PART ONE: CONFLICTING VALUES

Chapter 1: Views of Technology

> Technology, the source of the problem, will once again prove to contain within itself the germs of a solution compatible with the betterment of man's lot and dignity.
>
> Charles Susskind[1]

> Our enslavement to the machine has never been more complete.
>
> John Zerman and Alice Carnes[2]

> What we call Man's power over Nature turns out to be a power exercised by some men over other men with Nature as its instrument.
>
> C. S. Lewis[3]

Appraisals of modern technology diverge widely. Some see it as the beneficent source of higher living standards, improved health, and better communications. They claim that any problems created by technology are themselves amenable to technological solutions. Others are critical of technology, holding that it leads to alienation from nature, environmental destruction, the mechanization of human life, and the loss of human freedom. A third group asserts that technology is ambiguous, its impacts varying according to the social context in which it is designed and used, because it is both a product and a source of economic and political power.[4]

In this chapter, views of technology are grouped under three headings: Technology as Liberator, Technology as Threat, and Technology as Instrument of Power. In each case the underlying assumptions and value judgments are examined. I will indicate why I agree with the third of these positions, which emphasizes the social construction and use of particular technologies. The issues cut across disciplines; I draw from the writings of engineers, historians, sociologists, political scientists, philosophers, and theologians. The human and environmental values relevant to the appraisal of technology are further analyzed in chapters 2 and 3. These three chapters provide the ethical categories and principles for examining policy decisions about particular technologies in later chapters.

Technology may be defined as *the application of organized knowledge to practical tasks by ordered systems of people and machines*.[5] There are several advantages to such a broad definition. “Organized knowledge” allows us to include technologies based on practical experience and invention as well as those based on scientific theories. The “practical tasks” can include both the production of material goods (in industry and agriculture, for instance) and the provision of services (by computers, communications media, and biotechnologies, among others). Reference to “ordered systems of people and machines” directs attention to social institutions as well as to the hardware of technology. The breadth of the definition also reminds us that there are major differences among technologies.

I. TECHNOLOGY AS LIBERATOR

Throughout modern history, technological developments have been enthusiastically welcomed because of their potential for liberating us from hunger, disease, and poverty. Technology has been celebrated as the source of material progress and human fulfillment.

1. THE BENEFITS OF TECHNOLOGY

Defenders of technology point out that four kinds of benefits can be distinguished if one looks at its recent history and considers its future:

1. Higher Living Standards. New drugs, better medical attention, and improved sanitation and nutrition have more than doubled the average life span in industrial nations within the past century. Machines have released us from much of the backbreaking labor that in previous ages absorbed most of people's time and energy. Material progress represents liberation from the tyranny of nature. The ancient dream of a life free from famine and disease is beginning to be realized through technology. The standard of living of low-income families in industrial societies has doubled in a generation, even though relative incomes have changed little. Many people in developing nations now look on technology as their principal source of hope. Productivity and economic growth, it is said, benefit everyone in the long run.

2. Opportunity for Choice. Individual choice has a wider scope today than ever before because technology has produced new options not previously available and a greater range of products and services. Social and geographical mobility allow a greater choice of jobs and locations. In an urban industrial society, a person's options are not as limited by parental or community expectations as they were in a small-town agrarian society. The dynamism of technology can liberate people from static and confining traditions to assume responsibility for their own lives. Birth control techniques, for example, allow a couple to choose the size and timing of their family. Power over nature gives greater opportunity for the exercise of human freedom.[6]

3. More Leisure. Increases in productivity have led to shorter working hours. Computers and automation hold the promise of eliminating much of the monotonous work typical of earlier industrialism. Through most of history, leisure and cultural pursuits have been the privilege of the few, while the mass of humanity was preoccupied with survival. In an affluent society there is time for continuing education, the arts, social service, sports, and participation in community life. Technology can contribute to the enrichment of human life and the flowering of creativity. Laborsaving devices free us to do what machines cannot do. Proponents of this viewpoint say that people can move behind materialism when their material needs are met.

4. Improved Communications. With new forms of transportation, one can in a few hours travel to distant cities that once took months to reach. With electronic technologies (radio, television, computer networks, and so on), the speed, range, and scope of communication have vastly increased. The combination of visual images and auditory message have an immediacy not found in the linear sequence of the printed word. These new media offer the possibility of instant worldwide communication, greater interaction, understanding, and mutual appreciation in the "global village." It has been suggested that by dialing coded numbers on telephones hooked into computer networks, citizens could participate in an instant referendum on political issues. According as its defenders, technology brings psychological and social benefits as well as material progress.

In part 2 we will encounter *optimistic forecasts* of each of the particular technologies examined. In agriculture, some experts anticipate that the continuing Green Revolution and the genetic engineering of new crops will provide adequate food for a growing world population. In the case of energy, it is claimed that breeder reactors and fusion will provide environmentally benign power to replace fossil fuels. Computer enthusiasts anticipate the Information Age in which industry is automated and communications networks enhance commercial, professional, and personal life. Biotechnology promises the eradication of genetic diseases, the improvement of health, and the deliberate design of new species—even the modification of humanity itself. In subsequent chapters we will examine each of these specific claims as well as the general attitudes they reveal.

OPTIMISTIC VIEWS OF TECHNOLOGY

Let us look at some authors who have expressed optimism regarding technology. Melvin Kranzberg, a prominent historian of technology, has presented a very positive picture of the technological past and future. He argues that urban industrial societies offer *more freedom* than rural ones and provide grater choice of occupations, friends, activities, and life-styles. The work week has been cut in half, and human wants have been dramatically fulfilled.[7]Emanuel Mesthene, former director of the Harvard Program in Technology and Society, grants that every technology brings risks as well as benefits, but he says that our task is the rational management of risk. Some technologies poison the environment, but others reduce pollution. A new technology may displace some workers but it also creates new jobs. Nineteenth-century factories and twentieth-century assembly lines did involve dirty and monotonous work, but the newer technologies allow greater creativity and individuality.[8]

A *postindustrial society*, it is said, is already beginning to emerge. In this new society, according to the sociologist Daniel Bell, power will be based on knowledge rather than property. The dominant class will be scientists, engineers, and technical experts; the dominant institutions will be intellectual ones (universities, industrial laboratories, and research institutes). The economy will be devoted mainly to services rather than material goods. Decisions will be made on rational-technical grounds, marking "the end of ideology." There will be a general consensus on social values; experts will coordinate social planning, using rational techniques such as decision theory and systems analysis. This will be a future-oriented society, the age of the professional managers, the technocrats.[9] A bright picture of the coming technological society has been given by many "futurists," including Buckminster Fuller, Herman Kahn, and Alvin Toffler.[10]

