HUMANIZATION OF TECHNOLOGY: SLOGAN OR ETHICAL IMPERATIVE?

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How are we to humanize technology? Technology obviously can affect human beings negatively, so few would deny that there might be some need to "humanize" it. But there is little agreement about what such an endeavor might entail beyond paying some attention to "human values" along with the mainstream concerns of technology. To be determined, then, is how much attention, and to which values. How do we decide, like the Little Prince, which ones are most deserving of our attention? The easy answer, long heard on Madison Avenue, is simply to equate value with interest—and then, if necessary, create the interest. But a value founded only on interest is as flighty as a day at the stock exchange. So, in a world of finite resources, it is crucial that we think beyond interests to needs. But in a society such as ours where commerce is king, a determination of needs is not a very high priority; and, as a result, there is in the

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land a shortage of experts on how to decide what a human being really needs in order to be fully human.[1] Yet this we must learn if we are ever going to be serious about humanizing technology. For, a world full of people in need will no longer endure the privilege of interest artificially created and sustained. Thus, the basic question to which humanization of technology points is this: What, if anything, do human beings really need that technology might somehow deprive them of?

The answer to this question on the part of most proponents of technology, and even of some proponents of its humanization, tends to be: Nothing that more technology can't eventually restore a hundredfold! So it is not surprising that, to date, the humanization of technology movement has done more for certain corporate images (skillfully advertised) than it has for people. Yet in the very process of co-opting the concept of humanizing technology, the corporate interests in question have inadvertently called attention to at least one affirmative answer to our basic question: Technology can and does deprive human beings of personal and professional responsibility, and it is poorly equipped to restore it.

It is, of course, by no means obvious that any such charge is justified or, if justified, is rightly laid at the door of technology. For, to begin with, not everyone's ox is ordinarily gored at the same time or in the same manner. So as a result, what Garrett Hardin has called "the tragedy of the commons" may strike not collectively but only selectively.[2] And accordingly, so long as there are prophets available to say that this may reasonably be hoped, the old Malthusian zero-sum game will undoubtedly continue to be played by players who seek to prove their fitness by surviving. In other words, so long as man's ego feeds on symbols of superiority over other men, it seems unlikely that "To the victor belong the spoils" will be replaced in human consciousness by stern warnings to the effect that pride may precede a fall. For, even the gentleman who had just completed half the distance of his fall from a tall building was reportedly then of the opinion that everything was just fine—so far!

What follows from these seeming jeremiads is not doomsday minus a lifetime or two, but rather a suggestion that technology, like fate, does not treat everyone alike. And accordingly, no individual group, however perspicacious in its own eyes, is in a position to declare that technology has been humanized, even, I dare say, in its own regard.[3] So, as a start, one might honestly recognize that some people's lives are negatively affected by machines, and that for just that reason they may not appreciate the subtleties of scholarly rationalizations to the contrary.[4] But in order to come around to any such uncommon insight, one must further learn that there is more to "assessing" technology than merely testing a machine or attempting to estimate how long it will take people to accept what the machine will produce. The "more" that is here at issue, furthermore, is

not encompassed by any merely quantitative systems approach, however subtle and sophisticated that may be. Nothing less than responsible concern for all reasonably possible consequences will suffice, whether such is presently deemed feasible or not.[5] In either case, this is an ideal toward which assessment, or evaluation, of technology must consciously, and conscientiously, move.[6] This being done, a systematic appreciation of human needs, including a need for responsibility, would be incorporated into one's analysis and, indeed, would be made in some fashion controlling. To show that this is eminently reasonable requires an adequate account both of (1) the teleology of man-machine relations and of (2) the ethical considerations implicit therein. With regard to the first, it must be recognized that man-machine teleology is not confined to the level of machine design and operation but necessarily includes that of organizational policy and planning. With regard to the second, it must be shown that ethical considerations are engendered on both levels, especially the latter. What follows is, essentially, an attempt to support these claims.

I. BEYOND "HUMAN FACTORS"

That man-machine teleology includes the level of organizational policy and planning would seem obvious from the viewpoint of management science and of the economics of technology.[7] But to the engineer concerned with system design, human goals and purposes tend to be relevant only insofar as human factors have an effect, especially a negative one, on a system's efficiency. Thus, the propaedeutic task of opening the way to an ethics of technology involves showing that considerations of design are subservient to and dependent upon those of management goals. Much of this work has in effect already been undertaken by such scholars as Lewis Mumford, Jacques Ellul, Victor Ferkiss, Nobert Wiener, and many others.[8] Here it will suffice to restate the basic thrust of their conclusions schematically by way of a kind of phenomenological comparison between the concepts of *cyborg* and *prosthesis*.

As will be seen, these concepts are models of the man-machine relationship in the sense that each is "an ordered set of assumptions about a complex system."[9] But included in the assumptions of each model are conflicting interpretations as to whether the requirements of machine or those of man are controlling. Given this conflict of interpretation, it will be argued that neither model can be adequately tested without reference to management goals.

Consider, as a point of departure, what an assembly-line worker is reported to have said about his job on the line:

> I don't like to work on the line. . . . You can't beat the machine. Sure, maybe I can keep it up for an hour, but it's rugged doing it eight hours a day, every day in the week, all year long. It's easy for the time-study fellow to come down there with a stop watch and figure out just how much you can do in a minute and fifty-two seconds. . . . But they can't clock how a man feels. . . . I like a job where you feel like you're accomplishing something and doing it right. When everything's laid out for you and the parts are all alike, there's not much you feel you accomplish. The big thing is that steady push of the conveyor—a gigantic machine which I can't control.[10]

The "time-study fellow" here referred to has since learned to talk about employee responsibility in the form of "job enrichment" and the like. But for the most part he, or what is now in fact a variety of specialists on man-machine relations, attempts with his particular set of tools to evaluate how effectively any given man-machine system is doing or would do whatever job is assigned to it. This evaluation might take the classic form of comparing present, ongoing man-machine performance against some desired standard, productivity or whatever, as is done by means of the various time-study techniques which may all be subsumed under the title of Taylorism.[11] Other, more recently developed approaches study animals for clues to making better machines (bionics), study machines for clues to making better men (cybernetics), or study men's use of machines in order better to coordinate the work of man and machine together (ergonomics).[12] Each of these and other related approaches takes it for granted that machines will play an increasingly important role in human endeavors, and so strive to render the relationship between man and machine as palatable and especially as productive as possible. They also have in common, by way of corollary, a kind of professional indifference to such broad normative questions as whether, to what extent, and under what circumstances it is desirable for human beings to be conjoined with machines. Thus, to the extent that man-machine specialists even bother to speculate beyond their carefully circumscribed programs of research, they tend simply to assume that in the future men and machines will and should be getting together even more than they already are today.[13]

This widely held version of the doctrine that more is better thrives best in minds that see no need to seek alternatives and hence would not appreciate the Socratic dictum that the unexamined life is not worth living. But there are alternatives—indeed, to use Robert Theobald's expression, alternative futures—which are in fact latent in the alternative ways in which futurists tend to speak about an evolving merger between man and machine. This postulated merger, or symbiosis, can look very different depending on whether the human being is thought of as a component of a machine system or the machine as a component of a human system. Any such model that gives the machine priority I call a cyborg, and one that gives the human being priority I call a prosthesis.

Each of these concepts has a fairly well-established meaning within one and the same circumscribed field of discourse, namely, that of bioengineering. But the concept of cyborg encapsulates the perspective of the engineer; that of prosthesis, the perspective of medical specialists. Each may be a synonym of the other with regard to the *explicandum,* but not with regard to the explication. And in this difference there is, so to speak, all the difference in the world.

