examples—the giving of orders, speculating about events, guessing riddles, making up stories, forming and testing hypotheses, and so forth—to indicate the wide range of language games involved in various "forms of life." Whether he meant to suggest that these are patterns that occur naturally to all human beings or that they are primarily cultural conventions that can change with time and setting is a question open to dispute.[9] For the purposes here, what matters is not the ultimate philosophical status of Wittgenstein's concept but its suggestiveness in helping us to overcome another widespread and extremely narrow conception: our normal understanding of the meaning of technology in human life.

As they become woven into the texture of everyday existence, the devices, techniques, and systems we adopt shed their tool-like qualities to become part of our very humanity. In an important sense we become the beings who work on assembly lines, who talk on telephones, who do our figuring on pocket calculators, who eat processed foods, who clean our homes with powerful chemicals. Of course, working, talking, figuring, eating, cleaning, and such things have been parts of human activity for a very long time. But technological innovations can radically alter these common patterns and on occasion generate entirely new ones, often with surprising results. The role television plays in our society offers some poignant examples. None of those who worked to perfect the technology of television in its early years and few of those who brought television sets into their homes ever intended the device to be employed as the universal babysitter. That, however, has become one of televisions' most common functions in the modern home. Similarly, if anyone in the 1930s had predicted people would eventually be watching seven hours of television each day, the forecast would have been laughed away as absurd. But recent surveys indicate that we Americans do spend that much time, roughly one-third of our lives, staring at the tube. Those who wish to reassert freedom of choice in the matter sometimes observe, "You can always turn off your TV." In a trivial sense that is true. At least for the time being the on/off button is still included as standard equipment on most sets (perhaps someday it will become optional). But given how central television has become to the content of everyday life, how it has become the accustomed topic of conversation in workplaces, schools, and other social gatherings, it is apparent that television is a phenomenon that, in the larger sense, cannot be "turned off" at all. Deeply insinuated into people's perceptions, thoughts, and behavior, it has become an indelible part of modern culture.

Most changes in the content of everyday life brought on by technology can be recognized as versions of earlier patterns. Parents have always had to entertain and instruct children and to find ways of keeping the little ones out of their hair. Having youngsters watch several hours of television cartoons is, in one

way of looking at the matter, merely a new method for handling this age-old task, although the "merely" is of no small significance. It is important to ask, Where, if at all, have modern technologies added *fundamentally new* activities to the range of things human beings do? Where and how have innovations in science and technology begun to alter the very *conditions of life* itself? Is computer programming only a powerful recombination of forms of life known for ages—doing mathematics, listing, sorting, planning, organizing, etc.—or is it something unprecedented? Is industrialized agribusiness simply a renovation of older ways of farming, or does it amount to an entirely new phenomenon?

Certainly, there are some accomplishments of modern technology, manned air flight, for example, that are clearly altogether novel. Flying in airplanes is not just another version of modes of travel previously known; it is something new. Although the hope of humans flying is as old as the myth of Daedalus and Icarus or the angels of the *Old Testament*, it took a certain kind of modern machinery to realize the dream in practice. Even beyond the numerous breakthroughs that have pushed the boundaries of human action, however, lie certain kinds of changes now on the horizon that would amount to a fundamental change in the conditions of human life itself. One such prospect is that of altering human biology through genetic engineering. Another is the founding of permanent settlements in outer space. Both of these possibilities call into question what it means to be human and what constitutes "the human condition."[10] Speculation about such matters is now largely the work of science fiction, whose notorious perversity as a literary genre signals the troubles that lie in wait when we begin thinking about becoming creatures fundamentally different from any the earth has seen. A great many futuristic novels are blatantly technopornographic.

But, on the whole, most of the transformations that occur in the wake of technological innovation are actually variations of very old patterns. Wittgenstein's philosophically conservative maxim "What has to be accepted, the given, is—so one could say—*forms of life*" could well be the guiding rule of a phenomenology of technical practice.[11] For instance, asking a question and awaiting an answer, a form of interaction we all know well, is much the same activity whether it is a person we are confronting or a computer. There are, of course, significant differences between persons and computers (although it is fashionable in some circles to ignore them). Forms of life that we mastered before the coming of the computer shape our expectations as we begin to use the instrument. One strategy of software design, therefore, tries to "humanize" the computers by having them say "Hello" when the user logs in or having them respond with witty remarks when a person makes an error. We carry with us highly structured anticipations about entities that appear to participate, if only minimally, in forms of life and associated language games that are parts of human culture. Those anticipations provide much of the persuasive power of those who prematurely claim great advances in "artificial intelligence" based on narrow but impressive demonstrations of computer performance. But then children have always fantasized that their dolls were alive and talking.

The view of technologies as forms of life I am proposing has its clearest beginnings in the writings of Karl Marx. In Part I of *The German Ideology*, Marx and Engels explain the relationship of human individuality and material conditions of production as follows: "The way in which men produce their means of subsistence depends first of all on the nature of the means of subsistence they actually find in existence and have to reproduce. This mode of production must not be considered simply as being the reproduction of the physical existence of the individuals. Rather it is a definite form of activity of these individuals, a definite form of expressing their life, a definite *mode of life* on their part. As individuals express their life, so they are."[12]

Marx's concept of production here is a very broad and suggestive one. It reveals the total inadequacy of any interpretation that finds social change a mere "side effect" or "impact" of technological innovation. While he clearly points to means of production that sustain life in an immediate, physical sense, Marx's view extends to a general understanding of human development in a world of diverse natural resources, tools, machines, products, and social relations. The notion is clearly not one of occasional human interaction with devices and material conditions that leave individuals unaffected. By changing the shape of material things, Marx observes, we also change ourselves. In this process human beings do not stand at the mercy of a great deterministic punch press that cranks out precisely tailored persons at a certain rate during a given historical period. Instead, the situation Marx describes is one in which individuals are actively involved in the daily creation and recreation, production and

reproduction of the world in which they live. Thus, as they employ tools and techniques, work in social labor arrangements, make and consume products, and adapt their behavior to the material conditions they encounter in their natural and artificial environment, individuals realize possibilities for human existence that are inaccessible in more primitive modes of production.

Marx expands upon this idea in "The Chapter on Capital" in the *Grundrisse*. The development of forces of production in history, he argues, holds the promise of the development of a many-sided individuality in all human beings. Capital's unlimited pursuit of wealth leads it to develop the productive powers of labor to a state "where the possession and preservation of general wealth require a lesser labour time of society as a whole, and where the labouring society relates scientifically to the process of its progressive reproduction, its reproduction in constantly greater abundance." This movement toward a general form of wealth "creates the material elements for the development of the rich individuality which is all-sided in its production as in its consumption, and whose labour also therefore appears no longer as labour, but as the full development of activity itself."[13]

If one has access to tools and materials of woodworking, a person can develop the human qualities found in the activities of carpentry. If one is able to employ the instruments and techniques of music making, one can become (in that aspect of one's life) a musician. Marx's ideal here, a variety of materialist humanism, anticipates that in a properly structured society under modern conditions of production, people would engage in a very wide range of activities that enrich their individuality along many dimensions. It is that promise which, he argues, the institutions of capitalism thwart and cripple.[14]

As applied to an understanding of technology, the philosophies of Marx and Wittgenstein direct our attention to the fabric of everyday existence. Wittgenstein points to a vast multiplicity of cultural practices that comprise our common world. Asking us to notice "what we say when," his approach can help us recognize the way language reflects the content of technical practice. It makes sense to ask, for example, how the adoption of digital computers might alter the way people think of their own faculties and activities. If Wittgenstein is correct, we would expect that changes of this kind would appear, sooner or later, in the language people use to talk about themselves. Indeed, it has now become commonplace to hear people say "I need to access your data." "I'm not programmed for that." "We must improve our interface." "The mind is the best computer we have."

Marx, on the other hand, recommends that we see the actions and interactions of everyday life within an enormous tapestry of historical developments. On occasion, as in the chapter on "Machinery and Large-Scale Industry" in *Capital*, his mode of interpretation also includes a place for a more microscopic treatment of specific technologies in human experience.[15] But on the whole his theory seeks to explain very large patterns, especially relationships between different social classes, that unfold at each stage in the history of material production. These developments set the stage for people's ability to survive and express themselves, for their ways of being human.

Return to Making

TO INVOKE Wittgenstein and Marx in this context, however, is not to suggest that either one or both provide a sufficient basis for a critical philosophy of technology. Proposing an attitude in which forms of life must be accepted as "the given," Wittgenstein decides that philosophy "leaves everything as it is."[16] Although some Wittgensteinians are eager to point out that this position does not necessarily commit the philosopher to conservatism in an economic or political sense, it does seem that as applied to the study of forms of life in the realm of technology, Wittgenstein leaves us with little more than a passive traditionalism. If one hopes to interpret technological phenomena in a way that suggests positive judgments and actions, Wittgensteinian philosophy leaves much to be desired.

In a much different way Marx and Marxism contain the potential for an equally woeful passivity. This mode of understanding places its hope in historical tendencies that promise human emancipation at some point. As forces of production and social relations of production develop and as the proletariat makes its way toward revolution, Marx and his orthodox followers are willing to allow capitalist technology, for example, the factory system, to develop to its farthest extent. Marx and Engels scoffed at the utopians, anarchists, and romantic critics of industrialism who thought it possible to make moral and political judgments about the course a technological society ought to take and to influence that path through the application of

philosophical principles. Following this lead, most Marxists have believed that while capitalism is a target to be attacked, technological expansion is entirely good in itself, something to be encouraged without reservation. In its own way, then, Marxist theory upholds an attitude as nearly lethargic as the Wittgensteinian decision to "leave everything as it is." The famous eleventh thesis on Feuerbach—"The philosophers have only interpreted the world in various ways; the point, however, is to change it"—conceals an important qualification: that judgment, action, and change are ultimately products of history. In its view of technological development Marxism anticipates a history of rapidly evolving material productivity, an inevitable course of events in which attempts to propose moral and political limits have no place. When socialism replaces capitalism, so the promise goes, the machine will finally move into high gear, presumably releasing humankind from its age-old miseries.

Whatever their shortcomings, however, the philosophies of Marx and Wittgenstein share a fruitful insight: the observation that social activity is an ongoing process of world-making. Throughout their lives people come together to renew the fabric of relationships, transactions, and meanings that sustain their common existence. Indeed, if they did not engage in this continuing activity of material and social production, the human world would literally fall apart. All social roles and frameworks—from the most rewarding to the most oppressive—must somehow be restored and reproduced with the rise of the sun each day.

From this point of view, the important question about technology becomes, As we "make things work," what kind of *world* are we making? This suggests that we pay attention not only to the making of physical instruments and processes, although that certainly remains important, but also to the production of psychological, social, and political conditions as a part of any significant technical change. Are we going to design and build circumstances that enlarge possibilities for growth in human freedom, sociability, intelligence, creativity, and self-government? Or are we headed in an altogether different direction?

It is true that not every technological innovation embodies choices of great significance. Some developments are more-or-less innocuous; many create only trivial modifications in how we live. But in general, where there are substantial changes being made in what people are doing and at a substantial investment of social resources, then it always pays to ask in advance about the qualities of the artifacts, institutions, and human experiences currently on the drawing board.

Inquiries of this kind present an important challenge to all disciplines in the social sciences and humanities. Indeed, there are many historians, anthropologists, sociologists, psychologists, and artists whose work sheds light on long-overlooked human dimensions of technology. Even engineers and other technical professionals have much to contribute here when they find courage to go beyond the narrow-gauge categories of their training.