Samuel Florman is an articulate engineer and author who has written extensively *defending technology* against its detractors. He insists that the critics have romanticized the life of earlier centuries and rural societies. Living standards were actually very low, work was brutal, and roles were rigidly defined. People have much greater freedom in technological societies. The automobile, for example, enables people to do what they want and enhances geographical and class mobility. People move to cities because they prefer life there to "the tedium and squalor of the countryside." Florman says that worker alienation in industry is rare, and many people prefer the comfortable monotony of routine tasks to the pressures of decision and accountability. Technology is not an independent force out of control; it is the product of human choice, a response to public demand expressed through the market place.[11]

Florman grants that technology often has undesirable side effects, but he says that these are amenable to *technological solutions*. One of his heroes is Benjamin Franklin, who “proposed technological ways of coping with the unpleasant consequences of technology.”[12] Florman holds that environmental and health risks are inherent in every technical advance. Any product or process can be made safer, but always at an economic cost. Economic growth and lower prices for consumers are often more important than additional safety, and absolute safety is an illusory goal. Large-scale systems are usually more efficient than small-scale ones. It is often easier to find a “technical fix” for a social problem than to try to change human behavior or get agreement on political policies.[13]

Florman urges us to rely on *the judgment of experts* in decisions about technology. He says that no citizen can be adequately informed about complex technical questions such as acid rain or radioactive waste disposal. Public discussion of these issues only leads to anxiety and erratic political actions. We should rely on the recommendations of experts on such matters.[14] Florman extols the “unquenchable spirit” and “irrepressible human will” evident in technology: For all our apprehensions, we have no choice but to press ahead. We must do so, first, as the name of compassion. By turning our backs on technological change, we would be expressing our satisfaction with current world levels of hunger, disease, and privates. Further, we must press ahead in the name of the human adventure. Without experimentation and change our existence would be a dull business. We simply cannot sleep while there are masses to feed and diseases to conquer, seas to explore and heaving to servey.[15]

Some theologians have also given very positive appraisals of technology. They see it as a source not only of higher living standards but also of *greater freedom and creative expression*. In his earlier writings, Harvey Cox held that freedom to master and shape the world through technology liberates us from the confines of tradition. Christianity brought about the desacralization of nature and allowed it to be controlled and used for human welfare.[16] Norris Clarke was technology as an instrument of human fulfillment and self-expression in the use of our God-given intelligence to transform the world. Liberation from bondage to nature, he says, is the victory of spirit over matter. As cocreators with God we can celebrate the contribution of reason to the enrichment of human life.[17] Other theologians have affirmed technology as an instrument of love and compassion in relieving human suffering—a modern response to the biblical command to feed the hungry and help the neighbor in need.

The Jesuit paleontologist Pierre Teilhard de Chardin, writing in the early year of nuclear power, computers, and molecular biology, expressed *a hopeful vision of the technological future*. He envisioned computers and electronic communication in a network of interconnected consciousness, a global layer of thought that he called “the noosphere.” He defended eugenics, “artificial neo-life,” and the remodeling of the human organism by manipulation of the genes. With this new power over heredity, he said, we can replace the crude forces of natural selection and “seize the tiller” to control the direction of future evolution. We will have total power over matter, “reconstructing the very stuff of the universe.” He looked to a day of interplanetary travel and the unification of our own planet, based on intellectual and cultural interaction.[18]

Here was an inspiring vision of a planetary future in which *technology and spiritual development* would be linked together. Teilhard affirmed the value of secular life in the world and the importance of human efforts in “building the earth” as we cooperate in the creative work of God. Technology is participation in divine creativity. He rejected any note of despair, which would cut the nerve of constructive action. At times he seemed to have unlimited confidence in humanity's capacity to shape its own destiny. But his confidence really lay in the unity, convergence, and ascent of the cosmic process of which humanity and technology are manifestations. The ultimate source of that unity and ascent is God as known in the Christ whose role is cosmic. For Teilhard eschatological hope looks not to an intervention discontinuous from history, but to the fulfillment of a continuing process to which our own actions contribute.

Teilhard's writings present us with a magnificent sweep of time from past to future. But they do not consider the institutional structures of economic power and self-interest that now control the directions of technological development. Teilhard seldom acknowledged the tragic hold of social injustice on human life. He was writing before the destructive environmental impacts of technology were evident. When Teilhard looked to the past, he portrayed humanity as an integral part of the natural world, interdependent with other creatures. But when he looked to the future, he expected that because of our technology and our spirituality we will be increasingly separated from other creatures. Humanity will move beyond dependence on the organic world. Though he was ultimately theocentric (centered on God), and he talked about the redemption of the whole cosmos, many of his images are anthro-pocentric (centered on humanity) and imply that other forms of life are left behind in the spiritualization of humankind that technology will help to bring about.

3. A REPLY TO THE OPTIMISTS

Subsequent chapters will point to inadequacies of these views, but some major criticisms can be summarized here.

First, the *environmental costs and human risks* of technology are dismissed too rapidly. The optimists are confident that technical solutions can be found for environmental problems. Of course, pollution abatement technologies can treat many of the effluents of industry, but often unexpected, indirect, or delayed consequences occur. The effects of carcinogens may not show up for twenty-five years or more. The increased death rates among shipyard workers exposed to asbestos in the early 1940s were not evident until the late 1960s. Toxic wastes may contaminate groundwater decades after they have been buried. The hole in the ozone layer caused by the release of chlorofluorocarbons had not been anticipated by any scientists. Above all, soil erosion and massive deforestation threaten the biological resources essential for human life, and global warming from our use of fossil fuels threatens devastating changes in world climates.

Second, environmental destruction is symptomatic of a deeper problem: *alienation from nature*. The idea of human domination of nature has many roots. Western religious traditions have often drawn a sharp line between humanity and other creatures (see chapter 3). Economic institutions treat nature as a resource for human exploitation. But technological enthusiasts contribute to this devaluation of the natural world if they view it as an object to be controlled and manipulated. Many engineers are trained in the physical sciences and interpret living things in mechanistic rather than ecological terms. Others spend their entire professional lives in the technosphere of artifacts, machines, electronics, and computers, cut off from the world of nature. To be sure, sensitivity to nature is sometimes found among technological optimists, but it is more frequently found among the critics of technology.