The notion of a cyborg, in the first instance, refers to a system of human and machine components combined and coordinated in such a way as to utilize the capabilities of each toward the accomplishment of what neither can do alone. The word "cyborg" itself was coined by combining the two words, "cybernetic" and "organism," and abbreviating them to the two syllables, cyb and org.[14] The word "cybernetic" comes from a Greek word meaning to control or govern; and, as used today, it refers to a science that combines engineering and neurology to study ways of automatically controlling or regulating process both in machines and in human beings. A cyborg, then, is a kind of inevitable side effect of the cybernetic endeavor in that it involves a system consisting of both human and machine components, all of which are coordinated and controlled toward the accomplishment of a pre-set task. In this sense, a semi-automated assembly line might be thought of as a cyborg. A more obvious example would be that of an astronaut ensconced in his space suit and meticulously plugged into the artificial environment of his space capsule, all of which is elaborately regulated and controlled on earth by an even more complex system of interrelated men and machines.[15] In the broadest sense, then, any system of machinery the design and proper functioning of which calls for some continuing human input (what engineers call "man-in-the-loop") may be thought of as a cyborg.

The concept of a prosthesis, in the first instance, refers now as it has for centuries to a device or instrument whereby some function of the human organism that has been impaired is at least partially restored. In this sense, a cane; a pair of eyeglasses; a brace, support or corset; a hearing aid are all examples of prostheses or, as they are also called, prosthetic devices. Also appropriately included under the heading of prostheses are such sophisticated artificial devices as joints, arteries, pacemakers, hands, feet, arms, legs and so on.[16] By way of extension, one may also speak of any medical apparatus whatever as being a prosthesis in relation to man, however momentarily it is actually in contact with, or a component of, the human biological system. In this sense, the heart-lung machine, the renal dialysis machine, the encephalograph, the cardiograph, and countless others may all be thought of as prosthetic devices, inasmuch as they all have as their common function to contribute in some way to the well-being of the human organism. Still more broadly, one may

think of an entire hospital complex, with all of its staff and facilities, or, for that matter, of the entire health care delivery system of a given nation or even of the world as a whole, as being prosthetic. In the widest sense of all, one may say that any machine or set of machines, whether medically related or not, is prosthetic if and to the extent that it supplies for some inadequacy of one or more human organisms.

As may be noted from this brief explication of terms, "cyborg" and "prosthesis" represent markedly different models of the man-machine relationship. "Cyborg" stresses man's inferiority to the machine; "prosthesis," the subservience of the machine to man. "Cyborg" orients a relatively undifferentiated human being or group of human beings to the otherwise unattainable requirements of a machine system; "prosthesis" directs the capabilities of certain machines to the limitations or handicap of an otherwise independently valuable human being. Thus, at least to the extent that language is revelatory of reality, the cyborg model tends to give priority to the needs of a machine; the prosthesis model, to the needs of a human being. And thus, the former may be said to "dehumanize" human beings, the latter to "humanize" machines.

In summary, then, in the case of a prosthetic relationship the machine compensates for a deficiency in the human organism, whereas in the case of a cyborg relationship the human organism compensates for a deficiency in the machine. As a sign of the former, if the organism could function well on its own, there would be no need for the prosthesis. As a sign of the latter, if the machine could function well on its own, there would be no need for the human component.

Implicit in these remarks is a suggestion that we are dealing with two incompatible ways of thinking of the goal-directedness of a man-machine system. But such is not necessarily the case. When viewed as a prosthesis, the end or goal of a man-machine system is presumed to be given (call it human well-being) and the means are determined accordingly. When viewed as a cyborg, means are also selected with a view to an end; but the end itself is comparatively arbitrary, and, though determinate once selected, remains at least in principle subject to change. Thus, as a direct consequence of the higher degree of freedom attributed to a cyborg, it is possible to view the cyborg as itself having a prosthetic goal.[17] It may therefore be contended that, though the prosthesis is by definition directed toward human well-being, the cyborg may be so directed by choice.

It is, then, precisely at this point that mere phenomenology must give way to the reality principle. For, as more than one advertising agency has discovered for its corporate client, there is no point in suggesting that one's favorite technology is arguably dehumanizing when it is possible to portray it instead as being a notably humanizing factor in society. This

may be, and indeed has been, done in various ways, such as by focusing attention either on some great benefit allegedly to be derived from a suspect technology, or on the absence of notable harm therefrom, or, still more irrelevantly, on some wholesome, altruistic human beings who just happen to be associated with that technology. What is left unattended by such diversionary public relations is, of course, the whole range of basic questions that might arise out of a thorough cost-benefit analysis, especially where such analysis is carefully honed to determine whether those who bear most of the costs are even approximately the same as those who reap most of the benefits.[18] But any such course of investigation might well lead, on occasion, to the embarrassing discovery that the Emperor's new clothes are only original equipment that comes with the model. And, what could be even more embarrassing, the Emperor in question might even be one who has written over the entrance to his palace: "Let no one ignorant of prosthetics enter here."

The point here, as Aristotle saw after only thirty years under Plato, is that there are more things in the world than definitions dream of. In particular, not even an enterprise such as the health care industry is necessarily directed to human well-being merely because it describes itself as being dedicated to what I have associated with prosthesis. For, as numerous analysts of health care delivery in the United States have concluded, in effect, there might be far more similarities between a hospital patient and our unhappy assembly-line worker than any neat distinction between teleological models would allow.[19] Nor will the discrepancies in question be eliminated by simply improving the systematization of the system.[20] For, what is essentially being contested in the ongoing debate over health care in America is whether patients or professionals are intended to be the principal beneficiaries of the system.[21]

In other words, the weakness of some human beings may be exploited to increase the power of others. And in the process of selecting means to that end, be it called human well-being or whatever, those to be exploited will be evaluated as would any other proposed tool on the basis of efficiency, accessibility, durability, cost, and other related factors.[22] Thus, for example, one who wanted to build a pyramid in a labor-intensive economy may well have estimated a need for w soldiers, x whips, y slaves, and z blocks of stone. This comparatively primitive approach to industrial planning, involving what Lewis Mumford calls a megamachine, has given way of late to considerably more mechanized approaches.[23] And in the new and essentially different context of automation, the powerless human being is finding more and more frequently that he does not even qualify, in Kantian terms, to be used as a means to an end, to say nothing of being the end toward which the means chosen are directed.

As the foregoing is intended to illustrate, then, one and the same man-

machine system may be evaluated very differently depending upon how the teleology thereof is construed. On a broader scale, the same can be said about any technology, since a technology, at least when viewed as a system, inescapably involves man-machine relations. What tips the normative scale in either direction is the dimensions of one's teleology. It may be assumed that any operator of a machine can ordinarily do more with than without the machine, whether the latter be viewed as correcting a deficiency or augmenting a capability. What really matters, however, is not the internal ends designed into the man-machine system but the externally intended ends toward the attainment of which such a system is meant to contribute.[24] It is these external ends, in turn, which are usually appealed to to determine the value of the component system.

The importance of external ends in evaluating technology is perhaps most clearly exemplified by the quasi-sectarian rhetoric of military budgeting, whose proponents have given more weight to such concepts as "balanced forces," "counterforce" and "deterrence" than to the hard realities of performance capability.[25] But analogous and, to some extent, overlapping considerations are common to the marketplace, where competitive strategy not infrequently tends to determine product selection and design.[26] From the viewpoint of the potential consumer, in turn, a given technology is seldom evaluated (except in the case of "impulse buying") just on the basis of technical performance. Rather, a given technology is evaluated in terms of its overall impact upon the techno-social system into which it would have to be inserted. Such evaluation could be, and in some instances has been, disastrously short-sighted, especially with regard to a technology which is unquestionably effective in and of itself though not necessarily in relation to any particular use to which it might be put. But to the extent that no consideration peripheral to a system's maintenance (e.g., novelty, prestige, pressure from competitors) is allowed to be controlling, people generally get the kind of technology they want, especially if the people in question happen to be in positions of power.