The study of politics offers its own characteristic route into this territory. As the political imagination confronts technologies as forms of life, it should be able to say something about the choices (implicit or explicit) made in the course of technological innovation and the grounds for making those choices wisely. That is a task I take up in the next two chapters. Through technological creation and many other ways as well, we make a world for each other to live in. Much more than we have acknowledged in the past, we must admit our responsibility for what we are making.

2
DO ARTIFACTS HAVE POLITICS?

NO IDEA IS more provocative in controversies about technology and society than the notion that technical things have political qualities. At issue is the claim that the machines, structures, and systems of modern material culture can be accurately judged not only for their contributions to efficiency and productivity and their positive and negative environmental side effects, but also for the ways in which they can embody specific forms of power and authority. Since ideas of this kind are a persistent and troubling presence in discussions about the meaning of technology, they deserve explicit attention.

Writing in the early 1960s, Lewis Mumford gave classic statement to one version of the theme, arguing that "from late neolithic times in the Near East, right down to our own day, two technologies have recurrently existed side by side: one authoritarian, the other democratic, the first system-centered, immensely powerful, but inherently unstable, the other man-centered, relatively weak, but resourceful and durable."[1] This thesis stands at the heart of Mumford's studies of the city, architecture, and history of technics, and mirrors concerns voiced earlier in the works of Peter Kropotkin, William Morris, and other nineteenth-century critics of industrialism. During the 1970s, antinuclear and pro-solar energy movements in Europe and the United States adopted a similar notion as the centerpiece of their arguments. According to environmentalist Denis Hayes, "The increased deployment of nuclear power facilities must lead society toward authoritarianism. Indeed, safe reliance upon nuclear power as the principal source of energy may be possible only in a totalitarian state." Echoing the views of many proponents of appropriate technology and the soft energy path, Hayes contends that "dispersed solar sources are more compatible than centralized technologies with social equity, freedom and cultural pluralism."[2]

An eagerness to interpret technical artifacts in political language is by no means the exclusive property of critics of large-scale, high-technology systems. A long lineage of boosters has insisted that the biggest and best that science and industry made available were the best guarantees of democracy, freedom, and social justice. The factory system, automobile, telephone, radio, television, space program, and of course nuclear power have all at one time or another been described as democratizing, liberating forces. David Lillienthal's *T.V.A.: Democracy on the March*, for example, found this promise in the phosphate fertilizers and electricity that technical progress was bringing to rural Americans during the 1940s.[3] Three decades later Daniel Boorstin's *The Republic of Technology* extolled television for "its power to disband armies, to cashier presidents, to create a whole new democratic world—democratic in ways never before imagined, even in America."[4] Scarcely a new invention comes along that someone doesn't proclaim it as the salvation of a free society.

It is no surprise to learn that technical systems of various kinds are deeply interwoven in the conditions of modern politics. The physical arrangements of industrial production, warfare, communications, and the like have fundamentally changed the exercise of power and the experience of citizenship. But to go beyond this obvious fact and to argue that certain technologies *in themselves* have political properties seems, at first glance, completely mistaken. We all know that people have politics; things do not. To discover either virtues or evils in aggregates of steel, plastic, transistors, integrated circuits, chemicals, and the like seems just plain wrong, a way of mystifying human artifice and of avoiding the true sources, the human sources of freedom and oppression, justice and injustice. Blaming the hardware appears even more foolish than blaming the victims when it comes to judging conditions of public life.

Hence, the stern advice commonly given those who flirt with the notion that technical artifacts have political qualities: What matters is not technology itself, but the social or economic system in which it is embedded. This maxim, which in a number of variations is the central premise of a theory that can be called the

social determination of technology, has an obvious wisdom. It serves as a needed corrective to those who focus uncritically upon such things as "the computer and its social impacts" but who fail to look behind technical devices to see the social circumstances of their development, deployment, and use. This view provides an antidote to naive technological determinism—the idea that technology develops as the sole result of an internal dynamic and then, unmediated by any other influence, molds society to fit its patterns. Those who have not recognized the ways in which technologies are shaped by social and economic forces have not gotten very far.

But the corrective has its own shortcomings; taken literally, it suggests that technical *things* do not matter at all. Once one has done the detective work necessary to reveal the social origins—power holders behind a particular instance of technological change—one will have explained everything of importance. This conclusion offers comfort to social scientists. It validates what they had always suspected, namely, that there is nothing distinctive about the study of technology in the first place. Hence, they can return to their standard models of social power—those of interest-group politics, bureaucratic politics, Marxist models of class struggle, and the like—and have everything they need. The social determination of technology is, in this view, essentially no different from the social determination of, say, welfare policy or taxation.

There are, however, good reasons to believe that technology is politically significant in its own right, good reasons why the standard models of social science only go so far in accounting for what is most interesting and troublesome about the subject. Much of modern social and political thought contains recurring statements of what can be called a theory of technological politics, an odd mongrel of notions often crossbred with orthodox liberal, conservative, and socialist philosophies.[5] The theory of technological politics draws attention to the momentum of large-scale sociotechnical systems, to the response of modern societies to certain technological imperatives, and to the ways human ends are powerfully transformed as they are adapted to technical means. This perspective offers a novel framework of interpretation and explanation for some of the more puzzling patterns that have taken shape in and around the growth of modern material culture. Its starting point is a decision to take technical artifacts seriously. Rather than insist that we immediately reduce everything to the interplay of social forces, the theory of technological politics suggests that we pay attention to the characteristics of technical objects and the meaning of those characteristics. A necessary complement to, rather than a replacement for, theories of the social determination of technology, this approach identifies certain technologies as political phenomena in their own right. It points us back, to borrow Edmund Husserl's philosophical injunction, *to the things themselves*.

In what follows I will outline and illustrate two ways in which artifacts can contain political properties. First are instances in which the invention, design, or arrangement of a specific technical device or system becomes a way of settling an issue in the affairs of a particular community. Seen in the proper light, examples of this kind are fairly straightforward and easily understood. Second are cases of what can be called "inherently political technologies," man-made systems that appear to require or to be strongly compatible with particular kinds of political relationships. Arguments about cases of this kind are much more troublesome and closer to the heart of the matter. By the term "politics" I mean arrangements of power and authority in human associations as well as the activities that take place within those arrangements. For my purposes here, the term "technology" is understood to mean all of modern practical artifice, but to avoid confusion I prefer to speak of "technologies" plural, smaller or larger pieces or systems of hardware of a specific kind.[6] My intention is not to settle any of the issues here once and for all, but to indicate their general dimensions and significance.

Technical Arrangements and Social Order

ANYONE WHO has traveled the highways of America and has gotten used to the normal height of overpasses may well find something a little odd about some of the bridges over the parkways on Long Island, New York. Many of the overpasses are extraordinarily low, having as little as nine feet of clearance at the curb. Even those who happened to notice this structural peculiarity would not be inclined to attach any special meaning to it. In our accustomed way of looking at things such as roads and bridges, we see the details of form as innocuous and seldom give them a second thought.

It turns out, however, that some two hundred or so low-hanging overpasses on Long Island are there for a reason. They were deliberately designed and built that way by someone who wanted to achieve a particular social effect. Robert Moses, the master builder of roads, parks, bridges, and other public works of the 1920s to the 1970s in New York, built his overpasses according to specifications that would discourage the presence of buses on his parkways. According to evidence provided by Moses' biographer, Robert A. Caro, the reasons reflect Moses' social class bias and racial prejudice. Automobile-owning whites of "upper" and "comfortable middle" classes, as he called them, would be free to use the parkways for recreation and commuting. Poor people and blacks, who normally used public transit, were kept off the roads because the twelve-foot tall buses could not handle the overpasses. One consequence was to limit access of racial minorities and low-income groups to Jones Beach, Moses' widely acclaimed public park. Moses made doubly sure of this result by vetoing a proposed extension of the Long Island Railroad to Jones Beach.

Robert Moses' life is a fascinating story in recent U.S. political history. His dealings with mayors, governors, and presidents; his careful manipulation of legislatures, banks, labor unions, the press, and public opinion could be studied by political scientists for years. But the most important and enduring results of his work are his technologies, the vast engineering projects that give New York much of its present form. For generations after Moses' death and the alliances he forged have fallen apart, his public works, especially the highways and bridges he built to favor the use of the automobile over the development of mass transit, will continue to shape that city. Many of his monumental structures of concrete and steel embody a systematic social inequality, a way of engineering relationships among people that, after a time, became just another part of the landscape. As New York planner Lee Koppleman told Caro about the low bridges on Wantagh Parkway, "The old son of a gun had made sure that buses would *never* be able to use his goddamned parkways."[7]

Histories of architecture, city planning, and public works contain many examples of physical arrangements with explicit or implicit political purposes. One can point to Baron Haussmann's broad Parisian thoroughfares, engineered at Louis Napoleon's direction to prevent any recurrence of street fighting of the kind that took place during the revolution of 1848. Or one can visit any number of grotesque concrete buildings and huge plazas constructed on university campuses in the United States during the late 1960s and early 1970s to defuse student demonstrations. Studies of industrial machines and instruments also turn up interesting political stories, including some that violate our normal expectations about why technological innovations are made in the first place. If we suppose that new technologies are introduced to achieve increased efficiency, the history of technology shows that we will sometimes be disappointed. Technological change expresses a panoply of human motives, not the least of which is the desire of some to have dominion over others even though it may require an occasional sacrifice of cost savings and some violation of the normal standard of trying to get more from less.

One poignant illustration can be found in the history of nineteenth-century industrial mechanization. At Cyrus McCormick's reaper manufacturing plant in Chicago in the middle 1880s, pneumatic molding machines, a new and largely untested innovation, were added to the foundry at an estimated cost of $500,000. The standard economic interpretation would lead us to expect that this step was taken to modernize the plant and achieve the kind of efficiencies that mechanization brings. But historian Robert Ozanne has put the development in a broader context. At the time, Cyrus McCormick II was engaged in a battle with the National Union of Iron Molders. He saw the addition of the new machines as a way to "weed out the bad element among the men," namely, the skilled workers who had organized the union local in Chicago.[8] The new machines, manned by unskilled laborers, actually produced inferior castings at a higher cost than the earlier process. After three years of use the machines were, in fact, abandoned, but by that time they had served their purpose—the destruction of the union. Thus, the story of these technical developments at the McCormick factory cannot be adequately understood outside the record of workers' attempts to organize, police repression of the labor movement in Chicago during that period, and the events surrounding the bombing at Haymarket Square. Technological history and U.S. political history were at that moment deeply intertwined.

In the examples of Moses' low bridges and McCormick's molding machines, one sees the importance of technical arrangements that precede the *use* of the things in question. It is obvious that technologies can be used in ways that enhance the power, authority, and privilege of some over others, for example, the use of television to sell a candidate. In our accustomed way of thinking technologies are seen as neutral tools that can be used well or poorly, for good, evil, or something in between. But we usually do not stop to inquire whether a given device might have been designed and built in such a way that it produces a set of consequences logically and temporally *prior to any of its professed uses*. Robert Moses' bridges, after all, were used to carry automobiles from one point to another; McCormick's machines were used to make metal castings; both technologies, however, encompassed purposes far beyond their immediate use. If our moral and political language for evaluating technology includes only categories having to do with tools and uses, if it does not include attention to the meaning of the designs and arrangements of our artifacts, then we will be blinded to much that is intellectually and practically crucial.