Third, technology has contributed to *the concentration of economic and political* prove. Only relatively affluent groups or nations can afford the latest technology the gaps between rich and poor have been perpetuated and in many ideas increased by technological developments. In a world of limited resources, it also appears impossible for all nations to sustain the standards of living of industrial nations today, much less the higher standards that industrial nations expect in the future. Affluent nations use a grossly disproportionate share of the world's energy and resources. Commitment to justice within nations also requires a more serious analysis of the distribution of the fonts and benefits of technology. We will find many technologies in which one group enjoys the benefits while another group is exposed to the risks and social costs.

Fourth, large-scale technologies typical of industrial nations today are particularly problematic. They are capital-intensive rather than labor-intensive, and they add to unemployment in many parts of the world. Large-scale systems send to be vulnerable to error, accident, or sabotage. The near catastrophe at the Three Mile Island nuclear plant in 1979 and the Chernobyl disaster in 1986 were the products of human errors, faulty equipment, poor design, and unreliable safety procedures. Nuclear energy is a prime example of a vulnerable, centralized, capital-intensive technology. Systems in which human or mechanical failures can be disastrous are risky even in a stable society, quite apart from additional risks under conditions of social unrest. The large scale of many current systems is as much the product of government subsidies, tax and credit policies, and particular corporate interests as of any inherent economies of scale.

Fifth, greater *dependence on experts* for policy decisions would not be desirable. The technocrats claim that their judgments are value free; the technical elite is supposedly nonpolitical. But those with power seldom use it rationally and objectively when their own interests are at slake. When social planners think they are deciding for the good of all—whether in the French or Russian revolutions or in the proposed technocracy of the future—the assumed innocence of moral intentions is likely to be corrupted in practice. Social controls over the controllers are always essential. I will suggest that the most important from of freedom is participation in the decisions affecting our lives. We will return in chapter 8 to this crucial question: How can both experts and citizens contribute to technological policy decisions in a democracy?

Lastly, we must question the linear view of the *science-technology-society relationship*, which is assumed by many proponents of optimistic views. Technology is taken to be applied science, and it is thought to have an essentially one-way impact on society. The official slogan of the Century of Progress exposition in Chicago in 1933 was: "Science Finds—Industry Applies—Man Conforms." This has been called "the assembly-line view" because it pictures science at the start of the line and a stream of technological products pouring off the end of the line.[19] If technology is fundamentally benign, there is no need for government interference except to regulate the most serious risks. Whatever guidance is needed for technological development is supplied by the expression of consumer preferences through the marketplace. In this view, technologies develop from the "push" of science and the "pull" of economic profits.

I accept the basic framework of private ownership in *a free market economy*, but I believe it has severe limitations that require correction through political processes. When wealth is distributed unevenly, the luxuries of a few people carry much more weight in the marketplace than the basic needs of many others. Many of the social and environmental costs of industrial processes are not included in market prices. Because long-term consequences are discounted at the current interest rate, they are virtually ignored in economic decisions. Our evaluation of technology, in short, must encompass questions of justice, participation, environmental protection, and long-term sustainability, as well as short-term economic efficiency.

II. TECHNOLOGY AS THREAT

At the opposite extreme are the critics of modern technology who see it as a threat to authentic human life. We will confine ourselves here to criticisms of the human rather than environmental consequences of technology.

1. THE HUMAN COSTS OF TECHNOLOGY

Five characteristics of industrial technology seem to its critics particularly inimical to human fulfillment.[20]

1. Uniformity in a Mass Society. Mass production yields standardized products, and mass media tend to produce a uniform national culture. Individuality is lost and local or regional differences are obliterated in the homogeneity of industrialization. Nonconformity hinders efficiency, so cooperative and docile workers are rewarded. Even the interactions among people are mechanized and objectified. Human identity is defined by roles in organizations. Conformity to a mass society jeopardizes spontaneity and freedom. According to the critics, there is little evidence that an electronic, computerized, automated society will produce more diversity than earlier industrialism did.

2. Narrow Criteria of Efficiency. Technology leads to rational and efficient organization, which requires fragmentation, specialization, speed, the maximization of output. The criterion is efficiency in achieving a single goal or a narrow range of objectives; side effects and human costs are ignored. Quantitative criteria tend to crowd out qualitative ones. The worker becomes the servant of the machine, adjusting to its schedule and tempo, adapting to its requirements. Meaningful work roles exist for only a small number of people in industrial societies today. Advertising creates demand for new products, whether or not they fill real needs, in order to stimulate a larger volume of production and a consumer society.

3. Impersonality and Manipulation Relationships in a technological society are specialized and functional. Genuine community and interpersonal interaction are threatened when people feel like cogs in a well-oiled machine. In a bureaucracy, the goals of the organization are paramount and responsibility is diffused, so that no one feels personally responsible. Moreover, technology has created subtle ways of manipulating people and new techniques of electronic surveillance and psychological conditioning. When the technological mentality is dominant, people are viewed and treated like objects.

4 Uncontrollability. Separate technologies form an interlocking system, a total, mutually reinforcing network that seems to lead a life of its own. “Run-away technology” is said to be like a vehicle out of control, with a momentum that cannot be stopped. Some critics assert that technology is not just a set of adaptable tools lot human use but an all-encompassing form of life, a pervauttuie with its own logic and dynamic. Its consequences are unintended and unforeseeable. Like the sorcerer's apprentice who found the magic formula to make his broom carry water but did not know how to make it stop, we have set in motion forces that we cannot control. The individual feels powerless facing a monolithic system.

5. Alienation of the Worker. The worker's alienation was a central theme in the writing of Karl Marx. Under capitalism, he said, workers do not own their own tools or machines, and they are powerless in their work life. They can sell their labor as a commodity, but their work is not a meaningful form of self-expression. Marx held that such alienation is a product of capitalist ownership and would disappear under state ownership. He was optimistic about the use of technology in a communist economic order, and thus he belongs with the third group below, the contextualists, but his idea of alienation has influenced the pessimists.

More recent writers point out that *alienation* has been common in state-managed industrial economies too and seems to be a product of the division of labor, rationalization of production, and hierarchical management in large organizations, regardless of the economic system. Studs Terkel and others have found in interviews that resentment, frustration, and a sense of powerlessness are widespread among American industrial workers. This contrasts strongly with the greater work autonomy, job satisfaction, and commitment to work found in the professions, skilled trades, and family-owned farms.[21]

Other features of technological development since World War II have evoked widespread concern. The allocation of more than two-thirds of the U.S. federal research and development budget to military purposes has diverted expertise from environmental problems and urgent human needs, Technology also seems to have contributed to the impoverishment of human relationships and a loss of community. The youth counterculture of the 1970s was critical of technology and sought harmony with nature, intensity of personal experience, supportive communities, and alternative life-styles apart from the prevailing industrial order. While many of its expressions were short-lived, many of its characteristic attitudes, including disillusionment with technology, have persisted among some of the younger generation.[22]

2. RECENT CRITICS OF TECHNOLOGY

To the French philosopher and social critic Jacques Ellul, technology is *an autonomous and uncontrollable force* that dehumanizes all that it touches. The enemy is "technique"—a broad term Ellul uses to refer to the technological mentality and structure that he sees pervading not only industrial processes, but also all social, political, and economic life affected by them. Efficiency and organization, he says, are sought in all activities. The machine enslaves people when they adapt to its demands. Technology has its own inherent logic and inner necessity. Rational order is everywhere imposed at the expense of spontaneity and freedom.