To this extent, at least, people do tend to evaluate a technology not just in terms of what it can do, but in terms of what it can, or is likely to, do *for them;* thus, they favor the technology that complements or, better, augments their interests; they do not favor the technology that threatens their interests. This being the case, they can usually be counted on to manifest various sorts of discretion and selectivity. At the extremes, they may either reject out of hand or openly welcome a new technology for no better reason than that it is new. But choice of technology is not usually so simple and straightforward, except in perhaps metaphysical and hortatory statements for or against technology in general. What is far more often the case is that a proposed technology is viewed somewhat ambivalently, by virtue of such considerations as the following: on balance, its advantages

do not clearly outweigh its disadvantages; projected costs threaten to exceed benefits; alternative technologies are available and none can be shown to be clearly preferable to any other; undesirable consequences of utilization can be anticipated and are seemingly inevitable. This ambivalence toward technology may be said to constitute a fundamental characteristic of our times, especially where undesirable consequences are discerned. Indeed, this ambivalence may even be identified as the one central moral question of our technological age: to approve or not to approve, to have or not to have, to use or not to use an available or attainable technology.

What a question such as this asks us to determine is, essentially, how to decide when, where, and under what conditions a technological development may be considered an asset rather than a liability.[27] Many subsidiary questions are, of course, involved in this one basic, though complex, question. But the most important of these, I think, is this: Is the present or proposed technological development aimed primarily at satisfying (1) special (e.g., vested economic or political) interests, or (2) clearly demonstrable human needs? It has, of course, been customary for centuries in marketing circles to foster "needs" that correspond with products that one is prepared to manufacture and distribute. But this mercantile approach to a definition of need proves not to be persuasive when technology on which many people have become dependent shows unmistakable signs of being obsolescent. This broad-ranging problematique involves many different kinds of technology, if not all sooner or later, but the general nature of the problem seems especially well illustrated in our times by the example of the American petroleum industry's response to the "energy crisis."[28]

As described by industry advertising in the United States, the essence of the crisis is really very simple: America needs more petroleum, whatever the cost; so the industry is responding by an all-out effort to produce it. What this means in terms of technology, of course, is increased emphasis on equipment to get more oil out of older fields, to find and exploit new fields which were heretofore comparatively inaccessible in terms of technology, cost or politics, and to expedite importation of foreign oil.[29] As a result of this assessment of the problem, we find the once stalled Alaskan pipeline now well underway, many heretofore taboo government-owned lands now available for exploration and exploitation, and a marked increase in support for both offshore exploration and construction of coastal superports for tankers. Complementing these developments in the political arena is a campaign to offset increased costs by way of deregulation of natural gas, increase in the price of gasoline to the consumer, modification of emission standards, and sufficiently competitive improvements in automobile fuel economy (why only now, and so

easy to do?) to challenge fuel-economizing foreign cars and to forestall introduction of alternatives to the gasoline-consuming motor vehicle. Moreover, this campaign almost succeeded in persuading Congress to approve increased federal taxes on gasoline to fund research and development of alternative energy technology. This latter would undoubtedly continue to be concentrated in the areas of coal and nuclear power, since these have come to be increasingly under the control of the same oil industry that has in the past controlled most aspects of our energy policy, including that of research and development.[30]

These reactions to OPEC's success at establishing a pricing cartel are, of course, well understood by the OPEC leaders themselves. Indeed, it is even more likely that their currently posted price for a barrel of oil is determined by the known current cost of producing a barrel alternatively from shale. It may therefore be assumed that, when the cost of such an alternative approximates that of OPEC petroleum, the latter's price will be adjusted accordingly. In the meantime, analysts are attempting to assess the staying power of the OPEC cartel in light of such divergent interests as those of an OPEC country like Venezuela, whose oil reserves are near exhaustion, and one like Saudi Arabia, which still has abundant reserves.[31]

In the meantime, what remains peripheral to these high-level calculated risks, of course, is any marked interest, at least for the time being, in a serious effort at developing energy technologies that are in no way dependent upon, or even under the control of, the petroleum industry.[32] Individual and even many corporate interests would seem at first glance to have everything to gain from such research and development, which have already been effectively stalled for at least several decades too long. But, thanks in large measure to the efforts of the petroleum industry itself, dependency on petroleum and petroleum-fueled technology has come to pervade almost the entire network of America's economic life and lifestyle, from the wrapper for my lunch to the suburb from which I carry it to work in my gasoline-powered automobile on a concrete-and-steel expressway.

Lest this point still not be obvious, consider how extensive has been this American dependence on petroleum. Natural gas has become the principal source of space, especially residential heating. Derivatives of oil (petrochemicals) are used in the manufacture of numerous synthetic materials, such as nylon, which, for all its advantages, requires high-energy consumption for its production and is a nonbiodegradable substitute for such biodegradable natural products as cotton, silk and wool.[33] DDT and other chemically related biocides, which are by-products of American petroleum research, have created as many problems as they ever solved. It is well known how Rachel Carson's *The Silent Spring*, and

then in time both state and federal government agencies, came to recognize the harmful consequences of using these products in our own country.[34] Now similar concerns are being articulated, with increasing insistence, in the Third World as well, especially among younger scientists in the developing nations, who recognize, as their leaders have not, that education and socio-economic improvement are far more reliable approaches to the elimination of malaria, as has been proven in practice in Israel, Malaysia, Taiwan and California.[35] Then, too, America's enormous military consumption of petroleum, not only as fuel but in the form of napalm, herbicides and other destructive agents, supports the claim that our government has even come to think of petroleum as an instrument of international problem-solving.[36]

Most oil consumed by Americans, however, is still in the form of gasoline; and nine-tenths of all gasoline consumed in the United States is consumed as fuel in motor vehicles, where it produces not only horsepower but also noxious emissions which still defy even dedicated efforts at neutralization. In addition to the increasingly serious health problems which follow from concentrating both people and oversized automobiles in urban areas whose modernity is tainted by the absence of adequate mass transportation, the petroleum complex is responsible for excessive misallocation of resources. Motor vehicles (over a hundred million of them already in 1968) require one-fifth of all the steel and two-thirds of all the rubber consumed in the United States, along with large amounts of such other materials as glass, chrome, mercury, copper and sulfur.[37]

Thus has the American petroleum industry locked us into excessive dependence on the production, refinement, distribution, and consumption of a substance which is both nonrenewable and increasingly limited in supply. Versatile investors, no doubt, will "get out" of petroleum in time for the next energy era. But in the meantime this disproportionate concentration shall have been the direct or indirect cause of countless deleterious effects, especially in the automotive industry and its many satellites. The United States, accordingly, cannot continue to develop solely or even primarily on the basis of a petroleum-fueled technology. So it will either change over to a different energy technology or it will begin to break down. In either case, those whose livelihoods are directly or indirectly dependent upon the petroleum industry—and that includes most Americans, to some degree—may well experience professional and personal breakdowns of their own.

In a word, human beings will be affected negatively by virtue of their particular relationship to a complex technology. Yet there is nothing in all of this that human factors analysis, or anything like it, would even be prepared to consider, to say nothing of doing anything about. Thus are we driven by the very seriousness of the present crisis—which, of course,

extends far beyond the borders of the United States—to begin to recognize philosophically as well as institutionally that the teleology of man-machine relations is preeminently a question of managerial responsibility.