Because the point is most easily understood in the light of particular intentions embodied in physical form, I have so far offered illustrations that seem almost conspiratorial. But to recognize the political dimensions in the shapes of technology does not require that we look for conscious conspiracies or malicious intentions. The organized movement of handicapped people in the United States during the 1970s pointed out the countless ways in which machines, instruments, and structures of common use—buses, buildings, sidewalks, plumbing fixtures, and so forth—made it impossible for many handicapped persons to move freely about, a condition that systematically excluded them from public life. It is safe to say that designs unsuited for the handicapped arose more from long-standing neglect than from anyone's active intention. But once the issue was brought to public attention, it became evident that justice required a remedy. A whole range of artifacts have been redesigned and rebuilt to accommodate this minority.

Indeed, many of the most important examples of technologies that have political consequences are those that transcend the simple categories "intended" and "unintended" altogether. These are instances in which the very process of technical development is so thoroughly biased in a particular direction that it regularly produces results heralded as wonderful breakthroughs by some social interests and crushing setbacks by others. In such cases it is neither correct nor insightful to say, "Someone intended to do somebody else harm." Rather one must say that the technological deck has been stacked in advance to favor certain social interests and that some people were bound to receive a better hand than others.

The mechanical tomato harvester, a remarkable device perfected by researchers at the University of California from the late 1940s to the present offers an illustrative tale. The machine is able to harvest tomatoes in a single pass through a row, cutting the plants from the ground, shaking the fruit loose, and (in the newest models) sorting the tomatoes electronically into large plastic gondolas that hold up to twenty-five tons of produce headed for canning factories. To accommodate the rough motion of these harvesters in the field, agricultural researchers have bred new varieties of tomatoes that are hardier, sturdier, and less tasty than those previously grown. The harvesters replace the system of handpicking in which crews of farm workers would pass through the fields three or four times, putting ripe tomatoes in lug boxes and saving immature fruit for later harvest.[9] Studies in California indicate that the use of the machine reduces costs by approximately five to seven dollars per ton as compared to hand harvesting.[10] But the benefits are by no means equally divided in the agricultural economy. In fact, the machine in the garden has in this instance been the occasion for a thorough reshaping of social relationships involved in tomato production in rural California.

By virtue of their very size and cost of more than $50,000 each, the machines are compatible only with a highly concentrated form of tomato growing. With the introduction of this new method of harvesting, the number of tomato growers declined from approximately 4,000 in the early 1960s to about 600 in 1973, and yet there was a substantial increase in tons of tomatoes produced. By the late 1970s an estimated 32,000 jobs in the tomato industry had been eliminated as a direct consequence of mechanization.[11] Thus, a jump in productivity to the benefit of very large growers has occurred at the sacrifice of other rural agricultural communities.

The University of California's research on and development of agricultural machines such as the tomato harvester eventually

became the subject of a lawsuit filed by attorneys for California Rural Legal Assistance, an organization representing a group of farm workers and other interested parties. The suit charged that university officials are spending tax monies on projects that benefit a handful of private interests to the detriment of farm workers, small farmers, consumers, and rural California generally and asks for a court injunction to stop the practice. The university denied these charges, arguing that to accept them "would require elimination of all research with any potential practical application."[12]

As far as I know, no one argued that the development of the tomato harvester was the result of a plot. Two students of the controversy, William Friedland and Amy Barton, specifically exonerate the original developers of the machine and the hard tomato from any desire to facilitate economic concentration in that industry.[13] What we see here instead is an ongoing social process in which scientific knowledge, technological invention, and corporate profit reinforce each other in deeply entrenched patterns, patterns that bear the unmistakable stamp of political and economic power. Over many decades agricultural research and development in U.S. land-grant colleges and universities has tended to favor the interests of large agribusiness concerns.[14] It is in the face of such subtly ingrained patterns that opponents of innovations such as the tomato harvester are made to seem "antitechnology" or "antiprogress." For the harvester is not merely the symbol of a social order that rewards some while punishing others; it is in a true sense an embodiment of that order.

Within a given category of technological change there are, roughly speaking, two kinds of choices that can affect the relative distribution of power, authority, and privilege in a community. Often the crucial decision is a simple "yes or no" choice—are we going to develop and adopt the thing or not? In recent years many local, national, and international disputes about technology have centered on "yes or no" judgments about such things as food additives, pesticides, the building of highways, nuclear reactors, dam projects, and proposed high-tech weapons. The fundamental choice about an antiballistic missile or supersonic transport is whether or not the thing is going to join society as a piece of its operating equipment. Reasons given for and against are frequently as important as those concerning the adoption of an important new law.

A second range of choices, equally critical in many instances, has to do with specific features in the design or arrangement of a technical system after the decision to go ahead with it has already been made. Even after a utility company wins permission to build a large electric power line, important controversies can remain with respect to the placement of its route and the design of its towers; even after an organization has decided to institute a system of computers, controversies can still arise with regard to the kinds of components, programs, modes of access, and other specific features the system will include. Once the mechanical tomato harvester had been developed in its basic form, a design alteration of critical social significance—the addition of electronic sorters, for example—changed the character of the machine's effects upon the balance of wealth and power in California agriculture. Some of the most interesting research on technology and politics at present focuses upon the attempt to demonstrate in a detailed, concrete fashion how seemingly innocuous design features in mass transit systems, water projects, industrial machinery, and other technologies actually mask social choices of profound significance. Historian David Noble has studied two kinds of automated machine tool systems that have different implications for the relative power of management and labor in the industries that might employ them. He has shown that although the basic electronic and mechanical components of the record/playback and numerical control systems are similar, the choice of one design over another has crucial consequences for social struggles on the shop floor. To see the matter solely in terms of cost cutting, efficiency, or the modernization of equipment is to miss a decisive element in the story.[15]

From such examples I would offer some general conclusions. These correspond to the interpretation of technologies as "forms of life" presented in the previous chapter, filling in the explicitly political dimensions of that point of view.

The things we call "technologies" are ways of building order in our world. Many technical devices and systems important in everyday life contain possibilities for many different ways of ordering human activity. Consciously or unconsciously, deliberately or inadvertently, societies choose structures for technologies that influence how people are going to work, communicate, travel, consume, and so forth over a very long time. In the processes by which structuring decisions are made, different people are situated differently and possess unequal degrees of power as

well as unequal levels of awareness. By far the greatest latitude of choice exists the very first time a particular instrument, system, or technique is introduced. Because choices tend to become strongly fixed in material equipment, economic investment, and social habit, the original flexibility vanishes for all practical purposes once the initial commitments are made. In that sense technological innovations are similar to legislative acts or political foundings that establish a framework for public order that will endure over many generations. For that reason the same careful attention one would give to the rules, roles, and relationships of politics must also be given to such things as the building of highways, the creation of television networks, and the tailoring of seemingly insignificant features on new machines. The issues that divide or unite people in society are settled not only in the institutions and practices of politics proper, but also, and less obviously, in tangible arrangements of steel and concrete, wires and semiconductors, nuts and bolts.

Inherently Political Technologies

None of the arguments and examples considered thus far addresses a stronger, more troubling claim often made in writings about technology and society—the belief that some technologies are by their very nature political in a specific way. According to this view, the adoption of a given technical system unavoidably brings with it conditions for human relationships that have a distinctive political cast—for example, centralized or decentralized, egalitarian or inegalitarian, repressive or liberating. This is ultimately what is at stake in assertions such as those of Lewis Mumford that two traditions of technology, one authoritarian, the other democratic, exist side by side in Western history. In all the cases cited above the technologies are relatively flexible in design and arrangement and variable in their effects. Although one can recognize a particular result produced in a particular setting, one can also easily imagine how a roughly similar device or system might have been built or situated with very much different political consequences. The idea we must now examine and evaluate is that certain kinds of technology do not allow such flexibility, and that to choose them is to choose unalterably a particular form of political life.

A remarkably forceful statement of one version of this argument appears in Friedrich Engels's little essay "On Authority" written in 1872. Answering anarchists who believed that authority is an evil that ought to be abolished altogether, Engels launches into a panegyric for authoritarianism, maintaining, among other things, that strong authority is a necessary condition in modern industry. To advance his case in the strongest possible way, he asks his readers to imagine that the revolution has already occurred. "Supposing a social revolution dethroned the capitalists, who now exercise their authority over the production and circulation of wealth. Supposing, to adopt entirely the point of view of the anti-authoritarians, that the land and the instruments of labour had become the collective property of the workers who use them. Will authority have disappeared or will it have only changed its form?"[16]

His answer draws upon lessons from three sociotechnical systems of his day, cotton-spinning mills, railways, and ships at sea. He observes that on its way to becoming finished thread, cotton moves through a number of different operations at different locations in the factory. The workers perform a wide variety of tasks, from running the steam engine to carrying the products from one room to another. Because these tasks must be coordinated and because the timing of the work is "fixed by the authority of the steam," laborers must learn to accept a rigid discipline. They must, according to Engels, work at regular hours and agree to subordinate their individual wills to the persons in charge of factory operations. If they fail to do so, they risk the horrifying possibility that production will come to a grinding halt. Engels pulls no punches. "The automatic machinery of a big factory," he writes, "is much more despotic than the small capitalists who employ workers ever have been."[17]

Similar lessons are adduced in Engels's analysis of the necessary operating conditions for railways and ships at sea. Both require the subordination of workers to an "imperious authority" that sees to it that things run according to plan. Engels finds that far from being an idiosyncrasy of capitalist social organization, relationships of authority and subordination arise "independently of all social organization, [and] are imposed upon us together with the material conditions under which we produce and make products circulate." Again, he intends this to be stern advice to the anarchists who, according to Engels, thought it possible simply to eradicate subordination and superordination at a single stroke. All such schemes are nonsense. The roots of unavoidable authoritarianism are, he argues, deeply implanted

in the human involvement with science and technology. "If man, by dint of his knowledge and inventive genius, has subdued the forces of nature, the latter avenge themselves upon him by subjecting him, insofar as he employs them, to a veritable despotism independent of all social organization."[18]

Attempts to justify strong authority on the basis of supposedly necessary conditions of technical practice have an ancient history. A pivotal theme in the *Republic* is Plato's quest to borrow the authority of *technē* and employ it by analogy to buttress his argument in favor of authority in the state. Among the illustrations he chooses, like Engels, is that of a ship on the high seas. Because large sailing vessels by their very nature need to be steered with a firm hand, sailors must yield to their captain's commands; no reasonable person believes that ships can be run democratically. Plato goes on to suggest that governing a state is rather like being captain of a ship or like practicing medicine as a physician. Much the same conditions that require central rule and decisive action in organized technical activity also create this need in government.

In Engels's argument, and arguments like it, the justification for authority is no longer made by Plato's classic analogy, but rather directly with reference to technology itself. If the basic case is as compelling as Engels believed it to be, one would expect that as a society adopted increasingly complicated technical systems as its material basis, the prospects for authoritarian ways of life would be greatly enhanced. Central control by knowledgeable people acting at the top of a rigid social hierarchy would seem increasingly prudent. In this respect his stand in "On Authority" appears to be at variance with Karl Marx's position in Volume I of *Capital*. Marx tries to show that increasing mechanization will render obsolete the hierarchical division of labor and the relationships of subordination that, in his view, were necessary during the early stages of modern manufacturing. "Modern Industry," he writes, "sweeps away by technical means the manufacturing division of labor, under which each man is bound hand and foot for life to a single detail operation. At the same time, the capitalistic form of that industry reproduces this same division of labour in a still more monstrous shape; in the factory proper, by converting the workman into a living appendage of the machine."[19] In Marx's view the conditions that will eventually dissolve the capitalist division of labor and facilitate proletarian revolution are conditions latent in industrial technology itself. The differences between Marx's position in *Capital* and Engels's in his essay raise an important question for socialism: What, after all, does modern technology make possible or necessary in political life? The theoretical tension we see here mirrors many troubles in the practice of freedom and authority that had muddied the tracks of socialist revolution.