Ellul ends with a *technological determinism*, since technique is self-perpetuating, all-pervasive, and inescapable. Any opposition is simply absorbed as we become addicted to the products of technology. Public opinion and the state become the servants of technique rather than its masters. Technique is global, monolithic, and unvarying among diverse regions and nations. Ellul offers us no way out, since all our institutions, the media, and our personal lives are totally in its grip. He holds that biblical ethics can provide a viewpoint transcending society from which to judge the sinfulness of the technological order and can give us the motivation to revolt against it, but he holds out little hope of controlling it.[23] Some interpreters see in Ellul's recent writings a very guarded hope that a radical Christian freedom that rejects cultural illusions of technological progress might in the long run lead to the transformation rather than the rejection of technology. But Ellul does not spell out such a transformation because he holds that the outcome is in God's hands, not outs, and most of his writings are extremely pessimistic about social change.[24]

The political scientist Langdon Winner has given a sophisticated version of the argument that technology is *an autonomous system* that shapes all human activities to its own requirements. It makes little difference who is nominally in control—elected politicians, technical experts, capitalist executives, or socialist managers—if decisions are determined by the demands of the technical system. Human ends are then adapted to suit the techniques available rather than the reverse. Winner says that large-scale systems are self-perpetuating, extending their control over resources and markets and molding human life to fit their own smooth functioning. Technology is not a neutral means to human ends but an all-encompassing system that imposes its patterns on every aspect of life and thought.[25]

The philosopher Hans Jonas is impressed by *the new scale of technological power* and its influence on events distant in time and place. Traditional Western ethics have been anthropocentric and have considered only short-range consequences. Technological change has its own momentum, and its pace is too rapid for trial-and-error readjustments. Now genetics gives us power over humanity itself. Jonas calls for a new ethic of responsibility for the human future and for nonhuman nature. We should err on the side of caution, adopting policies designed to avert catastrophe rather than to maximize short-run benefits. "The magnitude of these stakes, taken with the insufficiency of our predictive knowledge, leads to the pragmatic rule to give the prophecy of doom priority over the prophecy of bliss."[26] We should seek "the least harm," not "the greatest good." We have no right to tamper genetically with human nature or to accept policies that entail even the remote possibility of the extinction of humanity in a nuclear holocaust.

Another philosopher, Albert Borgmann, does not want to return to a pretechnological past, but he urges the selection of technologies that encourage *genuine human fulfillment*. Building on the ideas of Heidegger, he holds that authentic human existence requires the engagement and depth that occur when simple things and practices focus our attention and center our lives. We have let technology define the good life in terms of production and consumption, and we have ended with mindless labor and mindless leisure. A fast-food restaurant replaces the family meal, which was an occasion of communication and celebration. The simple pleasures of making music, hiking and running, gathering with friends around the hearth, or engaging in creative and self-reliant work should be our goals. Borgmann thinks that some large-scale capital-intensive industry is needed (especially in transportation and communication), but he urges the development of small-scale labor-intensive, locally owned enterprises (in arts and crafts, health care, and education, for example). We should challenge the rule of technology and restrict it to the limited role of supporting the humanly meaningful activities associated with a simpler life.[27]

In *Technology and Power*, the psychologist David Kipnis maintains that those who control a technology have power over other people and this affects personal attitudes as well as social structures, Power holders interpret technological superiority as moral superiority and tend to look down on weaker parties. Kipnis shows that military and transportation technologies fed the conviction of colonists that they were superior to colonized peoples. Similarly, medical knowledge and specialization have led doctors to treat patients as impersonal cases and to keep patients at arms length with a minimum of personal communication. Automation gave engineers and managers increased power over workers, who no longer needed special skills. In general, "power corrupts" and leads people to rationalize their use of power for their own ends. Kipnis claims that the person with technological knowledge-often has not only a potent instrument of control but also a self-image that assumes superiority over people who lack that knowledge and the concomitant opportunities to make decisions affecting their lives.[28]

Some Christian groups are critical of *the impact of technology on human life*. The Amish for example, have resolutely turned their backs on radios, television, and even automobiles. By hard work, community cooperation, and frugal ways, they have prospered in agriculture and have continued their distinctive life-styles and educational patterns. Main theologians who do not totally reject technology criticize its tendency to generate a Promethean pride and a quest for unlimited power. The search for omnipotence is a denial of creaturehood. Unqualified devotion to technology as a total way of life, they say, is a form of idolatry. Technology is finally thought of as the source of salvation, the agent of secularized redemption.[29] In an affluent society, a legitimate concern for material progress readily becomes a frantic pursuit of comfort, a total dedication to self-gratification. Such an obsession with things distorts our basic values as well as our relationships with other persons. Exclusive dependence on technological rationality also leads to a truncation of experience, a loss of imaginative and emotional life, and an impoverishment of personal existence.

Technology is *imperialistic and addictive*, according to these critics. The optimists may think that, by fulfilling our material needs, technology liberates us from materialism and allows us to turn to intellectual, artistic, and spiritual pursuits. But it does not seem to be working out that way. Our material wants have escalated and appear insatiable. Yesterday's luxuries are today's necessities. The rich are usually more anxious about their future than the poor. Once we allow technology to define the good life, we have excluded many important human values from consideration.