II. TOWARD HUMAN RESPONSIBILITY

The foregoing considerations notwithstanding, it hardly needs mentioning that, except for the symbolic ritual of electoral politics, the concept of managerial responsibility has traditionally been given a very narrow, if not altogether meaningless, interpretation. For, in spite of numerous laws, in this country and abroad, that are aimed at regulating business and industry, a corporate executive who is not prone to fraud or embezzlement is rarely held personally responsible for anything except satisfactory aggrandizement of corporate profits.[38] Such, at least, would seem to be a legitimate interpretation of John Kenneth Galbraith's account of the corporate "technostructure,"[39] which tends to prevail over such alternative accounts as Ferdinand Lundberg's finger-pointing at "the rich and the super-rich."[40] Nor would one yet be likely to find very wide support for the proposal now being explored to introduce ethical considerations into investment decisions.[41] Maintaining the kind of respect for white collars that was manifest throughout the post-trial Watergate sentencing, our decision-makers prefer to find scapegoats on the man-machine level of the laborer. In short, our ethics of technology tends to be confined to the operational, or first-order, teleology of short-run goals, and seldom encompasses the managerial, or second-order, teleology of long-run goals.[42]

So accustomed have we become to this pre-system approach to allocating responsibility that we seldom even notice that it is inadequate and, arguably, unjust except when, as in the case of America's energy problem, we are abruptly confronted with a "glitch" that is so glaring as to force us to reconsider not simply a system-component but the system as a whole. This, in turn, suggests a need to distinguish between operational and managerial glitches. (The operational glitch usually points to no more than a flaw in first-order design which may be corrected by repair, improvement or replacement of some particular subsystem. But the managerial glitch points to a flaw in the second order design which may be corrected only by repairing, improving or replacing the entire system to the ends of which the subsystem contributes.) But such distinctions notwithstanding, people—like the semiconscious characters in a Chekhov play—tend if at all possible to limit their remodeling instincts to first-order considerations rather than acknowledge the need for a new second-order system.

In other words, what is especially noteworthy about America's energy problem is only the dimensions of its possible consequences, not its uniqueness. Such technological overdevelopment is a common and well-known characteristic of the evolutionary process, and has resulted in the extinction of innumerable species whose particular set of endogenous tools proved inadequate when the environment to which they were adapted changed.[43] Thus any species, once evolved, has a vested interest in the maintenance of the kind of environment in which it has been successful—a principle, in other words, of stability, conservatism, synchrony, system maintenance.

In historical times, and on the cultural level, the vested interests of some human beings have often led to a technological overdevelopment for the sake of system maintenance. And on occasion such overdevelopment may result in a glitch of some notoriety and seriousness, as was the case, for example, when an American pilot of a high-flying reconnaissance plane was shot down over the Soviet Union and placed on trial. So also in the case of the Cuban Missile Crisis, of various disasters associated with storage and shipment of poison gases, or with the premature distribution of an inadequately tested drug such as thalidomide, or with the malfunction of an inadequately tested system during a manned or unmanned space flight, and, most recently, all the electronic skullduggery referred to for short as "Watergate," not to mention the demise of American influence in southeast Asia in spite of considerable technological efforts to achieve the contrary.

What such notorious glitches tell us about technology is, first of all, that human beings learn how to use an available technology far more quickly than they learn how to decide whether, to what extent, and for how long that technology ought to be used at all. Said glitches would seem to suggest the insurmountable inadequacy of the purely "technological fix." But, if so, they have not notably discouraged men from entrusting the achievement of their ambitions to yet other technological devices. For example, during America's recent involvement in southeast Asia we came to see communications technology, among others, made the basis for what has all too appropriately been entitled an "electronic battlefield."[44] Indeed, it is in large measure due to confidence in a fully implemented electronic battlefield that the Nixon administration believed it could withdraw American ground forces from Vietnam without significantly diminishing the efficacy of our country's military "presence" there. But, as subsequent events have shown, the American approach to problem-solving in southeast Asia may well go down in history as a prime example of a glitch in the doctrine of technological fixing.[45]

To be learned from all of this, secondly, is that people tend to pass judgment on any given technological quest for power largely on the basis of their views about the goals thereby to be pursued. For proponents of

those goals, for example, the end does tend to justify the means, however noxious those means may be. Thus, if there is or is ever to be anything like an ethics of technology, its greatest challenge is to learn how to surmount the bias of those who may deign to speak for it.

It is perhaps in order to evade "humanizing" considerations such as the above that the all-systems-go technophile chooses to canonize the cliché that technology (like science) is in and of itself "value-neutral," and just happens to get used for ends that are deemed either good or evil. The obvious (and, for technocrats, convenient) corollary to this cliché is that, when an embarrassing if not catastrophic glitch happens to surface, one may call for stricter regulation of the consumers rather than the purveyors of technology. Such a view suggests either insufficient consideration or willful disregard of the social, political and economic realities that determine the context and orientation of technological endeavors. For, in a word, it is not generally the case that technology is just incidentally developed and then fortuitously used, after the fact, in support of power; far more commonly, power tends to mandate the development of whatever technology it deems can contribute to its own maintenance, if not aggrandizement, and to discourage whatever may not.[46]

To the extent that this statement of the relationship between technology and power is correct, it is perhaps unnecessary even to ask what motivates power to technologize. For, on this reading, power need not have any reason to technologize beyond itself, beyond its own maintenance and expansion. But people on occasion do tend to have alternative aspirations; so the power motive is generally reconciled with people's aspirations, insofar as possible, by way of ideology. It has been claimed in recent years, especially by one of the most ideological of technocrats, that ideologies are extinct, at least in developed countries.[47] But this claim of being free of ideology is but a special form of the general tendency on the part of people of whatever persuasion to think of their own ideas as being wholesome, benevolent, constructive, and of those of others as being somehow sinister, deleterious, destructive. From a more epistemological point of view, an in-group tends simply to think of its own views as representing truth, or *the* truth, and of others' as being, at best, ideologies or, if malevolence is suspected, even conspiracies. Such cultural bias (which, to be sure, might take the form of an inverse cultural bias) does not provide a very solid basis for distinguishing between "good" and "bad" technologization of power. A more adequate basis, it seems to me, is the philosophy of man which a given technologization presupposes.

There are, with respect to technologization, two basic kinds of philosophy of man: one defensive, the other supportive. By a defensive philosophy of man I mean one which thinks of man primarily as a hostile and destructive being that must be carefully watched and vigilantly

guarded against. By a supportive philosophy of man I mean one which tends rather to think of man primarily as the earth's most valuable resource—one which, if properly supported, cannot help but increase and multiply the amount of good in our midst. When made the basis for technologization, the former produces a technologization of despair, the latter, a technologization of hope.

A technologization of despair is one which is based on the cyborgean belief that human beings in and of themselves are capable of making only minimal if not counterproductive contributions to goals deemed worthy of attainment. Such technologization accordingly aims at maximum mechanization of all means to the ends pursued, including the control and, if necessary, the suppression of attempts at human intervention. A technologization of hope is one which is based on the belief that it is only or at least primarily in and through the contributions of human beings that any really worthwhile and lasting good can be accomplished. Such technologization accordingly aims at mechanizing only the processes which can supplement and complement human pursuit of humanly desirable goals, the most comprehensive of which is the prosthetic goal of human well-being as such.

Although no rigorous mapping seems possible in these matters, there is good reason for suggesting that one's approach to technologization depends very much upon such psycho-social factors as the following: (1) the degree of well-being desired for one's most preferred interest group; (2) the degree of commitment to that desire; (3) the extent to which that desire is being or is deemed capable of being fulfilled; and (4) the seriousness of threats (real or imagined) to such fulfillment.