Arguments to the effect that technologies are in some sense inherently political have been advanced in a wide variety of contexts, far too many to summarize here. My reading of such notions, however, reveals there are two basic ways of stating the case. One version claims that the adoption of a given technical system actually requires the creation and maintenance of a particular set of social conditions as the operating environment of that system. Engels's position is of this kind. A similar view is offered by a contemporary writer who holds that "if you accept nuclear power plants, you also accept a techno-scientific-industrial-military elite. Without these people in charge, you could not have nuclear power."[20] In this conception some kinds of technology require their social environments to be structured in a particular way in much the same sense that an automobile requires wheels in order to move. The thing could not exist as an effective operating entity unless certain social as well as material conditions were met. The meaning of "required" here is that of practical (rather than logical) necessity. Thus, Plato thought it a practical necessity that a ship at sea have one captain and an unquestionably obedient crew.

A second, somewhat weaker, version of the argument holds that a given kind of technology is strongly compatible with, but does not strictly require, social and political relationships of a particular stripe. Many advocates of solar energy have argued that technologies of that variety are more compatible with a democratic, egalitarian society than energy systems based on coal, oil, and nuclear power; at the same time they do not maintain that anything about solar energy requires democracy. Their case is, briefly, that solar energy is decentralizing in both a technical and political sense: technically speaking, it is vastly more reasonable to build solar systems in a disaggregated, widely distributed manner than in large-scale centralized plants; politically speaking, solar energy accommodates the attempts of individuals and local communities to manage their affairs effectively because they are dealing with systems that are more accessible,

comprehensible, and controllable than huge centralized sources. In this view solar energy is desirable not only for its economic and environmental benefits, but also for the salutary institutions it is likely to permit in other areas of public life.[21]

Within both versions of the argument there is a further distinction to be made between conditions that are internal to the workings of a given technical system and those that are external to it. Engels's thesis concerns internal social relations said to be required within cotton factories and railways, for example; what such relationships mean for the condition of society at large is, for him, a separate question. In contrast, the solar advocate's belief that solar technologies are compatible with democracy pertains to the way they complement aspects of society removed from the organization of those technologies as such.

There are, then, several different directions that arguments of this kind can follow. Are the social conditions predicated said to be required by, or strongly compatible with, the workings of a given technical system? Are those conditions internal to that system or external to it (or both)? Although writings that address such questions are often unclear about what is being asserted, arguments in this general category are an important part of modern political discourse. They enter into many attempts to explain how changes in social life take place in the wake of technological innovation. More important, they are often used to buttress attempts to justify or criticize proposed courses of action involving new technology. By offering distinctly political reasons for or against the adoption of a particular technology, arguments of this kind stand apart from more commonly employed, more easily quantifiable claims about economic costs and benefits, environmental impacts, and possible risks to public health and safety that technical systems may involve. The issue here does not concern how many jobs will be created, how much income generated, how many pollutants added, or how many cancers produced. Rather, the issue has to do with ways in which choices about technology have important consequences for the form and quality of human associations.

If we examine social patterns that characterize the environments of technical systems, we find certain devices and systems almost invariably linked to specific ways of organizing power and authority. The important question is: Does this state of affairs derive from an unavoidable social response to intractable properties in the things themselves, or is it instead a pattern imposed independently by a governing body, ruling class, or some other social or cultural institution to further its own purposes?

Taking the most obvious example, the atom bomb is an inherently political artifact. As long as it exists at all, its lethal properties demand that it be controlled by a centralized, rigidly hierarchical chain of command closed to all influences that might make its workings unpredictable. The internal social system of the bomb must be authoritarian; there is no other way. The state of affairs stands as a practical necessity independent of any larger political system in which the bomb is embedded, independent of the type of regime or character of its rulers. Indeed, democratic states must try to find ways to ensure that the social structures and mentality that characterize the management of nuclear weapons do not "spin off" or "spill over" into the polity as a whole.

The bomb is, of course, a special case. The reasons very rigid relationships of authority are necessary in its immediate presence should be clear to anyone. If, however, we look for other instances in which particular varieties of technology are widely perceived to need the maintenance of a special pattern of power and authority, modern technical history contains a wealth of examples.

Alfred D. Chandler in *The Visible Hand*, a monumental study of modern business enterprise, presents impressive documentation to defend the hypothesis that the construction and day-to-day operation of many systems of production, transportation, and communication in the nineteenth and twentieth centuries require the development of particular social form—a large-scale centralized, hierarchical organization administered by highly skilled managers. Typical of Chandler's reasoning is his analysis of the growth of the railroads.[22]

> Technology made possible fast, all-weather transportation; but safe, regular, reliable movement of goods and passengers, as well as the continuing maintenance and repair of locomotives, rolling stock, and track, roadbed, stations, roundhouses, and other equipment, required the creation of a sizable administrative organization. It meant the employment of a set of managers to supervise these functional activities over an extensive geographical area; and the appointment of an administrative command of middle and top executives to monitor, evaluate, and coordinate the work of managers responsible for the day-to-day operations.

Throughout his book Chandler points to ways in which technologies used in the production and distribution of electricity, chemicals, and a wide range of industrial goods "demanded" or "required" this form of human association. "Hence, the operational requirements of railroads demanded the creation of the first administrative hierarchies in American business."[23]

Were there other conceivable ways of organizing these aggregates of people and apparatus? Chandler shows that a previously dominant social form, the small traditional family firm, simply could not handle the task in most cases. Although he does not speculate further, it is clear that he believes there is, to be realistic, very little latitude in the forms of power and authority appropriate within modern sociotechnical systems. The properties of many modern technologies—oil pipelines and refineries, for example—are such that overwhelmingly impressive economies of scale and speed are possible. If such systems are to work effectively, efficiently, quickly, and safely, certain requirements of internal social organization have to be fulfilled; the material possibilities that modern technologies make available could not be exploited otherwise. Chandler acknowledges that as one compares sociotechnical institutions of different nations, one sees "ways in which cultural attitudes, values, ideologies, political systems, and social structure affect these imperatives."[24] But the weight of argument and empirical evidence in *The Visible Hand* suggests that any significant departure from the basic pattern would be, at best, highly unlikely.

It may be that other conceivable arrangements of power and authority, for example, those of decentralized, democratic worker self-management, could prove capable of administering factories, refineries, communications systems, and railroads as well as or better than the organizations Chandler describes. Evidence from automobile assembly teams in Sweden and worker-managed plants in Yugoslavia and other countries is often presented to salvage these possibilities. Unable to settle controversies over this matter here, I merely point to what I consider to be their bone of contention. The available evidence tends to show that many large, sophisticated technological systems are in fact highly compatible with centralized, hierarchical managerial control. The interesting question, however, has to do with whether or not this pattern is in any sense a requirement of such systems, a question that is not solely empirical. The matter ultimately rests on our judgments about what steps, if any, are practically necessary in the workings of particular kinds of technology and what, if anything, such measures require of the structure of human associations. Was Plato right in saying that a ship at sea needs steering by a decisive hand and that this could only be accomplished by a single captain and an obedient crew? Is Chandler correct in saying that the properties of large-scale systems require centralized, hierarchical managerial control?

To answer such questions, we would have to examine in some detail the moral claims of practical necessity (including those advocated in the doctrines of economics) and weigh them against moral claims of other sorts, for example, the notion that it is good for sailors to participate in the command of a ship or that workers have a right to be involved in making and administering decisions in a factory. It is characteristic of societies based on large, complex technological systems, however, that moral reasons other than those of practical necessity appear increasingly obsolete, "idealistic," and irrelevant. Whatever claims one may wish to make on behalf of liberty, justice, or equality can be immediately neutralized when confronted with arguments to the effect, "Fine, but that's no way to run a railroad" (or steel mill, or airline, or communication system, and so on). Here we encounter an important quality in modern political discourse and in the way people commonly think about what measures are justified in response to the possibilities technologies make available. In many instances, to say that some technologies are inherently political is to say that certain widely accepted reasons of practical necessity—especially the need to maintain crucial technological systems as smoothly working entities—have tended to eclipse other sorts of moral and political reasoning.

One attempt to salvage the autonomy of politics from the bind of practical necessity involves the notion that conditions of human association found in the internal workings of technological systems can easily be kept separate from the polity as a whole. Americans have long rested content in the belief that arrangements of power and authority inside industrial corporations, public utilities, and the like have little bearing on public institutions, practices, and ideas at large. That "democracy stops at the factory gates" was taken as a fact of life that had nothing to do with the practice of political freedom. But can the internal politics of technology and the politics of the whole community be so easily separated? A recent study of business leaders in the United States, contemporary exemplars of

Chandler's "visible hand of management," found them remarkably impatient with such democratic scruples as "one man, one vote." If democracy doesn't work for the firm, the most critical institution in all of society, American executives ask, how well can it be expected to work for the government of a nation—particularly when that government attempts to interfere with the achievements of the firm? The authors of the report observe that patterns of authority that work effectively in the corporation become for businessmen "the desirable model against which to compare political and economic relationships in the rest of society."[25] While such findings are far from conclusive, they do reflect a sentiment increasingly common in the land: what dilemmas such as the energy crisis require is not a redistribution of wealth or broader public participation but, rather, stronger, centralized public and private management.

An especially vivid case in which the operational requirements of a technical system might influence the quality of public life is the debates about the risks of nuclear power. As the supply of uranium for nuclear reactors runs out, a proposed alternative fuel is the plutonium generated as a by-product in reactor cores. Well-known objections to plutonium recycling focus on its unacceptable economic costs, its risks of environmental contamination, and its dangers in regard to the international proliferation of nuclear weapons. Beyond these concerns, however, stands another less widely appreciated set of hazards—those that involve the sacrifice of civil liberties. The widespread use of plutonium as a fuel increases the chance that this toxic substance might be stolen by terrorists, organized crime, or other persons. This raises the prospect, and not a trivial one, that extraordinary measures would have to be taken to safeguard plutonium from theft and to recover it should the substance be stolen. Workers in the nuclear industry as well as ordinary citizens outside could well become subject to background security checks, covert surveillance, wiretapping, informers, and even emergency measures under martial law—all justified by the need to safeguard plutonium.

Russell W. Ayres's study of the legal ramifications of plutonium recycling concludes: "With the passage of time and the increase in the quantity of plutonium in existence will come pressure to eliminate the traditional checks the courts and legislatures place on the activities of the executive and to develop a powerful central authority better able to enforce strict safeguards." He avers that "once a quantity of plutonium had been stolen, the case for literally turning the country upside down to get it back would be overwhelming." Ayres anticipates and worries about the kinds of thinking that, I have argued, characterize inherently political technologies. It is still true that in a world in which human beings make and maintain artificial systems nothing is "required" in an absolute sense. Nevertheless, once a course of action is under way, once artifacts such as nuclear power plants have been built and put in operation, the kinds of reasoning that justify the adaptation of social life to technical requirements pop up as spontaneously as flowers in the spring. In Ayres's words, "Once recycling begins and the risks of plutonium theft become real rather than hypothetical, the case for governmental infringement of protected rights will seem compelling."[26] After a certain point, those who cannot accept the hard requirements and imperatives will be dismissed as dreamers and fools.