Several theologians have expressed particular concern for the impact of technology on *religious life*. Paul Tillich claims that the rationality and impersonality of technological systems undermine the personal presuppositions of religious commitment.[30] Gabriel Marcel believes that the technological outlook pervades our lives and excludes a sense of the sacred. The technician treats everything as a problem that can be solved by manipulative techniques without personal involvement. But this misses the mystery of human existence, which is known only through involvement as a total person. The technician treats other people as objects to be understood and controlled.[31]Martin Buber contrasts the I–It relation of objective detachment with the I–Thou relation of mutuality, responsiveness, and personal involvement. If the calculating attitude of control and mastery dominates a person's life, it excludes the openness and receptivity that are prerequisites of a relationship to God or to other persons.[32] P. H. Sun holds that a high-tech environment inhibits the life of prayer. Atdtudes of power and domination are incompatible with the humility and reverence that prayer requires.[33]

3. A REPLY TO THE PESSIMISTS

In replying to these authors, we may note first that there are *great variations among technologies*, which are ignored when they are lumped together and condemned wholesale. Computerized offices differ greatly from steel mills and auto assembly lines, even if they share some features in common. One survey of journal articles finds that philosophers and those historians who trace broad trends (in economic and urban history, for example) often claim that technology determines history, whereas the historians or sociologists who make detailed studies of particular technologies are usually aware of the diversity of social, political, and economic interests that affect the design of a machine and its uses.[34] I will maintain that the uses of any technology vary greatly depending on its social contexts. To be sure, technological systems are interlocked, but they do not form a monolithic system impervious to political influence or totally dominating all other social forces In particular, technology assessment and legislation offer opportunities for controlling technology, as we shall see.

Second, technological pessimists neglect possible avenues for *the redirection of technology*. The “inevitability” or “inherent logic” of technological developments is not supported by historical studies. We will note below some cases in which there were competing technical designs and the choice among them was affected by various political and social factors. Technological determinism underestimates the diversity of forces that contribute to technological change. Unrelieved pessimism undercuts human action and becomes a self-fulfilling prophecy. If we are convinced that nothing can be done to improve the system, we will indeed do nothing to try to improve it. This would give to the commercial sponsors of technology the choices that are ours as responsible citizens.

Third, technology can be *the servant of human values*. Life is indeed impoverished if the technological attitudes of mastery and power dominate one's outlook. Calculation and control do exclude mutuality and receptivity in human relationships and prevent the humility and reverence that religious awareness requires. But I would submit that the threat to these areas of human existence comes not from technology itself but from preoccupation with material progress and unqualified reliance on technology. We can make decisions about technology within a wider context of human and environmental values.

III. TECHNOLOGY AS INSTRUMENT OF POWER

A third basic position holds that technology is neither inherently good nor inherently evil but is an ambiguous instrument of power whose consequences depend on its social context. Some technologies seem to be neutral if they can be used for good or evil according to the goals of the users. A knife can be used for surgery or for minder. An isotope separator can enrich uranium for peaceful nuclear reactors or for aggression with nuclear weapons. But historical analysis suggests that most technologies are already molded by particular interests and institutional goals. Technologies are social constructions, and they are seldom neutral because particular purposes are already built into their design. Alternative purposes would lead to alternative designs. Yet most designs still allow some choice as to how they are deployed.

1. TECHNOLOGY AND POLITICAL POWER

Like the authors in the previous group, those in this group are critical of many features of current technology. But they offer hope that technology can he used for more humane ends, either by political measures for more effective guidance within existing institutions or by changes in the economic and political systems themselves.

The people who make most of the decisions about technology today are not a technical elite or technocrats trying to run society rationally or disinterested experts whose activity was supposed to mark “the end of ideology.” The decisions are made by managers dedicated to *the interests of institutions*, especially industrial corporations and government bureaucracies. The goals of research are determined largely by the goals of institutions: corporate profits, institutional growth, bureaucratic power, and so forth. Expertise serves the interests of organizations and only secondarily the welfare of people or the environment.

The interlocking structure of *technologically based government agencies and corporations*, sometimes called the “technocomplex,” is wider than the “military-industrial complex.” Many companies are virtually dependent on government contracts. The staff members of regulatory agencies, in turn, are mainly recruited from the industries they are supposed to regulate. We will see later that particular legislative committees, government agencies, and industries have formed three-way alliances to promote such technologies as nuclear energy or pesticides. Networks of industries with common interests form lobbies of immense political power. For example, U.S. legislation supporting railroads and public mass transit systems was blocked by a coalition of auto manufacturers, insurance companies, oil companies, labor unions, and the highway construction industry. But citizens can also influence the direction of technological development. Public opposition to nuclear power plants was as important as rising costs in stopping plans to construct new plants in almost all Western nations.

The historian Arnold Pacey gives many examples of *the management of technology for power and profit*. This is most clearly evident in the defense industries with their close ties to government agencies. But often the institutional biases associated with expertise are more subtle. Pacey gives as one example the Western experts in India and Bangladesh who in the 1960s advised the use of large drilling rigs and diesel pumps for wells, imported from the West. By 1975, two thirds of the pumps had broken down because the users lacked the skills and maintenance networks to operate them. Pacey calls for greater public participation and a more democratic distribution of power in the decisions affecting technology. He also urges the upgrading of indigenous technologies, the exploration of intermediate-scale processes, and greater dialogue between experts and users. Need-oriented values and local human benefits would then play a larger part in technological change.[35]

2. THE REDIRECTION OF TECHNOLOGY

The political scientist Victor Ferkiss expresses hope about the redirection of technology. He thinks that both the optimists and the pessimists have neglected the diversity among different technologies and *the potential role of political structures* in reformulating policies. In the past, technology has been an instrument of profit, and decisions have been motivated in short-run private interests. Freedom understood individualistically became license for the economically powerful. Individual rights were given precedence over the common good, despite our increasing interdependence. Choices that could only be made and enforced collectively—such as laws concerning air and water pollution—were resisted AS infringements on free enterprise. But Ferkiss thinks that economic criteria can be subordinated to such social criteria as ecological balance and human need. He believes it is possible to combine centralized, systemwide planning in basic decisions with decentralized implementation, cultural diversity, and citizen participation.[36]

There is a considerable range of views among *contemporary Marxists*. Most there Marx's conviction that technology is necessary for solving social problems but that under capitalism it has been an instrument of exploitation, repression, and dehumanization. In modern capitalism, according to Marxists, corporations dominate the government and political processes serve the interests of the ruling class. The technical elite likewise serves the profits of the owners. Marxists grant that absolute standards of living have risen for every time under capitalist technology. But relative inequalities have increased, so that class distinctions and poverty amidst luxury remain. Marxists assign justice a higher priority than freedom. Clearly they blame capitalism rather than technology for these evils of modern industrialism. They believe that alienation and inequality will disappear and technology will be wholly benign when the working class owns the means of production. The workers, not the technologists, are the agents of liberation. Marxists are thus as critical as the pessimists concerning the consequences of technology within capitalism but as enthusiastic as the optimists concerning its potentialities—within a proletarian economic order.