The interest group in question may be a single individual, a family (nuclear or extended), a community (clan, tribe, village, ethnic or racial group, commune or whatever), a corporation, a society or nation-state, a particular geographic region or continent, or even mankind as a whole. Each of the four factors calls for a subjective estimate, which, however, may be based on whatever objective information is or is adjudged to be pertinent. Depending on which of the factors are given greatest emphasis, one's attitude toward technologization may be favorable either to a technologization of despair (e.g., an emphasis on the first and fourth factors) or to a technologization of hope (e.g., an emphasis on the first and third).

As the foregoing suggests, the primordial policy goal that should be implicit in all planning is to identify genuine human needs and try to figure out how they might be given priority among human interests. This being stated, what can we identify as a genuine human need?

It seems obvious that nutrition is a universal need among human beings, and as such a human need. But perhaps neither sexual pleasure nor even a

minimum of sleep is a universal need. What, then, of shelter? Artificial as distinguished from organic means of transportation? Membership in some sort of cultural group? Membership in a country club? As these questions are meant to suggest, as soon as one moves beyond the obviously physical or organic on to the psychosocial and cultural level, universality seems to give way rapidly to selectivity. It would, for example, be foolish to say that everyone needs to participate in a fertility rite; but it would be just as foolish to claim that everyone needs a raincoat and an umbrella.

In other words, it is perhaps where needs leave off, at the edge of the physical or organic, that culturally determined interests begin. But some interests may very properly be designated common interests, in the sense that they are in some fashion common to all human beings. Primordial among these common interests are undoubtedly what Abraham Maslow identified as constituting a hierarchy of "needs."[48] Developed to account for certain unexpected data in industrial psychology and now being applied rather broadly, Maslow's theory amounts to a claim that humans take an interest in their needs sequentially, beginning with that which is most basic, namely, survival, and rising to that of self-actualization. Whether all this applies universally, outside of the industrial setting, is a question that need not be resolved here. For, even allowing for the possibility of discrepancies both between and within groups, it does seem reasonable to say, with Maslow, that above and beyond the basic needs for survival and security, human beings need esteem and self-actualization, or what I prefer to identify, respectively, as professional and personal responsibility. So, even granting that there are surely culturally determined ways of ascertaining whether and to what extent one's needs or interests in this regard have been satisfied, they remain for all that transcultural.

With thoughts such as these in mind, I assume (1) that every need contributes to or brings forth an interest (necessity the mother of invention); and (2) that every interest manifests or contributes to a need (invention the mother of necessity). Telescoping these two assertions into one, it may be claimed that, phenomenologically speaking, an interest is a presumptive need. Beyond the phenomenological, however, there remains the gnawing problem of ascertaining whether and to what extent any alleged need is in accord with human nature. This problem, once deemed very simple, has now become almost insoluble, largely because of the way in which the theory of evolution has come to dominate considerations of human nature in general and of human use of technology in particular.[49]

For centuries man's understanding of and expectations for himself have been conditioned by one or another absolutist notion of human nature. Whether contrasted with superhuman, even divine, natures (as was rather customary early in the game) or with subhuman natures, as the present

generation seems to prefer, human nature is a theoretical construct which serves to separate and even isolate man from his environment. Even when thought of evaluatively, as in the expression "just human nature" or as in Hobbes's view of "man a wolf to his fellow man" or as in Nietzsche's "human, all too human," the assumption has been that there exists somehow a distinct and describable entity that is both causal and constrictive with regard to human behavior.

Curiously enough, human nature is seldom thought of as being adequate to the demands that are placed upon human beings. Rather must it (human nature) be saved or redeemed in some fashion, whether by drawing upon divine grace or the forces of the cosmos, by finding a charismatic leader, or by building a machine or two. In any event, human nature, precisely inasmuch as it is deemed to be definable, suggests, or indeed constitutes, bounds to what a human being is capable of without external support of some kind from somewhere. What these bounds may be is quite diversely articulated. But differences of detail aside, the very common effort to distinguish, i.e., single out, man from everything else simply points to the still more basic truth that human beings are inseparably connected to a greater and richer world within and beyond themselves.

Some people, of course, have been so taken with the chemistry of consciousness that they attempt to locate the greater and richer world in a realm beneath ordinary experience. Others, usually thought of as mystics, have pointed beyond the ordinary. But all these "heads," be they psychedelic or monastic, eventually get around to telling us that the world they see is the world we all see, only they see it better. Generally speaking, they claim to like our world better as they imagine it to have been before humans came along to modify it, at times almost beyond recognition. And whether one thinks of them, in this regard, as "wilderness nuts" or whatever, it would be folly indeed to disregard the particular message which they in their own way help to keep alive in the world, namely, that we are tied to and totally dependent upon the natural environment which not only bore the first of our species but bears each of us as well.[50]

That there are unbreakable ties between things "in nature" and man has been noted by the most primitive of peoples as well as by the anthropologists who chose to interpret such "savage thinking" as totemism.[51] Sophisticated theories aside, there is something hauntingly important about the primitive's sense of at least selective oneness with nature. For, unless you take very seriously the sports world custom of selecting a team mascot, modern man has lost not only this, but just about any other, sense of belonging to nature. On occasion, to be sure, lava still flows too far, mine walls still collapse on miners, dams still fail to hold back impounded water, or the deteriorating carcass of some strange form

of marine life is washed ashore to detract from one's early-morning swim. But, such distractions aside, modern man has been encouraged to believe the lethal myth that he is as free of nature's humbling constraints as is the butterfly of its once imprisoning chrysalis. That this freedom, like that of the butterfly, is attributed to our advanced technology only serves to thicken the plot. For, it is not unheard of that even mighty flying machines, like Icarus, fall out of the sky, or that whole cities, like Atlantis, are suddenly reclaimed by the earth. Indeed, it is at least conceivable that still mightier machines may be coming to supplant us, as Samuel Butler before and many science fiction writers since have forebodingly fantasized.[52] But in the meantime we "run" our machines, not altogether unlike the nature-doomed innocents on the supposedly unsinkable *Titanic*, or the sociopolitically preoccupied passengers on Katherine Anne Porter's *Ship of Fools*. Discounting such signs of vulnerability in machines as well as in man, technocrats and technophiles see very positive images of themselves in their machines; and so they feel free to discount as shortsighted the sort of fear for man's good image that burdened William Jennings Bryan in the so-called "monkey trial" of a teacher named Scopes and, incidentally, of another named Darwin.[53] Momentary glitches aside, so the tacit argument would claim, we makers and manipulators of machines are eating the pudding that proves, so the burden of proof must be on the nay-sayers and second-guessers. These latter curiosities, it is expected, will eventually disappear once and for all, just as surely as has the whooping crane and the Inca and all other weaklings weeded out in the unemotional struggle that ever sees the fittest survive to glory in their ordeal-proven fitness.

Such, in brief, is the legacy of social Darwinism, which transformed Darwin's meticulous study of our animal origins and heritage into a brazenly antibiological and at least tacitly antihuman ideology to legitimate the industrial will to power.[54] By no means defunct, this ideologization and ultimate mechanization of the evolutionary view of things is perhaps most brazenly propounded by Richard R. Landers in his guided tour through the "dybosphere."[55] It is rather cleverly argued by Bruce Mazlish, who claims that neither Sigmund Freud nor Jerome Bruner went far enough when they pointed out how human beings have learned to acknowledge their oneness with nature, with animals, and with one another. They must learn to acknowledge, as indeed they are doing, their oneness with machines. For, as Mazlish has it, it is no longer possible even to think of man apart from machines.[56]

One must admire the epistemological daring of such a claim, for it is patently false at least on the level of overt awareness. But it illustrates very well indeed the increasingly common device of interpreting all man-machine relations as being prosthetic, by simply accentuating the

beneficial aspects of the machinery in question.[57] But, as at least one science-fiction writer has suggested, even prosthetized man may use his supplementary capabilities for other than universally edifying purposes.[58] Which is to say, in effect, that however mechanized man may become, if a mechanized man is to remain recognizably human, he shall have to make an independent choice or two along the way.[59] And however such choices come to be made, and whatever problem they may concern, the underlying issue will ever remain whether human beings wish to continue being human. What this means in practice is known to anyone who has ever seen a terminal patient refuse to be "helped" by exotic biomedical technology.[60] Its broader ramifications may be suggested by way of some concluding reflections on the ethical and legal import of certain seminal ideas of two biologists, René Dubos and Garrett Hardin.