* * *

The two varieties of interpretation I have outlined indicate how artifacts can have political qualities. In the first instance we noticed ways in which specific features in the design or arrangement of a device or system could provide a convenient means of establishing patterns of power and authority in a given setting. Technologies of this kind have a range of flexibility in the dimensions of their material form. It is precisely because they are flexible that their consequences for society must be understood with reference to the social actors able to influence which designs and arrangements are chosen. In the second instance we examined ways in which the intractable properties of certain kinds of technology are strongly, perhaps unavoidably, linked to particular institutionalized patterns of power and authority. Here the initial choice about whether or not to adopt something is decisive in regard to its consequences. There are no alternative physical designs or arrangements that would make a significant difference; there are, furthermore, no genuine possibilities for creative intervention by different social systems—capitalist or socialist—that could change the intractability of the entity or significantly alter the quality of its political effects.

To know which variety of interpretation is applicable in a given case is often what is at stake in disputes, some of them passionate ones, about the meaning of technology for how we live. I have argued a "both/and" position here, for it seems to

me that both kinds of understanding are applicable in different circumstances. Indeed, it can happen that within a particular complex of technology—a system of communication or transportation, for example—some aspects may be flexible in their possibilities for society, while other aspects may be (for better or worse) completely intractable. The two varieties of interpretation I have examined here can overlap and intersect at many points.

These are, of course, issues on which people can disagree. Thus, some proponents of energy from renewable resources now believe they have at last discovered a set of intrinsically democratic, egalitarian, communitarian technologies. In my best estimation, however, the social consequences of building renewable energy systems will surely depend on the specific configurations of both hardware and the social institutions created to bring that energy to us. It may be that we will find ways to turn this silk purse into a sow's ear. By comparison, advocates of the further development of nuclear power seem to believe that they are working on a rather flexible technology whose adverse social effects can be fixed by changing the design parameters of reactors and nuclear waste disposal systems. For reasons indicated above, I believe them to be dead wrong in that faith. Yes, we may be able to manage some of the "risks" to public health and safety that nuclear power brings. But as society adapts to the more dangerous and apparently indelible features of nuclear power, what will be the long-range toll in human freedom?

My belief that we ought to attend more closely to technical objects themselves is not to say that we can ignore the contexts in which those objects are situated. A ship at sea may well require, as Plato and Engels insisted, a single captain and obedient crew. But a ship out of service, parked at the dock, needs only a caretaker. To understand which technologies and which contexts are important to us, and why, is an enterprise that must involve both the study of specific technical systems and their history as well as a thorough grasp of the concepts and controversies of political theory. In our times people are often willing to make drastic changes in the way they live to accommodate technological innovation while at the same time resisting similar kinds of changes justified on political grounds. If for no other reason than that, it is important for us to achieve a clearer view of these matters than has been our habit so far.

3

TECHNĒ AND POLITEIA

TO ACHIEVE a political understanding of technology requires that we examine the realm of tools and instruments from a fresh point of view. We have already begun to recognize some of the ways in which conditions of power, authority, freedom, and social justice are deeply embedded in technical structures. From this standpoint no part of modern technology can be judged neutral a priori. All varieties of hardware and their corresponding forms of social life must be scrutinized to see whether they are friendly or unfriendly to the idea of a just society.

But what does the study of politics have to contribute to our thinking about the realm of instrumental things? Where can one turn to look for a political theory of technology?

A Classic Analogy

IN THE previous chapter I noted that rooted in Western political thought is a powerful analogy linking the practice of technology to that of politics. In his *Republic*, *Laws*, *Statesman*, and other dialogues, Plato asserts that statecraft is a *technē*, one of the practical arts. Much like architecture, weaving, shipbuilding, and other arts and crafts, politics is a field of practice that has its own distinctive knowledge, its own special skills. As we have seen, one purpose of Plato's argument was to discredit those who believed that the affairs of public life could be left to mere amateurs, the democratic masses. But beyond that it is clear he thought the art of politics could be useful in the same way as any other *technē*, that it could produce well-crafted works of lasting value.

The works he had in mind were good constitutions, supremely well-crafted products of political architecture. *Politeia*, the title of the *Republic* in Greek, means the constitution of a polis, the proper order of human relationships within a city-state. The dialogue describes and justifies what Plato holds to be the institutional arrangements appropriate to the best *politeia*. He returns to this theme in the *Laws*, a discussion of the "second best" constitution, comparing his work to that of a well-established craft. "The shipwright, you know, begins his work by laying down the keel of the vessel and indicating her outlines, and I feel myself to be doing the same thing in my attempt to present you with outlines of human lives. . . . I am really laying the keels of the vessels by due consideration of the question by what means or manner of life we shall make our voyage over the sea of time to the best purpose."[1] There is evidence that Plato actually sought to realize his skills as a designer/builder of political societies. He traveled from Athens to live at the court of Dionysius the Elder, tyrant of Syracuse, hoping to transform his host into a genuine philosopher-king, a person willing to apply the true principles of political *technē*. The attempt did not succeed.

In Plato's interpretation the analogy between technology and politics works in one direction only; *technē* serves as a model for politics and not the other way around. Although respectful of the power of the material arts, he remained deeply suspicious of them. Thus, in the *Laws* he excludes craftsmen from positions of citizenship, explaining that they already have an art that requires their full attention. At the same time he forbids citizens to engage in any material craft whatsoever because citizenship makes full demands on them. Plato's discomfort with technology has remained characteristic of moral and political philosophers to this day. Most of them have politely ignored the substance of technical life, hoping perhaps that it would remain segregated in a narrowly defined corner of human life. Evidently, it did not occur to anyone that Plato's pregnant analogy would at some point qualify in reverse, that *technē* itself might become *politeia*, that technical forms of life might in themselves play a powerful role in shaping society. When that finally happened, political theory would find itself totally unprepared.

The one-sided comparison of technical and political creativity appears again in modern political thought. Writing in *The Social Contract*, Jean-Jacques Rousseau employs a mechanical metaphor to illuminate the art of constitution making. "A prince," he says, "has only to follow a model which the lawgiver provides. The lawgiver is the engineer who invents the machine; the prince is merely the mechanic who sets it up and operates it."[2] At another point in the book, Rousseau compares the work of the lawgiver to that of an architect. With a frustrated ambition reminiscent of Plato's, Rousseau offered himself as a political engineer or architect of exactly this kind, writing treatises on the constitutions of Corsica and Poland in the hope that his ideas might influence the founding of new states.

A practical opportunity of exactly that kind later became available to the founders of modern nation states, among them the leaders of the American Revolution. From the earliest rumblings of rebellion in the seventeenth century to the adoption of the U.S. Constitution in 1787, the nation was alive with disputes about the application of political principles to the design of public institutions. Once again the ancient analogy between politics and technology became an expressive idea. Taking what they found useful from previous history and existing theories, thinkers like Madison, Hamilton, Adams, and Jefferson tried to devise a "science of politics," a science specifically aimed at providing knowledge for a collective act of architectonic skill. Thus, in *The Federalist Papers*, to take one example, we find a sustained discussion of how to move from abstract political notions such as power, liberty, and public good to their tangible manifestations in the divisions, functions, powers, relationships, and limits of the Constitution. "The science of politics," Hamilton explains in "Federalist No. 9," "like most other sciences, has received great improvement. The efficacy of various principles is now well understood, which were either not known at all, or imperfectly known to the ancients. The regular distribution of power into distinct departments; the introduction of legislative balances and checks; the institution of courts composed of judges holding their offices during good behavior; the representation of the people in the legislature by deputies of their own election: these are wholly new discoveries, or have made their principal progress towards perfection in modern times." Metaphors from eighteenth-century science and mechanical invention—for example, "the ENLARGEMENT of the ORBIT within which such systems are to revolve"[3] and references to the idea of checks and balances—pervade *The Federalist Papers* and indicate the extent to which its writers saw the

founding as the creation of an ingenious political/mechanical device.

But even as the eighteenth century was reviving the comparison between technology and politics, even as philosopher statesmen were restoring the *technē* of constitution making, another extremely powerful mode of institutionalization was taking shape in the United States and Europe. The industrial revolution with its distinctive ways of arranging people, machines, and materials for production very soon began to compete with strictly political institutions for power, authority, and the loyalties of men and women. Writing in 1781 in his *Notes on Virginia*, Thomas Jefferson noted the new force abroad in the world and commented upon its probable meaning for political society. The system of manufacturing emerging at the time would, he argued, be incompatible with the life of a stable, virtuous republic. Manufacturing would create a thoroughly dependent rather than a self-sufficient populace. "Dependence," he warned, "begets subservience and venality, suffocates the germ of virtue, and prepares fit tools for the designs of ambition." In his view the industrial mode of production threatened "the manners and spirit of a people which preserve a republic in vigor. A degeneracy in these is a canker which soon eats to the heart of its laws and constitution."[4] For that reason he advised, in this book at least, that Americans agree to leave the workshops in Europe.

Abundance and Freedom

JEFFERSON'S PLEA echoes a belief common in writings of ancient Greece and Rome that civic virtue and material prosperity are antithetical. Human nature, according to this view, is easily corrupted by wealth. The indolent, pleasure-seeking habits of luxurious living tend to subvert qualities of frugality, self-restraint, and self-sacrifice needed to maintain a free society. By implication, any society that wishes to maintain civic virtue ought to approach technical innovation and economic growth with the utmost caution. At the time of the founding of the American republic, the country did not depend upon high levels of material production and consumption. In fact, during political discussions of the 1770s and 1780s, the quest for material wealth was sometimes mentioned as a danger, a source of corruption. A speaker before the Continental Congress in 1775 called upon the citizenry to "banish the syren LUXURY with all her train of fascinating pleasures, idle dissipation, and expensive amusements from our borders," and to institute "honest industry, sober frugality, simplicity of manners, and plain hospitality and christian benevolence."[5]

There are signs that a desire to shape industrial development to accord with the ideals of the republican political tradition continued to interest some Americans well into the 1830s. Attempts to include elements of a republican community in the building of the factory town in Lowell, Massachusetts, show this impulse at work.[6] But these efforts were neither prominent in the economic patterns then taking shape nor successful in their own right. In the 1840s and decades since the notion that industrial development might be shaped or limited by republican virtues dropped out of common discourse, echoed only in the woeful lamentations of Henry David Thoreau, Henry Adams, Lewis Mumford, Paul Goodman, and a host of others now flippantly dismissed as "romantics" and "pastoralists."

In fact, the republican tradition of political thought had long since made its peace with the primary carrier of technical change, entrepreneurial capitalism. Moral and political thinkers from Machiavelli to Montesquieu and Adam Smith had argued, contrary to the ancient wisdom, that the pursuit of economic advantage is actually a civilizing, moderating influence in society, the very basis of stable government. Rather than engage the fierce passion for glory that often leads to conflict, it is better, so the argument goes, to convince people to pursue their self-interest, an interest that inclines them toward rational behavior.[7] The framers of the American Constitution were, by and large, convinced of the wisdom of this formula. They expected that Americans would act in a self-interested manner, employing whatever instruments they needed to generate wealth. The competition of these interests in society would, they believed, provide a check upon the concentration of power in the hands of any one faction. Thus, in one important sense republicanism and capitalism were fully reconciled at the time of the founding.