How, then, do Western Marxists view the human effects of *technology in Soviet history?* Reactions vary, but many would agree with Bernard Gendron that in the Soviet Union workers were as alienated, factories as hierarchically organized, experts as bureaucratic, and pollution and militarism as rampant as in the United States. But Gendron insists that the Soviet Union did not follow Marx's vision. The means of production were controlled by a small group within the Communist party, not by the workers. Gendron maintains that in a truly democratic socialism, technology would be humane and work would not be alienating.[37] Most commentators hold that the demise of communism in eastern Europe and the Soviet Union was a product of both its economic inefficiency and its political repression. It remains to be seen whether any distinctive legacy from Marxism will remain there after the economic and political turmoil of the early nineties.

We have seen that a few theologians are technological optimists, while others have adopted pessimistic positions. A larger number, however, see technology as *an ambiguous instrument of social power*. As an example consider Norman Faramelli, an engineer with theological training, who writes in a framework of christian ideas: stewardship of creation, concern for the dispossessed, and awareness of the corrupting influence of power. He distrusts technology as an instrument of corporate profit, but he believes it can be reoriented toward human liberation and ecological balance. Technology assessment and the legislative processes of democratic politics, he holds, can be effective in controlling technology. But Faramelli also advocates restructuring the economic order to achieve greater equality in the distribution of the fruits of technology.[38] Similar calls for the responsible use of technology in the service of basic human needs have been issued by task forces and conferences of the National Council of Churches and by the World Council of Churches (WCC).[39] According to one summary of WCC documents, “technological society is to be blessed for its capacity to meet basic wants, chastised for its encouragement of inordinate wants, transformed until it serves communal wants.”[40]

Egbert Schuurman, a Calvinist engineer from Holland, rejects many features of current technology but holds that it can be *transformed and redeemed* to be an instrument of God's love serving all creatures. Western thought since the Renaissance has increasingly encouraged “man the master of nature”; secular and reductionistic assumptions have prevailed. Schuurman says that technology was given a messianic role as the source of salvation, and under the rule of human sin it has ended by enslaving us so we are “exiles in Babylon.” But we can be converted to seek God's Kingdom, which comes as a gift, not by human effort. Receiving it in joy and love, and responding in obedience, we can cooperate in meaningful service of God and neighbor. Schuurman holds that technology can be redirected to advance both material and spiritual well-being. It has “a magnificent future” if it is incorporated into God's work of creation and redemption. A liberated technology could do much to heal the brokenness of nature and society. Unfortunately, he gives us few examples of what such a technology would be like or how we can work to promote it.[41]

The American theologian Roger Shinn has written extensively on Christian ethics and gives attention to *the structures of political and economic power* within \ which technological decisions are made. He agrees with the pessimists that various technologies reinforce each other in interlocking systems, and he acknowledges that large-scale technologies lead to the concentration of economic and political power. But he argues that when enough citizens are concerned, political processes can be effective in guiding technology toward human welfare. Policy changes require a combination of protest, political pressure, and the kind of new vision that the biblical concern for social justice can provide.[42]

This third position seems to me more consistent with *the biblical outlook* than either of the alternatives. Preoccupation with technology does become a form of idolatry, a denial of the sovereignty of God, and a threat to distinctively human existence. But technology directed to genuine human needs is a legitimate expression of humankind's creative capacities and an essential contribution to its welfare. In a world of disease and hunger, technology rightly used can be a far-reaching expression of concern for persons. The biblical understanding of human nature is realistic about the abuses of power and the institutionalization of self-interest. But it also is idealistic in its demands for social justice in the distribution of the fruits of technology. It brings together celebration of human creativity and suspicion of human power.

The attitudes toward technology outlined in this chapter can be correlated with the typology of historic Christian attitudes toward society set forth by H. Richard Niebuhr.[43] At the one extreme is *accommodation to society*. Here society is considered basically good and its positive potentialities are affirmed. Niebuhr Cites the example of liberal theologians of the nineteenth century who had little to say concerning sin, revelation, or grace. They were confident about human reason, scientific and technological knowledge, and social progress. They would side with our first group, those who are optimistic about technology.

At the opposite extreme, Niebuhr describes Christian groups advocating *withdrawal from society*. They believe that society is basically sinful. The Christian perfectionists, seeking to maintain their purity and to practice radical obedience, have withdrawn into monasteries or into separate communities, as the Mennonites and Amish have done. They would tend to side with our sec-and group, the critics of technology.

Niebuhr holds that the majority of Christians are in three movements that fall between the extremes of accommodation and withdrawal. A *synthesis of christianity and society* has been advocated historically by the Roman Catholic Church. Aquinas held that there is both a revealed law, known through scripture the church, and a natural law, built into the created order and accesable human reason. Church and state have different roles but can cooperate for human welfare in society. This view encourages a qualified optimism about social change (and, I suggest, about technology).

Another option is the view of Christian life and society as *two separate realms*, as held in the Lutheran tradition. Here there is a compartmentalization of spiritual and temporal spheres and different standards for personal and public life. Sin is prevalent in all life, but in personal life it is overcome by grace; gospel comes before law as the Christian responds in faith and in love of neighbor. In the public sphere, however, sin must be restrained by the secular structures of authority and order. This view tends to be more pessimistic about social change, but it does not advocate withdrawal from society.

The final option described by Niebuhr is a *transformation of society* by Christian values. This position has much in common with the Catholic view and shares its understanding that God is at work in history, society, and nature as well as in personal life and the church. But it is more skeptical about the exercise power by the institutional church, and it looks instead to the activity of the layperson in society. Calvin, the Reformed and Puritan traditions, the Anglican, and the Methodists all sought a greater expression of Christian values in public life. They had great respect for the created world ordered by God, and they called for social justice and the redirection of cultural life. This position holds that social change (including the redirection of technology) is possible, but it is difficult because of the structures of group self-interest and institutional power. I favor this last option and will develop it further in subsequent chapters.

3. THE SOCIAL CONSTRUCTION OF TECHNOLOGY

How are science, technology, and society related? Three views have been proposed (see Fig. 1).

Fig. 1. Views of the Interactions of Science, Technology, and Society.

1. Linear Development. In linear development it is assumed that science leads to technology, which in turn has an essentially one-way impact on society. The deployment of technology is primarily a function of the marketplace. This view is common among the optimists. They consider technology to be predominantly beneficial, and therefore little government regulation or public policy choice is needed; consumers can influence technological development by expressing their preferences through the marketplace.