Dubos asserts in his *So Human an Animal* that "in practice people need what they want" and that what they want depends less on biological than on social requirements.[61] The major thrust of his argument is to the effect that if human beings are to survive they must rediscover the importance of satisfying inherited biological needs even at the cost of transforming or, if necessary, doing away with cultural demands that are antibiological. This may be done, thinks Dubos, with the help of scientific information, provided that science can be directed to formulating and resolving basic questions about who we are and where we are going. In this way, he anticipates, we may move beyond biologically harmful technological "cultures" to a universal "civilization" that will somehow perpetuate primitive oneness with nature by means of scientifically legitimated institutions.

Implicit in this view is the assumption that human beings are capable of creating—or, in Gabor's expression, inventing—their own future, regardless of the cultural conditions and resulting cultural bias to which they are inevitably subject in the present. In short, Dubos assumes with Gardner Murphy that human beings are free—that, in addition to their biologically inherited "first nature" and their socioculturally imposed "second nature," they have also at their disposal a kind of "third nature" of spontaneity, ingenuity and creativity.[62] Unfortunately, there is much in history that might better not have happened at all, however creative may have been the historical agents that brought it about. Michaelangelo may indeed have enriched us with his ingenuity; but then there were Genghis Khan, and Adolf Hitler, and possibly the man next door. Similarly, one technological development might increase food production; but another might take arable land out of cultivation indefinitely. The same invention might help either to maintain or to destroy a culture. Thus does the mixed impact of technology lead us to the suspicion that the freedom to choose is more a burden than a blessing, especially when the kinds of choices that

one must make almost certainly will have consequences beyond anyone's ability adequately to predict or control. But existential anguish alone is no substitute for adequate safeguards. Nor, at the other extreme, is the exculpatory determinism of one who claims impotence in the face of events which he has not single-handedly set in motion.

The principles elaborated at Nuremberg with regard to medical experimentation on human beings are applicable always, not only to war crimes as such but to any situation where human beings may be harmed without their informed consent.[63] Such, at least, is the standard which has evolved in most courts of law as well as in agencies such as the NIH which regulate funded medical experimentation requiring human subjects.[64] This doctrine of informed consent is by no means a panacea for every possible abuse of the laudable desire to advance human knowledge; but at least it is available, and it does provide a court with an entirely appropriate basis for awarding damages demonstrably undergone. Analogously, causes of action lie for damages to an individual resulting from faulty products, by virtue of such legal theories as that of implied warranty. And, of course, our courts have been finding for plaintiffs in numerous cases involving proven and causally determinable damage to the environment.[65] It seems clear, however, that a procedure such as litigation for damage already done is a minimally effective instrument for dealing with the kinds of problems that can conceivably arise from almost any technology if it is not adequately monitored.

Thus the need not only for prior review and regulation but also for the elaboration of policy on the basis of which such review and regulation shall be carried out. Prior review and regulation can be handled in part by means of such legal remedies as declaratory judgments, injunctions and restraining orders. Policy considerations are better arrived at, at least in principle, by way of a balanced mixture of legislative enactment and appellate review. As regards evaluation of technology, this ongoing process ought to have as its principal goal to enable society to assure itself that any creative endeavor supported in its behalf is fully *responsible*.

That creativity must be made responsible does not mean, in case this is not obvious, that those who create (or invent) should have responsibility attributed to them arbitrarily by anyone in need of a scapegoat. Intended here is what Garrett Hardin has appropriately called the cybernetic concept of responsibility, which he associates with Charles Frankel's proposal that "a decision is responsible when the man or group that makes it has to answer for it to those who are directly or indirectly affected by it."[66] On the basis of this definition of responsibility Hardin elaborates what amounts to two axioms for a systems approach to the evaluation of technology:

1. that "the morality of an act is a function of the state of the system at the time the act is performed . . .";
2. that "[w]henever the state of a system needs to be taken into account before an act can be approved or disapproved, an administrative agency is needed."[67]

This line of reasoning, as Hardin himself notes, can readily end in a cul-de-sac if the administrative agency in question cannot itself be held responsible; and in the absence of adequate information about how, and with regard to which, that agency makes decisions, quality control by way of overseeing will be ineffective at best.[68] Many, if not most, regulatory agencies of our federal (to say nothing of state) government such as the FCC, the FTC, the AEC, and perhaps already even the EPA, are often indistinguishable, in terms of personnel as well as results, from the vested interests which they have been established to regulate.[69] But an agency such as the FDA, for all of its inadequacies, does manage to give some meaning to its charge to keep us from ingesting what is not both safe and effective.[70] Much more is required, however—not necessarily in the form either of more laws or of more regulatory agencies, but in the form of more citizen involvement in the process whereby existing agencies decide what is in our best interest.

Citizen involvement in and of itself, of course, in the absence of enlightened appreciation of what is truly at stake in a given case, can do as much harm through zeal as might an ineffectual regulatory agency through neglect. Accordingly, it is absolutely essential to the humanization of technology, as here understood, that appropriate governmental and citizen interests be adequately complemented with duly issue-oriented professional responsibility on the part of scientists and engineers. Such, it would seem, is one of the principal conclusions arrived at by geneticists at the recent Asilomar Conference, who in effect chose to take seriously a cybernetic concept of responsibility on the level of peer evaluation.[71]

What remains to be seen is whether professional self-regulation of the sort agreed to at Asilomar will encourage others in analogous situations also to take responsibility even for unintended consequences that enter only peripherally into their planning for circumscribed goals.[72] For, one of the most prevalent consequences of modern industry-subservient technology is frustration of those most human of all human values, personal and professional responsibility. If these are ever effectively destroyed, then technology will indeed have become an end in itself and Cyborg will be its name. But if we do in fact learn how to require of ourselves and of others rational yet adequate responsibility for the foreseeable consequences of our actions, it may yet be possible to take Marshall McLuhan's dictum that our environment is a "programmed hap-

pening" not as a warning but prosthetically.[73] To settle for any less will be in effect to say to posterity that in our time the humanization of technology was mainly a manipulated slogan, not an ethical imperative.

FOOTNOTES

1. This is not meant to imply that no attempts are being made to develop such expertise. See, for example, Kurt Baier and Nicholas Rescher, eds., *Values and the Future*, New York: Free Press, 1969; Environmental Protection Agency, *The Quality of Life Concept: A Potential Tool for Decision-Makers*, Washington: EPA, 1973.

2. "The Tragedy of the Commons," *Science* 162 (Dec. 13, 1968) 1243–48, and widely reprinted thereafter, e.g., in *The Everlasting Universe*, eds. L. J. Forstner and J. H. Todd, Lexington, Mass.: Heath, 1971, pp. 174–93.