By the middle of the nineteenth century this point of view had been strongly augmented by another idea, one that to this day forms the basic self-image of Americans—a notion that equates abundance and freedom. The country was rich in land and resources; people liberated from the social hierarchies and status definitions of traditional societies were given the opportunity to exploit that material bounty in whatever ways they

could muster. In this context new technologies were seen as an undeniable blessing because they enabled the treasures to be extracted more quickly, because they vastly increased the product of labor. Factories, railroads, steamboats, telegraphs, and the like were greeted as the very essence of democratic freedom for the ways they rendered, as one mid–nineteenth-century writer explained, "the conveniences and elegancies of life accessible to the many instead of the few."[8]

American society encouraged people to be self-determining, to pursue their own economic goals. That policy would work, it was commonly believed, only if there were a surplus that guaranteed enough to go around. Class conflict, the scourge of democracy in the ancient world, could be avoided in the United States because the inequalities present in society would not matter very much. Material abundance would make it possible for everybody to have enough to be perfectly happy. Eventually, Americans took this notion to be a generally applicable theory: economic enterprise driven by the engine of technical improvement was the very essence of human freedom. Franklin D. Roosevelt reportedly remarked that if he could put one American book in the hands of every Russian, it would be the Sears, Roebuck catalogue.

In this way of looking at things the form of the technology you adopt does not matter. If you have cornucopia in your grasp, you do not worry about its shape. Insofar as it is a powerful thing, more power to it. Anything that history, literature, philosophy, or long-standing traditions might have to suggest about the prudence one ought to employ in the shaping of new institutions can be thrown in the trash bin. Describing the industrial revolution in Britain, historian Karl Polanyi drew an accurate picture of this attitude. "Fired by an emotional faith in spontaneity, the common-sense attitude toward change was discarded in favor of a mystical readiness to accept the social consequences of economic improvement, whatever they might be. The elementary truths of political science and statecraft were first discarded, then forgotten. It should need no elaboration that a process of undirected change, the pace of which is deemed too fast, should be slowed down, if possible, so as to safeguard the welfare of the community. Such household truths of traditional statesmanship, often merely reflecting the teachings of a social philosophy inherited from the ancients, were in the nineteenth century erased from the thoughts of the educated by the corrosive of a crude utilitarianism combined with an uncritical reliance on the alleged self-healing virtues of unconscious growth."[9] Indeed, by the late nineteenth century, an impressive array of scientific discoveries, technical inventions, and industrial innovations seemed to make the mastery of nature an accomplished fact rather than an idle dream. Many took this as a sign that all ancient wisdom, like all the old-fashioned machines and techniques, had simply been rendered obsolete. As one chronicler of the new technology wrote in *Scientific American*: "The speculative philosophy of the past is but a too empty consolation for short-lived, busy man, and, seeing with the eye of science the possibilities of matter, he has touched it with the divine breath of thought and made a new world."[10]

According to this view, everything one might desire of the relationship between expanding industrial technology and the building of a good society will happen automatically. All that is necessary is to make sure the machinery is up to date, well maintained, and well oiled. The only truly urgent questions that remain are ones of technical and economic efficiency. For unless a society keeps pace with the most efficient means available anywhere in the world, it will lag behind its competitors, a precondition of cultural decline.

A fascination with efficiency is a venerable tradition in American life. It is announced early on, for example, in Benjamin Franklin's maxims that economizing on time, effort, and money is a virtue. With the advance of industrialism in the late nineteenth and early twentieth centuries, this concern grew to something of an obsession among the well-educated in the United States. Understood to be a criterion applicable to personal and social life as well as to mechanical and economic systems, efficiency was upheld as a goal supremely valuable in its own right, one strongly linked to the progress of science, the growth of industry, the rise of professionalism, and the conservation of natural resources. During the Progressive Era the rule of efficient, well-trained professionals was upheld as a way of sanitizing government of the corruption of party machines and eliminating the influence of selfish interest groups. An eagerness to define important public issues as questions of efficiency has continued to be a favorite strategy in American politics over many decades; adherence to this norm has been (and still is) welcomed as the best way to achieve the ends of democracy without having to deal with democracy as a living political process. Demonstrat-

ing the efficiency of a course of action conveys an aura of scientific truth, social consensus, and compelling moral urgency. And Americans do not even worry much about the specific content of numerators and denominators used in efficiency measurements. As long as they are getting more for less, all is well.[11]

The Technical Constitution of Society

WITH THE PASSAGE of time the cornucopia of modern industrial production began to generate some distinctive institutional patterns. Today we can examine the interconnected systems of manufacturing, communications, transportation, and the like that have arisen during the past two centuries and appreciate how they form de facto a constitution of sorts, the constitution of a sociotechnical order. This way of arranging people and things, of course, did not develop as the result of the application of any particular plan or political theory. It grew gradually and in separate increments, invention by invention, industry by industry, engineering project by engineering project, system by system. From a contemporary vantage point, nevertheless, one can notice some of its characteristics and begin to see how they embody answers to age-old political questions—questions about membership, power, authority, order, freedom, and justice. Several of the characteristics that matter in this way of seeing things—characteristics that would certainly have interested Plato, Rousseau, Madison, Hamilton, and Jefferson—can be summarized as follows.

First is the ability of technologies of transportation and communication to facilitate control over events from a single center or small number of centers. Largely unchecked by effective countervailing influences, there has been an extraordinary centralization of social control in large business corporations, bureaucracies, and the military. It has seemed an expedient, rational way of doing things. Without anyone having explicitly chosen it, dependency upon highly centralized organizations has gradually become a dominant social form.

Second is a tendency for new devices and techniques to increase the most efficient or effective size of organized human associations. Over the past century more and more people have found themselves living and working within technology-based institutions that previous generations would have called gigantic. Justified by impressive economies of scale and, economies or not, always an expression of the power that accrues to very large organizations, this gigantism has become an accustomed feature in the material and social settings of everyday life.

Third is the way in which the rational arrangement of sociotechnical systems has tended to produce its own distinctive forms of hierarchical authority. Legitimized by the felt need to do things in what seems to be the most efficient, productive way, human roles and relationships are structured in rule-guided patterns that involve taking orders and giving orders along an elaborate chain of command. Thus, far from being a place of democratic freedom, the reality of the workplace tends to be undisguisedly authoritarian. At higher levels in the hierarchy, of course, professionals claim their special authority and relative freedom by virtue of their command of scientific and technical expertise. At the point in history in which forms of hierarchy based on religion and tradition had begun to crumble, the need to build and maintain technical systems offered a way to restore pyramidal social relations. It was a godsend for inequality.

Fourth is the tendency of large, centralized, hierarchically arranged sociotechnical entities to crowd out and eliminate other varieties of human activity. Hence, industrial techniques eclipsed craftwork; technologies of modern agribusiness made small-scale farming all but impossible; high-speed transportation crowded out slower means of getting about. It is not merely that useful devices and techniques of earlier periods have been rendered extinct, but also that patterns of social existence and individual experience that employed these tools have vanished as living realities.

Fifth are the various ways that large sociotechnical organizations exercise power to control the social and political influences that ostensibly control them. Human needs, markets, and political institutions that might regulate technology-based systems are often subject to manipulation by those very systems. Thus, to take one example, psychologically sophisticated techniques of advertising have become a customary way of altering people's ends to suit the structure of available means, a practice that now affects political campaigns no less than campaigns to sell underarm deodorant or Coca-Cola (with similar results).

There are many other characteristics of today's technological systems that can accurately be read as political phenomena. And it is certainly true that there are factors other than technology that strongly influence the developments I have mentioned. But

it is important to note that as our society adopts one sociotechnical system after another it answers some of the most important questions that political philosophers have ever asked about the proper order of human affairs. Should power be centralized or dispersed? What is the best size for units of social organization? What constitutes justifiable authority in human associations? Does a free society depend upon social uniformity or diversity? What are appropriate structures and processes of public deliberation and decision making? For the past century or longer our responses to such questions have often been instrumental ones, expressed in an instrumental language of efficiency and productivity, physically embodied in human/machine systems that seem to be nothing more than ways of providing goods and services.

If we compare the process through which today's sociotechnical constitution evolved to the process employed by the framers of the U.S. Constitution, the contrast is striking. Clearly, the founding fathers considered all of the crucial questions in classical political thought. When they included a particular feature in the structure of government, it was because they had studied the matter, debated it, and deliberately chosen the result. They understood that if all went well the structures they were building would last a good long time. Because the rules, roles, and relationships they agreed upon would shape the future life of a whole nation, the framers acknowledged a special responsibility—a responsibility of wise political craftsmanship. To realize this responsibility required a depth of knowledge about political institutions and sensitivity to human motives altogether rare in human history. The results of their work include two centuries of relatively stable government in the United States, a sign that they practiced their craft well.

Of course, there are founding fathers of our sociotechnical constitution as well—the inventors, entrepreneurs, financiers, engineers, and managers who have fashioned the material and social dimensions of new technologies. Some of their names are well known to the public—Thomas Edison, Henry Ford, J. P. Morgan, John D. Rockefeller, Alfred P. Sloan, Thomas Watson, and the like. The names of such figures as Theodore Vail, Samuel Insull, and William Mullholland are not household words, but their accomplishments as builders of technological infrastructures are equally impressive. In one sense the founders of technological systems are no strangers to politics; many of them have engaged in fierce political struggles to realize their aims. William Mullholland's ruthless machinations to bring Owens Valley water to Los Angeles' desert climate is a classic case in point.[12] But the qualities of political wisdom we find in the founders of the U.S. Constitution are, by and large, missing in those who design, engineer, and promote vast systems. Here the founding fathers have been concerned with such matters as the quest for profits, organizational control, and the pleasures of innovation. They have seldom been interested in the significance of their work on the overall structure of society or its justice.

For those who have embraced the formula of freedom through abundance, however, questions about the proper order of society do not matter very much. Over many decades technological optimists have been sustained by the belief that whatever happened to be created in the sphere of material/instrumental culture would certainly be compatible with freedom, democracy, and social justice. This amounts to a conviction that all technology—whatever its size, shape, or complexion—is inherently liberating. For reasons noted in the previous chapter, that is a very peculiar faith indeed.

It is true that on occasion agencies of the modern state have attempted to "regulate" business enterprises and technological applications of various kinds. On balance, however, the extent of that regulation has been modest. In the United States absolute monopolies are sometimes outlawed only to be replaced by enormous semimonopolies no less powerful in their ability to influence social outcomes. The history of regulation shows abundant instances in which the rules and procedures that govern production or trade were actually demanded or later captured by the industries they supposedly regulate. In general, the rule of thumb has been if a business makes goods and services widely available, at low cost with due regard for public health and safety, and with a reasonable return on investment, the republic is well served.[13]

In recent times the idea of recognizing limits upon the growth of certain technologies has experienced something of a revival. Many people are prepared to entertain the notion of limiting a given technology if:

1. Its application threatens public health or safety
2. Its use threatens to exhaust some vital resource
3. It degrades the quality of the environment (air, land, and water)

4. It threatens natural species and wilderness areas that ought to be preserved
5. Its application causes social stresses and strains of an exaggerated kind.

Along with ongoing discussions about ways to sustain economic growth, national competitiveness, and prosperity, these are the only matters of technology assessment that the general public, decision makers, and academicians are prepared to take seriously.

While such concerns are valid, they severely restrict the range of moral and political criteria that are permissible in public deliberations about technological change. Several years ago I tried to register my discomfort on this score with some colleagues in computer science and sociology who were doing a study of the then-novel systems of electronic funds transfer (EFT). They had concluded that such systems contained the potential for redistributing financial power in the world of banking. Electronic money would make possible a shift of power from smaller banks to large national and international financial institutions. Beyond that it appeared such systems posed serious problems about data protection and individual privacy. They asked me to suggest an effective way of presenting the possible dangers of this development to their audience of scholars and policy makers. I recommended that their research try to show that under conditions of heavy, continued exposure, EFT causes cancer in laboratory animals. Surely, that finding would be cause for concern. My ironic suggestion acknowledged what I take to be the central characteristic of socially acceptable criticism of technology in our time. Unless one can demonstrate conclusively that a particular technical practice will generate some physically evident catastrophe—cancer, birth defects, destruction of the ozone layer, or some other—one might as well remain silent.