2. Technological Determinism. Several degrees and types of determinism can be distinguished. Strict determinism asserts that only one outcome is possible. A more qualified claim is that there are very strong tendencies present in technological systems, but these could be at least partly counteracted if enough people were committed to resisting them. Again, technology may be considered an autonomous interlocking system, which develops by its own inherent logic, extended to the control of social institutions. Or the more limited claim is made that the development and deployment of technology in capitalist societies follows only one path, but the outcomes might be different in other economic systems. In all these versions, science is itself driven primarily by technological needs. Technology is either the "independent variable" on which other variables are dependent, or it is the overwhelmingly predominant force in historical change.

Technolological determinists will be pessimists if they hold that the consequences of technology are on balance socially and environmentally harmful Moreover, any from of determinism implies a limitation of human freedom and technological choice. However, some determinists retain great optimism about the consequences of technology. On the other hand, pessimists do not necessarily accept determinism, even in its weaker form. They may acknowledge the presence of technological choices but expect such choices to be missed because they are pessimistic about human nature and institutionalized greed. They may be pessimistic about our ability to respond to a world of global inequities and scarce resources. Nevertheless, determinism and pessimism are often found together among the critics of technology.

3. Contextual Interaction. Here there are six arrows instead of two, representing the complex interactions between science, technology, and society. Social and political forces affect the design as well as the uses of particular to technologies. Technologies are not neutral because social goals and institutional interests are built into the technical designs that are chosen. Because there are choices, public policy decisions about technology play a larger role here than in either of the other views. Contextualism is most common among our third group, those who see technology as an ambiguous instrument of social power.

Contextualists also point to *the diversity of science-technology interactions*. Sometimes a technology was indeed based on recent scientific discoveries. Biotechnology, for example, depends directly on recent research in molecular biology. In other cases, such as the steam engine or the electric power system, innovations occurred with very little input from new scientific discoveries. A machine or process may have been the result of creative practical innovation or the modification of an existing technology. As Frederick Ferré puts it, science and technology in the modern world are both products of the combination of theoretical and practical intelligence, and "neither gave birth to the other."[44] Technology has its own distinctive problems and builds up its own knowledge base and professional community, though it often uses science as a resource to draw on. The reverse contribution of technology to science is also often evident. The work of astronomers, for instance, has been dependent on a succession of new technologies, from optical telescopes to microwave antennae and rockets. George Wise writes, "Historical studies have shown that the relations between science and technology need not be those of domination and subordination. Each has maintained its distinctive knowledge base and methods while contributing to the other and to its patrons as well."[45]

In the previous volume, I discussed the *"social construction of science"* thesis, in which it is argued that not only the direction of scientific development but also the concepts and theories of science are determined by cultural assumption and interests. I concluded that the "strong program" among sociologists and philosophers of science carries this historical and cultural relativism too far, and I defended a reformulated understanding of objectivity, which gives a major role to empirical data while acknowledging the influence of society on interpretive paradigms.

The case for *"the social construction of technology"* seems to me much stronger. Values are built into particular technological designs. There is no one "best way" to design a technology. Different individuals and groups may define a problem differently and may have diverse criteria of success. Bijker and Pinch show that in the late nineteenth century inventors constructed many different types of bicycles. Controversies developed about the relative size of front and rear wheels, seat location, air tires, brakes, and so forth. Diverse users were en-visioned (workers, vacationers, racers, men and women) and diverse criteria (safety, comfort, speed, and so forth). In addition, the bicycle carried cultural meanings, affecting a person's self-image and social status. There was nothing logically or technically necessary about the model that finally won out and now found around the world.[46]

The historian John Staudenmaier writes that

> contextualism is rooted in the proposition that technical designs cannot be meaning fully interpreted in abstraction from their human context. The human fabric is not an envelope around a culturally neutral artifact. The values and world views, the intelligence and stupidity, the biases and vested interests of those who design, accept and maintain a technology are embedded in the technology itself.[47]

Both the linear and the determinist view imply that technology determines *work organization*. It is said that the technologies of the Industrial Revolution imposed their own requirements and made repetitive tasks inevitable. The contextualists reply that the design of a technology is itself affected by social relations. The replacement of workers by machines was intended not only to reduce labor costs but also to assert greater control by management over labor. For instance, the spinning mule helped to break the power of labor unions among skilled textile workers in nineteenth-century England. So me examples in the choice of designs for agricultural harvesters, nuclear reactors, and computer-controlled manufacturing are discussed in later chapters.

Other contextualists have pointed to the role of technology in *the subordination of women*. Engineering was once considered heavy and dirty work unsuitable for women, but long after it became a clean and intellectual profession, there are still few women in it. Technology has been an almost exclusively male preserve, reflected in toys for boys, the expectations of parents and teachers, and the vocational choices and job opportunities open to men and women. Most technologies are designed by men and add to the power of men.

Strong *gender divisions* are present among employees of technology-related companies. When telephones were introduced, women were the switchboard operators and record keepers, while men designed and repaired the equipment and managed the whole system. Typesetting in large printing frames once required physical strength and mechanical skills and was a male occupation. But men continued to exclude women from compositors' unions when some type, and more recently computer formatting, required only typing and formatting skills.[48] Today most computer designers and programmers are men, while in offices most of the data are entered at computer keyboards by women. With many middle-level jobs eliminated, these lower-level jobs often become dead ends for women.[49] A study of three computerized industries in Britain found that women were the low-paid operators, while only men understood and controlled the equipment, and men almost never worked under the supervision of women.[50]

Note that contextualism allows for a *two-way interaction* between technology and society. When technology is treated as merely one form of cultural expression among others, its distinctive characteristics may be ignored. In some renditions, the ways in which technology shapes culture are forgotten while the cultural forces on technology are scrutinized. The impact of technology sin society is particularly important in the transfer of a technology to a new cultural setting in a developing country. Some Third World authors have been beenly aware of technology as an instrument of power, and they portray a two-way interaction between technology and society across national boundaries.

IV. CONCLUSIONS

Let me try to summarize these three views of technology in relation to the conflicting values (identified in italics) that are discussed in the next two chapters, There are many variations within each of the three broad positions outlined above, but each represents a distinctive emphasis among these values.

The optimists stress the contribution of technology to *economic development*. They hold that greater productivity improves standards of living and makes *food and health* more widely available. For most of them, the most important form of *participatory freedom* is the economic freedom of the marketplace, though in general they are also committed to political democracy. These authors say that social justice and environmental protection should not be ignored, but they must not be allowed to jeopardize economic goals. The optimists usually evaluate technology in a utilitarian framework, seeking to maximize the balance of costs over benefits.