3. Such is, in effect, one message that can be heard in some critiques of the MIT/Club of Rome approach to designing a "world system." See H. S. D. Cole, *et al., Models of Doom: A Critique of the Limits to Growth*, New York: Universe, 1973; Ervin Laszlo, ed., *The World System*, New York: Braziller, 1973; David L. Sills, "The Environmental Movement and Its Critics," *Human Ecology* 3 (January 1975), 1–41, esp. 19; Charles Susskind, review of *The Limits to Growth*, *Ecology Law Quarterly* 2 (Fall, 1972), 879–88.

4. Involved here are both physical and economic injury. With regard to the former, Bureau of Labor statistics show that between 1961 and 1970 the manufacturing injury frequency rate rose from 11.8 disabling injuries per million man-hours worked to 15.2, an increase of 29 percent. According to the National Safety Council, there are 2,300,000 disabling injuries and 14,200 deaths per year from accidents on the job, resulting in $9.3 billion in lost wages, insurance, medical expenses and property damage—and there are indications that more accurate figures would be ten times higher. See Dan Cordtz, "Safety on the Job Becomes a Major Job for Management," *Fortune* 86 (November 1972), 113. Thus the manifest need for the Occupational Safety and Health Act of 1970, PL 91-596, S. 2193, 91st Congress, which went into effect April 28, 1971. In the first three years of OSHA, 172,000 inspections led to 115,000 citations involving 592,000 violations. Alexander J. Reis, "Three Years of OSHA: The View from Within," *Monthly Labor Review* 98 (March 1975), 35–36. Indirect or economic injury may arise, for example, from use of inappropriate technology, a point often made by critics of W. W. Rostow's stage theory of development. See John M. Culbertson, *Economic Development: An Ecological Approach*, New York: Knopf, 1971, pp. 257–91; Jagdish Bhagwati, *The Economics of Underdeveloped Countries*, New York: McGraw-Hill World Univ. Library, 1966, pp. 225–30; Stephen Enke, *Economics for Development*, Englewood Cliffs, N.J.: Prentice-Hall, 1963, pp. 189–206. By way of contrast, see Charles P. Kindelberger, *American Business Abroad*, New Haven and London: Yale University, 1969; Andrew Shonfield, *The Attack on World Poverty*, New York: Vintage, 1962.

5. The assessment done for NASA by the American Academy of Arts and Sciences verbalized such broad concern by declaring that its goal was to enable NASA to carry out its activities "in such a fashion that the net total of secondary effects can be optimized—within reasonable limits"—Raymond A. Bauer, *Second-Order Consequences*, Cambridge: MIT, 1969, p. 199. But under the circumstances this meant little more than searching for horses after the barn door was opened. Yet to be achieved is consistently responsible assessment *before* a new technology has become a political and economic necessity, as was acknowledged by the Panel on Technology Assessment of the National Academy of Sciences, *Technology: Processes of Assessment and Choice*, Report to the U.S. H.R. Committee on Science and Astronautics, Washington: U.S. Government Printing Office, 1969. See also Donella H. Meadows, *et al., The Limits to Growth*, New York: Universe 1972, pp. 146–55.

6. The word "ideal," as here used, is appropriately defined by Russell L. Ackhoff as "an objective which cannot be obtained in any time period but which can be approached without limit," specifically by an ideal-seeking system, i.e., "a purposeful system which, on attainment of any of its goals or objectives, then seeks another goal and objective which more closely approximates its ideal." Ackhoff, "Towards a System of System Concepts," in *Systems Behaviour*, eds. J. Beishon and G. Peters, London: Harper & Row for The Open Univ. Press, 1972, p. 87.

7. See Edwin Mansfield, *The Economics of Technological Change*, New York: Norton, 1968; Herbert A. Simon, "The Science of Design: Creating the Artificial," *The Sciences of the Artificial*, Cambridge and London: MIT, 1968, pp. 55–83; Michael Shanks, *The Innovators: The Economics of Technology*, Baltimore: Penguin, 1967; Robert W. Campbell, "Strategic and Operational Decision Making," *Soviet Economic Power*, 2nd ed., Boston: Houghton Mifflin, 1966, pp. 53–82.

8. The ideas of Mumford, Ellul and Wiener are perceptively introduced, along with those of several other well-known analysts of technology, by William Kuhns, *The Post-Industrial Prophets*, New York: Weybright and Talley, 1971; Harper Colophon, 1973. Those of Ferkiss and others, by Donald W. Shriver, Jr., "Man and His Machines: Four Angles of Vision," and by Paul T. Durbin, "Technology and Values: A Philosopher's Perspective," *Technology and Culture* 13 (October 1972), 531–76.

9. Meadows, *et al., op. cit.*, p. 20.

10. Robert W. Guest, "Men and Machines: An Assembly-Line Worker Looks at His Job," in *Modern Technology and Civilization*, ed. C. R. Walker, New York: McGraw-Hill, 1962, pp. 99–100.

11. Frederick W. Taylor, *The Principles of Scientific Management*, c. 1911, New York: Norton, 1967. See also Taylor Society, New York, *Frederick Winslow Taylor: A Memorial Volume*, 1920, Easton, Pa.: Hive, 1972; Samuel Haber, *Efficiency and Uplift*, Chicago and London: Univ. of Chicago, 1964.

12. The literature in each of these areas, especially that of cybernetics, is, of course, extensive. The following are especially helpful introductory surveys: Alphonse Chapanis, *Man-Machine Engineering*, Belmont, Cal.: Wadsworth, 1965; O. G. Edholm, *The Biology of Work*, New York: McGraw-Hill World Univ. Library, 1967; F. H. George, *Cybernetics and Biology*, Edinburgh and London: Oliver & Boyd, 1965; Lucien Gerardin, *Bionics*, New York: McGraw-Hill World Univ. Library, 1968; Arthur Porter, *Cybernetics Simplified*, London: English Universities, 1969; John F. Young, *Cybernetics*, New York: American Elsevier, 1969.

13. See, for example, Stafford Beer, *Cybernetics and Management*, New York: Wiley, 1964; Edwin G. Johnsen and William R. Corliss, *Human Factors Applications in Teleoperator Design and Operation*, New York: Wiley, 1971. There are, however, some notable exceptions to the rule, e.g., Norbert Wiener's *The Human Use of Human Beings*, Boston: Houghton Mifflin, 1950, and *God and Golem, Inc.*, Cambridge: MIT, 1966, and Anthony G. Oettinger's *Run, Computer, Run*, Cambridge: Harvard, 1969. The underlying value question here at issue, of course, involves weighing costs and benefits of automation. See Ben B. Seligman, *Most Notorious Victory*, New York: Free Press, 1966; George Terborgh, *The Automation Hysteria*, New York: Norton, 1965; "The Office of the Future," *Business Week*, June 30, 1975, 48–84.

14. Manfred Clynes, Foreword to *Cyborg: Evolution of the Superman*, D. S. Halacy, Jr., ed., New York: Harper & Row, 1965, p. 8.

15. An early but comprehensive treatment of the multiplicity of systems that must be coordinated will be found in Siegfried J. Gerathewohl, *Principles of Bioastronautics*, En-

glewood Cliffs, N.J.: Prentice-Hall, 1963. The managerial problems inherent in such coordination are lucidly analyzed by Leonard R. Sayles and Margaret K. Chandler, *Managing Large Systems*, New York: Harper & Row, 1971.

16. See Harold M. Schmeck, Jr., *The Semi-Artificial Man*, New York: Walker, 1965; Donald Longmore, *Spare-part Surgery*, Garden City, N.Y.: Doubleday, 1968.