The conversation about technology and society has continued to a point at which an obvious question needs to be addressed: Are there no shared ends that matter to us any longer other than the desire to be affluent while avoiding the risk of cancer? It may be that the answer is no. The prevailing consensus seems to be that people love a life of high consumption, tremble at the thought that it might end, and are displeased about having to clean up the messes that modern technologies sometimes bring. To argue a moral position convincingly these days requires that one speak to (and not depart from) people's love of material well-being, their fascination with efficiency, or their fear of death. The moral sentiments that hold force can be arrayed on a spectrum ranging from Adam Smith to Frederick W. Taylor to Thomas Hobbes. I do not wish to deny the validity of these sentiments, only to point out that they represent an extremely narrow mindset. Concerns about particular technological hazards are sometimes the beginning of a much broader political awareness. But for the most part we continue to disregard a problem that has been brewing since the earliest days of the industrial revolution—whether our society can establish forms and limits for technological change, forms and limits that derive from a positively articulated idea of what society ought to be.

As a way of beginning that project, I would suggest a simple heuristic exercise. Let us suppose that every political philosophy in a given time implies a technology or set of technologies in a particular pattern for its realization. And let us recognize that every technology of significance to us implies a set of political commitments that can be identified if one looks carefully enough. What appear to be merely instrumental choices are better seen as choices about the form of social and political life a society builds, choices about the kinds of people we want to become. Plato's metaphor, especially his reference to the shipwright, is one that an age of high technology ought to ponder carefully: we ought to lay out the keels of our vessels with due consideration to what means or manner of life best serves our purpose in our voyage over the sea of time. The vessels that matter now are such things as communications systems, transit systems, energy supply and distribution systems, information networks, household instruments, biomedical technologies, and of course systems of industrial and agricultural production. Just as Plato and Aristotle posed the question, What is the best form of political society? so also an age of high technology ought to ask, What forms of technology are compatible with the kind of society we want to build?

Answers to that question often appear as subliminal themes or concealed agendas in policy discussions that seem to be about productivity, efficiency, and economic growth. A perfect set of examples can be found among the dozens of sophisticated energy studies conducted during the 1970s in response to what was then called "the energy crisis." A careful reader can survey the various reports and interpret the political and social structures their analyses and recommendations imply.[14] Would it be

nuclear power administered by a benign priesthood of scientists? Would it be coal and oil brought to you by large, multinational corporations? Would it be synthetic fuels subsidized and administered by the state? Or would it be the soft energy path brought to you by you and your neighbors?

Whatever one's position might be, the prevailing consensus required that all parties base their arguments on a familiar premise: efficiency. Regardless of how a particular energy solution would affect the distribution of wealth and social power, the case for or against it had to be stated as a practical necessity deriving from demonstrable conditions of technical or economic efficiency. As the Ford Foundation's Nuclear Energy Policy Study Group explained: "When analyzing energy, one must first decide whether ordinary rules of economics can be applied." The group decided that, yes, energy should be considered "an economic variable, rather than something requiring special analysis."[15] After that decision had been made, of course, the rest was simply a matter of putting Btus or kilowatt-hours in the numerator and dollars in the denominator and worshipping the resulting ratio as gospel.

Even those who held unorthodox viewpoints in this debate found it necessary to uphold the supreme importance of this criterion. Thus, Amory B. Lovins, a leading proponent of soft energy paths, wrote of his method: "While not under the illusion that facts are separable from values, I have tried . . . to separate my personal preferences from my analytic assumptions and to rely not on modes of discourse that might be viewed as overtly ideological, but rather on classicial arguments of economic and engineering efficiency (which are only tacitly ideological)."[16] To Lovins's credit, he consistently argued that the social consequences of energy choices were, in the last analysis, the most important aspect of energy policy making. In his widely read *Soft Energy Paths*, Lovins called attention to "centrism, vulnerability, technocracy, repression, alienation" and other grave problems that afflict conventional energy solutions. Lovins compares "two energy paths that are distinguished by their antithetical social implications." He notes that basing energy decisions on social criteria may appear to involve a "heroic decision," that is, "doing something the more expensive way because it is desirable on other more important grounds than internal cost."

But Lovins is careful not to appeal to his readers' sense of courage or altruism. "Surprisingly," he writes, "a heroic decision does not seem to be necessary in this case, because the energy system that seems socially more attractive is also cheaper and easier."[17] But what if the analysis had shown the contrary? Would Lovins have been prepared to give up the social advantages believed to exist along the soft energy path? Would he have accepted "centrism, vulnerability, technocracy, repression, alienation," and the like? Here Lovins yielded ground that in recent history has again and again been abandoned as lost territory. It raises the question of whether even the best intentioned, best qualified analysts in technological decision making are anything more than mere efficiency worshippers.

Much the same strategy often appears in the arguments of those who favor democratic self-management, decentralization, and human-scale technology. As Paul Goodman once noted, "Now, if lecturing at a college, I happen to mention that some function of society which is highly centralized could be much decentralized without loss of efficiency, or perhaps with a gain in efficiency, at once the students want to talk about nothing else."[18] That approach is, indeed, one way of catching people's attention; if you can get away with it, it is certainly a most convincing kind of argument. Because the idea of efficiency attracts a wide consensus, it is sometimes used as a conceptual Trojan horse by those who have more challenging political agendas they hope to smuggle in. But victories won in this way are in other respects great losses. For they affirm in our words and in our methodologies that there are certain human ends that no longer dare be spoken in public. Lingering in that stuffy Trojan horse too long, even soldiers of virtue eventually suffocate.

Regimes of Instrumentality

IN OUR TIME *technē* has at last become *politeia*—our instruments are institutions in the making. The idea that a society might try to guide its sociotechnical development according to self-conscious, critically evaluated standards of form and limit can no longer be considered a "heroic decision"; it is simply good sense. Because technological innovation is inextricably linked to processes of social reconstruction, any society that hopes to control its own structural evolution must confront each significant set of technological possibilities with scrupulous care.

Applied in this setting, political theory can help reveal strategic decisions in technological design. From its perspective, each

significant area of technical/functional organization in modern society can be seen as a kind of regime, a regime of instrumentality, under which we are obliged to live. Thus, there are a number of regimes of mass production, each with a structure that may be interpreted as a technopolitical phenomenon. There are a number of regimes in energy production and distribution, in petroleum, coal, hydroelectricity, nuclear power, etc., each with a form that can be scrutinized for the politics of its structural properties. There is, of course, the regime of broadcast television and that of the automobile. If we were to identify and characterize all of the sociotechnical systems of in our society, all of our regimes of instrumentality and their complex interconnections, we would have a clear picture of the second constitution I mentioned earlier, one that stands parallel to and occasionally overlaps the constitution of political society as such.

The important task becomes, therefore, not that of studying the "effects" and "impacts" of technical change, but one of evaluating the material and social infrastructures specific technologies create for our life's activity. We should try to imagine and seek to build technical regimes compatible with freedom, social justice, and other key political ends. Insofar as the possibilities present in a given technology allow it, the thing ought to be designed in both its hardware and social components to accord with a deliberately articulated, widely shared notion of a society worthy of our care and loyalty. If it is clear that the social contract implicitly created by implementing a particular generic variety of technology is incompatible with the kind of society we deliberately choose—that is, if we are confronted with an inherently political technology of an unfriendly sort—then that kind of device or system ought to be excluded from society altogether.

What I am suggesting is a process of technological change disciplined by the political wisdom of democracy. It would require qualities of judiciousness in the populace that have rarely been applied to the judgment of instrumental/functional affairs. It would, presumably, produce results sometimes much different from those recommended by the rules of technical and economic efficiency. Other social and political norms, articulated by a democratic process, would gain renewed prominence. Faced with any proposal for a new technological system, citizens or their representatives would examine the social contract implied by building that system in a particular form. They would ask, How well do the proposed conditions match our best sense of who we are and what we want this society to be? Who gains and who loses power in the proposed change? Are the conditions produced by the change compatible with equality, social justice, and the common good?. To nurture this process would require building institutions in which the claims of technical expertise and those of a democratic citizenry would regularly meet face to face. Here the crucial deliberations would take place, revealing the substance of each person's arguments and interests. The heretofore concealed importance of technological choices would become a matter for explicit study and debate.

There are any number of ways in which the structural features of instrumental regimes might become a focus for democratic decision making. Technologies introduced in the workplace are the ones most often mentioned; in such cases it is usually fairly clear, as in developments in automation and robotization, whose interests are immediately helped and harmed in building a new system. There are, however, a wide variety of areas in which the political complexion of technological systems could fruitfully be explored. The following illustration is one in which there is no "crisis" or obvious social problem at hand, but in which the shape of an evolving system has interesting political dimensions.

The field of solar electricity, photovoltaic energy, is one in which the crucial choices are, to a certain extent, still open for discussion. We can expect to see events unfold in our lifetimes with outcomes that could have many different dimensions. If solar cells become feasible to mass produce, if their price in installed systems comes down to a reasonable level, solar electricity could make a contribution to our society's aggregate energy needs. If the day arrives that photovoltaic systems are technically and economically feasible (and many who work with solar electric prototypes believe they will be), there will be—at least in principle—a choice about how society will structure these systems. One could, for example, build centralized photovoltaic farms that hook directly into the existing electrical grid like any other form of centrally generated electric power. It might also be possible to produce a great number of stand-alone systems placed on the rooftops of homes, schools, factories, and the like. Or one could design and build medium-sized ensembles, perhaps at a neighborhood level. When it comes time to choose which model of photovoltaic development our society will have, a number of implicit questions will somehow be answered. How

large should such systems be? How many will be built? Who should own them? How should they be managed? Should they be fully automatic? Or should the producer/consumer of solar power be actively involved in activities of load management?

All of these are questions about the shape of a new regime of instrumentality. What kind of regime do we wish to build? What material and social structure should it have? In light of the patterns of technological development I mentioned earlier—patterns of centralization, gigantism, hierarchical authority, and so forth—perhaps it would be desirable to choose a model of photovoltaic development based on a more flexible, more democratic principle. Here is an opportunity to extend responsibility and control to a greater number of people, an opportunity to create diversity rather than uniformity in our sociotechnical constitution. Is this not an opportunity we should welcome and seek to realize? Suggesting this, I would not ask anyone to make exorbitant economic sacrifices. But rather than pursue the lemming-like course of choosing only that system design which provides the least expensive kilowatt, perhaps we ought to consider which system might play the more positive role in the technical infrastructure of freedom.

It goes without saying that the agencies now actually developing photovoltaics have no such questions in mind. Government-subsidized research, such as it is, focuses upon finding the most efficient and effective form of solar electricity and seeing it marketed in the "private sector."[19] Huge multinational petroleum corporations have bought up the smaller companies at work in this field; their motive seems to be desire to control the configuration of whatever mix of energy sources and technologies we will eventually have. As we have done so often in the past, our society has, in effect, delegated decision-making power to those whose plans are narrowly self-interested. One can predict, therefore, that when photovoltaic systems are introduced they will carry the same qualities of institutional and physical centralization that characterize so many modern technologies.