The pessimists typically make *personal fulfillment* their highest priority, and they interpret fulfillment in terms of human relationships and community life rather than material possessions. They are concerned about individual rights and the dignity of persons. They hold that *meaningful work* is as important as economic productivity in policies for technology. The pessimists are dedicated to *resource sustainability* and criticize the high levels of consumption in industrial societies today. They often advocate *respect for all creatures* and question the current technological goal of mastery of nature.

The contextualists are more likely to give prominence to *social justice* because they interpret technology as both a product and an instrument of social power. For them the most important fount of *participatory freedom* are opportunities for participation in political processes and in work-related decisions. They are less concerned about economic growth than about how that growth is distributed and who receives the costs and the benefits. Contextualists often seek *environmental protection* because they are aware of the natural as well as the social contexts in which technologies operate.

I am most sympathetic with the contextualists, though I am indebted to many of the insights of the pessimists. Four issues seem to me particularly important in analyzing the differences among the positions outlined above.

1. Defense of the Personal. The pessimists have defended human values in a materialistic and impersonal society. The place to begin, they say, is one's own life. Each of us can adopt individual life-styles more consistent with human and environmental values. Moreover, strong protest and vivid examples are needed to challenge the historical dominance of technological optimism and the disproportionate resource consumption of affluent societies. I admire these critics for defending individuality and choice in the face of standardization and bureaucracy. I join them in upholding the significance of personal relationships and a vision of personal fulfillment that goes beyond material affluence. I affirm the importance of the spiritual life, but I do not believe that it requires a rejection of technology. The answer to the destructive features of technology is not less technology, but technology of the right kind.

2. The Role of Politics. Differing models of social change are implied in the three positions. The first group usually assumes a free market model. Technology is predominantly beneficial, and the reduction of any undesirable side effects is itself a technical problem for the experts. Government intervention is needed only to regulate the most harmful impacts. Writers mentioned in the second section, by contrast, typically adopt some variant of technological determinism. Technology is dehumanizing and uncontrollable. They see run-away technology as an autonomous and all-embracing system that molds all of life, including the political sphere, to its requirements. The individual is helpless within the system. The views expressed in the third section presuppose a "social conflict" model. Technology influences human life but is itself part of a cultural system; it is an instrument of social power serving the purposes of those who control it. It does systematically impose distinctive forms on all areas of life, but these can be modified through political processes. Whereas the first two groups give little emphasis to politics, the third, with which I agree, holds that conflicts concerning technology must be resolved primarily in the political arena.

3. The Redirection of Technology. I believe that we should neither accept uncritically the past directions of technological development nor reject technology *in toto* but redirect it toward the realization of human and environmental values. In the past, technological decisions have usually been governed by narrowly economic criteria, to the neglect of environmental and human costs. In a later chapter we will look at technology assessment, a procedure designed to use a broad range of criteria to evaluate the diverse consequences of an emerging technology—*before* it has been deployed and has developed the rested interests and institutional momentum that make it seem uncontrollable. I will argue that new policy priorities concerning agriculture, energy, resource allocation, and the redirection of technology toward basic human seeds can be achieved within democratic political institutions. The key question will be: What decision-making processes and what technological policies can contribute to human and environmental values?

4. The Scale of Technology. Appropriate technology can be thought of as an attempt to achieve some of the material benefits of technology outlined in the first section without the destructive human costs discussed in the second section most of which result from large-scale centralized technologies. Intermediate-scale technology allows decentralization and greater local participation in decisions The decentralization of production also allows greater use of local materials and often a reduction of impact on the environment. Appropriate technology does not imply a return to primitive and prescientific methods; Father seeks to use the best science available toward goals different from those that have governed industrial production in the past.

Industrial technology was developed when capital and resources were abundant, and we continue to assume these conditions. Automation, for example, is capital-intensive and labor saving. Yet in *developing nations* capital is scarce and labor is abundant. The technologies needed there must be relatively inexpensive and labor-intensive. They must be of intermediate scale so that jobs can be created in rural areas and small towns, to slow down mass migration to the cities. They must fulfill basic human needs, especially for food, housing and health. Alternative patterns of modernization are less environmentally and socially destructive than the path that we have followed. It is increasingly evident that many of these goals are desirable also in industrial nations, I will suggest that we should develop a mixture of large and intermediate-scale technologies, which will require deliberate encouragement of the latter.

The redirection of technology will be no easy task. Contemporary technology is so tightly tied to industry, government, and the structures of economic power that changes in direction will be difficult to achieve. As the critics of technology recognize, the person who tries to work for change within the existing order may be absorbed by the establishment. But the welfare of humankind requires a creative technology that is economically productive, ecologically sound, socially just, and personally fulfilling.

Notes

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2. John Zerman and Alice Carnes. eds., *Questioning Technology* (Santa Cruz, CA: New Society Publishers, 1991), p. 217.

3. C. S. Lewis, *The Abolition of Man* (New York; Macmillan, 1965), p. 69.

4. Among the volumes dealing with broad attitudes toward technology are Albert H. Teich, ed., *Technology and the Future,* 5th ed. (New York: St. Martin's Press, 1989), and Carl Mitcham and Robert Mackey, eds., *Philosophy and Technology* (New York: Free Press, 1972).

5. This is close to the definition given by Arnold Pacey in *The Culture of Technology* (Cambridge: MIT Press, 1983), p. 6. Pace adds “living things” among the “ordered systems” (in order to include agriculture, medicine, and biotechnology), but I suggest that these are already included under the rubric of “practical tasks.” Frederick Ferré. *Philosophy of Technology* (Englewood Cliffs, NJ: Prentice-Hall, 1988), defines technology as “the practical implementation of intelligence” and argues that intelligence itself has both practical and theoretical forms.

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12. Florman, *Blaming Technology,* p. 183.

13. Cf. Alvin Weinberg, “Can Technology Replace Social Engineering,” in *Technology and the Future,* ed. Teich.

14. Samuel Florman, “Science for Public Consumption; More Than We Can Chew?” *Technology Review* 86 (April 1983): 12–13.

15. Florman, *Blaming Technology,* p. 193.

16. Harvey Cox, *The Secular City* (New York: Macmillan. 1965), and “The Responsibility of the Christian in a World of Technology,” in *Science and Religion,* ed. Ian G. Barbour (New York: Harper & Row, 1968).

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19. George Wise, “Science and Technology.” *Osiris,* 2d ser., 1 (1985): 229–46.

20. See for example Lewis Mumford, *The Myth of the Machine,* vol. 1, *Technics and Human Development,* and vol. 2. *The Pentagon of Power* (New York: Harcourt Brace Jovanovich, 1967 and 1969).

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