A crucial failure in modern political thought and political practice has been an inability or unwillingness even to begin the project I am suggesting here: the critical evaluation and control of our society's technical constitution. The silence of liberalism on this issue is matched by an equally obvious neglect in Marxist theory. Both persuasions have enthusiastically sought freedom in sheer material plenitude, welcoming whatever technological means (or monstrosities) seemed to produce abundance the fastest. It is, however, a serious mistake to construct one sociotechnical system after another in the blind faith that each will turn out to be politically benign. Many crucial choices about the forms and limits of our regimes of instrumentality must be enforced at the founding, at the genesis of each new technology. It is here that our best purposes must be heard.

NOTES

CHAPTER 1. *Technologies as Forms of Life*

1. Tom Wolfe, *The Right Stuff* (New York: Bantam Books, 1980), 270.
2. *The Encyclopedia of Philosophy*, 8 vols., Paul Edwards (editor-in-chief) (New York: Macmillan: 1967).
3. *Bibliography of the Philosophy of Technology*, Carl Mitcham and Robert Mackey (eds.) (Chicago: University of Chicago Press, 1973).
4. There are, of course, exceptions to this general attitude. See Stephen H. Unger, *Controlling Technology: Ethics and the Responsible Engineer* (New York: Holt, Rinehart and Winston, 1982).
5. An excellent corrective to the general thoughtlessness about "making" and "use" is to be found in Carl Mitcham, "Types of Technology," in *Research in Philosophy and Technology*, Paul Durbin (ed.) (Greenwich, Conn. JAI Press, 1978), 229–294.
6. J. L. Austin, *Philosophical Papers* (Oxford: Oxford University Press, 1961), 123–152.
7. See William Kolender et al., "Petitioner v. Edward Lawson," *Supreme Court Reporter* 103: 1855–1867, 1983. Edward Lawson had been arrested approximately fifteen times on his long walks and refused to provide identification when stopped by the police. Lawson cited his rights guaranteed by the Fourth and Fifth Amendments of the U.S. Constitution. The Court found the California vagrancy statute requiring "credible and reliable" identification to be unconstitutionally vague. See also Jim Mann, "State Vagrancy Law Voided as Overly Vague," *Los Angeles Times*, May 3, 1983, 1, 19.
8. Ludwig Wittgenstein, *Philosophical Investigations*, ed. 3, translated by G. E. M. Anscombe, with English and German indexes (New York: Macmillan, 1958), 11e.
9. Hanna Pitkin, *Wittgenstein and Justice: On the Significance of Ludwig Wittgenstein for Social and Political Thought* (Berkeley: University of California Press, 1972), 293.
10. For a thorough discussion of this idea, see Hannah Arendt, *The Human*

Condition (Chicago: University of Chicago Press, 1958); and Hannah Arendt, *Willing*, vol II of *The Life of the Mind* (New York: Harcourt Brace Jovanovich, 1978).

11. *Philosophical Investigations*, 226e.

12. Karl Marx and Friedrich Engels, "The German Ideology," in *Collected Works*, vol. 5 (New York: International Publishers, 1976), 31.

13. Karl Marx, *Grundrisse*, translated with a foreword by Martin Nicolaus (Harmondsworth, England: Penguin Books, 1973), 325.

14. An interesting discussion of Marx in this respect is Kostas Axelos' *Alienation, Praxis and Technē in the Thought of Karl Marx*, translated by Ronald Bruzina (Austin: University of Texas Press, 1976).

15. Karl Marx, *Capital*, vol. 1, translated by Ben Fowkes, with an introduction by Ernest Mandel (Harmondsworth, England: Penguin Books, 1976), chap. 15.

16. *Philosophical Investigations*, 49e.

CHAPTER 2. *Do Artifacts Have Politics?*

1. Lewis Mumford, "Authoritarian and Democratic Technics," *Technology and Culture* 5:1–8, 1964.

2. Denis Hayes, *Rays of Hope: The Transition to a Post-Petroleum World* (New York: W. W. Norton, 1977), 71, 159.

3. David Lillienthal, *T.V.A.: Democracy on the March* (New York: Harper and Brothers, 1944), 72–83.

4. Daniel J. Boorstin, *The Republic of Technology* (New York: Harper and Row, 1978), 7.

5. Langdon Winner, *Autonomous Technology: Technics-Out-of-Control as a Theme in Political Thought* (Cambridge: MIT Press, 1977).

6. The meaning of "technology" I employ in this essay does not encompass some of the broader definitions of that concept found in contemporary literature, for example, the notion of "technique" in the writings of Jacques Ellul. My purposes here are more limited. For a discussion of the difficulties that arise in attempts to define "technology," see *Autonomous Technology*, 8–12.

7. Robert A. Caro, *The Power Broker: Robert Moses and the Fall of New York* (New York: Random House, 1974), 318, 481, 514, 546, 951–958, 952.

8. Robert Ozanne, *A Century of Labor-Management Relations at McCormick and International Harvester* (Madison: University of Wisconsin Press, 1967), 20.

9. The early history of the tomato harvester is told in Wayne D. Rasmussen, "Advances in American Agriculture: The Mechanical Tomato Harvester as a Case Study," *Technology and Culture* 9:531–543, 1968.

10. Andrew Schmitz and David Seckler, "Mechanized Agriculture and Social Welfare: The Case of the Tomato Harvester," *American Journal of Agricultural Economics* 52:569–577, 1970.

11. William H. Friedland and Amy Barton, "Tomato Technology," *Society* 13:6, September/October 1976. See also William H. Friedland, *Social Sleepwalkers: Scientific and Technological Research in California Agriculture*, University of California, Davis, Department of Applied Behavioral Sciences, Research Monograph No. 13, 1974.

12. *University of California Clip Sheet* 54:36, May 1, 1979.

13. "Tomato Technology."

14. A history and critical analysis of agricultural research in the land-grant colleges is given in James Hightower, *Hard Tomatoes, Hard Times* (Cambridge: Schenkman, 1978).

15. David F. Noble, *Forces of Production: A Social History of Machine Tool Automation* (New York: Alfred A. Knopf, 1984).

16. Friedrich Engels, "On Authority," in *The Marx-Engels Reader*, ed. 2, Robert Tucker (ed.) (New York: W. W. Norton, 1978), 731.

17. Ibid.

18. Ibid., 732, 731.

19. Karl Marx, *Capital*, vol. 1, ed. 3, translated by Samuel Moore and Edward Aveling (New York: Modern Library, 1906), 530.

20. Jerry Mander, *Four Arguments for the Elimination of Television* (New York: William Morrow, 1978), 44.

21. See, for example, Robert Argue, Barbara Emanuel, and Stephen Graham, *The Sun Builders: A People's Guide to Solar, Wind and Wood Energy in Canada* (Toronto: Renewable Energy in Canada, 1978). "We think decentralization is an implicit component of renewable energy; this implies the decentralization of energy systems, communities and of power. Renewable energy doesn't require mammoth generation sources of disruptive transmission corridors. Our cities and towns, which have been dependent on centralized energy supplies, may be able to achieve some degree of autonomy, thereby controlling and administering their own energy needs." (16)

22. Alfred D. Chandler, Jr., *The Visible Hand: The Managerial Revolution in American Business* (Cambridge: Belknap, 1977), 244.

23. Ibid.

24. Ibid., 500.

25. Leonard Silk and David Vogel, *Ethics and Profits: The Crisis of Confidence in American Business* (New York: Simon and Schuster, 1976), 191.

26. Russell W. Ayres, "Policing Plutonium: The Civil Liberties Fallout," *Harvard Civil Rights—Civil Liberties Law Review* 10 (1975):443, 413–414, 374.

CHAPTER 3. *Technē and Politeia*

1. Plato, *Laws*, 7.803b, translated by A. E. Taylor, in *The Collected Dialogues of Plato*, Edith Hamilton and Huntington Cairns (eds.) (Princeton, N.J.: Princeton University Press, 1961), 1374.

2. Jean-Jacques Rousseau, *The Social Contract*, translated and introduced by Maurice Cranston (New York: Penguin Books, 1968), 84.

3. Alexander Hamilton, "Federalist No. 9," in *The Federalist Papers*, with an introduction by Clinton Rossiter (New York: Mentor Books, 1961), 72–73.

4. Thomas Jefferson, "Notes on Virginia," in *The Life and Selected Writings of Thomas Jefferson*, Adrienne Koch and William Peden (eds.) (New York: Modern Library, 1944), 28–281.

5. Quoted in Gordon S. Wood, *The Creation of the American Republic, 1776–1787* (New York: W. W. Norton, 1972), 114.

6. See John Kasson, *Civilizing the Machine: Technology and Republican Values in America, 1776–1900* (New York: Grossman, 1976).

7. See Albert O. Hirschman, *The Passions and the Interests: Political Arguments for Capitalism Before Its Triumph* (Princeton: Princeton University Press, 1977).

8. Denison Olmsted, "On the Democratic Tendencies of Science," *Barnard's Journal of Education*, vol. 1, 1855–1856, reprinted in *Changing Attitudes Toward American Technology*, Thomas Parke Hughes (ed.) (New York: Harper and Row, 1975), 148.

9. Karl Polanyi, *The Great Transformation* (Boston: Beacon Press, 1957), 33.

10. "Beta" (Edward W. Byrn), "The Progress of Invention During the Past Fifty Years," *Scientific American*, vol. 75, July 25, 1896, reprinted in Hughes (see note 8), 158–159.

11. For a discussion of the wide-ranging influence of the idea of efficiency in American thought, see Samuel Haber, *Efficiency and Uplift: Scientific Management in the Progressive Era, 1890–1920* (Chicago: Chicago University Press, 1964); and Samuel P. Hays, *Conservation and the Gospel of Efficiency: The Progressive Conservation Movement, 1890–1920* (New York: Atheneum, 1959).

12. See William L. Kahrl, *Water and Power: The Conflict Over Los Angeles' Water Supply in the Owens Valley* (Berkeley: University of California Press, 1982).

13. An analysis of the efficacy of various kinds of government regulation is contained in *The Politics of Regulation*, James Q. Wilson (ed.) (New York: Basic Books, 1980).

14. A representative selection of the ambitious energy studies done during the 1970s would include the following: *A Time to Choose*, The Energy Policy Project of the Ford Foundation (Cambridge: Ballinger, 1974); *Nuclear Power: Issues and Choices*, Report of the Nuclear Energy Policy Study Group (Cambridge: Ballinger, 1977); *Energy in America's Future: The Choices Before Us*, National Energy Studies Project (Baltimore: Johns Hopkins University Press, 1979); *Energy: The Next Twenty Years*, Report of the Study Group Sponsored by the Ford Foundation and Administered by Resources for the Future, Hans Landsberg et al. (Cambridge: Ballinger, 1979); *Energy in Transition, 1985–2010*, National Research Council Committee on Nuclear and Alternative Energy Systems (San Francisco: W. H. Freeman, 1980).

15. *Nuclear Power: Issues and Choices*, 44, 41.

16. Amory B. Lovins, "Technology Is the Answer! (But What Was the Question?): Energy as a Case Study of Inappropriate Technology," discussion paper for the Symposium on Social Values and Technological Change in an

International Context, Racine, Wis., June 1978, 1.

17. Amory B. Lovins, *Soft Energy Paths: Toward a Durable Peace* (Cambridge: Ballinger, 1977), 6–7.

18. Paul Goodman, *People or Personnel and Like a Conquered Province* (New York: Vintage Press, 1968), 4.

19. See, for example, J. L. Smith, "Photovoltaics," *Science* 212:1472–1478, 1981.