17. For example, though most of Marshall McLuhan's observations about media as extensions of the nervous system suggest a cyborg, he tends to think of media prosthetically, even when complaining about such overloads on the system as war in the global village. A deliberate usage of the prosthetic model is John McHale, "Doctor Jekyll and the Bride of Frankenstein," AAAS Convention, Philadelphia, 1971. Inversely, a minority opinion among prosthetics specialists has it that artificial devices might eventually function even *better* than the natural organs which they replace. See Schmeck, *op cit.*, p. 176 n.

18. See E. J. Mishan, *Technology and Growth*, New York: Praeger, 1970; Morton Mintz and Jerry S. Cohen, *America, Inc.*, New York: Dell, 1971; Walter J. Hickel, *Who Owns America?*, New York: Paperback Library, 1971; James Ridgeway, *The Politics of Ecology*, New York: Dutton, 1970; Peter d'A. Jones, ed., *The Robber Barons Revisited*, Boston: Heath, 1968; Philip A. M. Taylor, ed., *The Industrial Revolution in Britain: Triumph or Disaster?*, Boston: Heath, 1958.

19. The following are typical of the kinds of issues raised: Jerome Tuccille, *Here Comes Immortality*, New York: Stein and Day, 1973; Gerald Leach, *The Biocrats*, rev. ed., Baltimore: Penguin, 1972; Allan Chase, *The Biological Imperative*, Baltimore: Penguin, 1971; Dannie Abse, *Medicine on Trial*, London: Aldus, 1967; New York: Crown, 1969.

20. See Editors of *Fortune*, eds., *Our Ailing Medical System*, New York: Harper & Row Perennial, 1970; Research and Policy Committee of the Committee for Economic Development, *Building a National Health-Care System*, New York: Committee for Economic Development, 1973; Edward P. Luongo, M.D., *American Medicine in Crisis*, New York: Philosophical Library, 1971.

21. Barbara and John Ehrenreich, *The American Health Empire*, New York: Vintage, 1971; Ed Cray, *In Failing Health*, Indianapolis and New York: Bobbs-Merrill, 1970.

22. See, for example, David A. LeSourd, *et al.*, *Benefit/Cost Analysis of Kidney Disease Programs*, Washington: HEW/Public Health Service, 1968, esp. pp. 53–60.

23. *The Myth of the Machine: The Pentagon of Power*, New York: Harcourt Brace Jovanovich, 1970, pp. 236–99.

24. These broader reaches of purposiveness are developed with the assistance of cybernetic theory by Karl Deutsch, *The Nerves of Government*, New York: Free Press, 1963, pp. 91–93, and by Stafford Beer, *op. cit.* (n. 13).

25. See Alexander P. de Seversky, *America: Too Young to Die!* New York: McGraw-Hill, 1961, pp. 95–110; *F.A.S. Public Interest Report* 27, No. 2 (February, 1974). See also *ibid.*, 24, No. 10; 25, No. 4; 27, Nos. 3 and 5.

26. The computer industry provides an excellent example in this regard. See "A Tyro Challenges IBM in Big Computers," *Business Week*, May 12, 1975, 65–68; "Hewlett-Packard: Where Slower Growth is Smarter Management," *Business Week*, June 9, 1975, 50–58; William Rodgers, *Think: A Biography of the Watsons and IBM*, New York: Signet, 1970. See also "Corporate Planning: Piercing Future Fog in the Executive Suite," *Business Week*, April 28, 1975, 46–54.

27. See Raphael G. Kasper, ed., *Technology Assessment*, New York: Praeger, 1972; Lynton K. Caldwell, ed., *Science, Technology and Public Policy: A Selected and Annotated Bibliography*, Vol. 3, Bloomington, Ind.: Indiana Univ., 1972, pp. 59–66.

28. For numerous examples from other times and places, see David S. Landes, *The Unbound Prometheus: Technological Change and Industrial Development in Western Europe from 1750 to the Present*, London: Cambridge, 1969.

29. William C. Uhl, "Offshore, The Oil Hunt Gets Tough," and Werner Bamberger, "Rigs that Drillers Swear By," *The New York Times*, March 31, 1974, Section 3.

30. Hearings on Fuel and Energy Resources Before the House Committee on Interior and Insular Affairs, 92nd Congress, 2nd Sess., ser. 42, pt. I, Washington: U.S. GPO, 1972, pp. 58–59, 140–41, 301–07, 371; Morton Mintz and Jerry S. Cohen, *America, Inc.*, New York: Dell, 1971, pp. 227–57; Peter R. Odell, *Oil and World Power*, Baltimore, Penguin, 1970, pp. 23–43; Harvey O'Connor, *The Empire of Oil*, New York: Monthly Review Press, 1962; Robert Engler, *The Politics of Oil*, New York: Macmillan, 1961. As these studies tend to show, government policies influenced, if not determined, by the petroleum industry spill over from questions of energy into other areas not exclusive of military intervention. See also in this regard Wesley Marx, *Oilspill*, San Francisco and New York: Sierra Club, 1971, pp. 132–39.

31. "OPEC: The Economics of the Oil Cartel," *Business Week*, January 13, 1975, 77–81; *F.A.S. Public Interest Report* 27, No. 1 (January 1974); "Why OPEC Begins to Abandon the Dollar," *Business Week*, March 31, 1975, 18.

32. To the contrary, the American oil industry, among others, is busy expanding and solidifying its operations in the oil-producing countries. See "Building a New Middle East," *Business Week*, May 26, 1975, 38–54. Meanwhile, others talk of alternatives: Sidney E. Rolfe, "Whatever Happened to Project Independence?" *Saturday Review*, January 25, 1975, 25–28; Glenn Seaborg, "Finding a New Approach to Energistics—Fast!" *Saturday Review*, December 14, 1974, 44–48; Dietrich E. Thomsen, "Power from the Salton Trough," *Science News* 106 (July 13, 1974), 28–29; Victor K. McElheny, "Hydrogen—A Way Out of the Energy Crisis?" *The New York Times*, May 12, 1974, Section 3; John H. Douglas, "Coal: The Stopgap Fuel—Maybe," *Science News* 104 (July 7, 1973), 10–12; Arthur M. Squires, "Clean Power from Coal," *Science* 169 (August 28, 1970), 821–27; Peter E. Glaser, "Solar Energy—An Alternative Source for Power Generation," *Futures* 1 (June 1969), 304–13; "Power from the Sun: Its Future," *Science* 162 (November 22, 1968), 857–61.

33. Barry Commoner, "The Origins of the Environmental Crisis," Keynote Address before the Council of Europe, Second Symposium of Members of Parliament Specialists in Public Health, Stockholm, Sweden, July 1, 1971, pp. 14–15, Table IV.

34. Frank Graham, Jr., *Since Silent Spring*, Greenwich, Conn.: Fawcett Crest, 1970.

35. M. Taghi Farvar, *et al.*, "The Pollution of Asia," *Environment* 13 (October 1971), 10–17.

36. Steven Rose, ed., *CBW: Chemical and Biological Warfare*, Boston: Beacon, 1968; J. B. Nielands, *et al.*, *Harvest of Death: Chemical Warfare in Vietnam and Cambodia*, New York: Free Press, 1972.

37. Virginia Brodine, "A Special Burden," *Environment* 13 (March 1971), 22–24; Howard Lewis, *With Every Breath You Take*, New York: Brown, 1965; Max Carasso, *People vs. Cars*, New York: Autofacts, 1970; Helen Leavitt, *Superhighway—Superhoax*, New York: Ballantine, 1970. For more detailed and technical information, consult Committee on Environmental Information, 438 N. Skinker, Saint Louis, Missouri.

38. Thus the entirely predictable dissatisfaction with management of most American automobile manufacturing companies for not having anticipated the impact of the energy crunch on their industry. See Marylin Bender, "The Energy Trauma at General Motors," *The New York Times*, March 24, 1974, Section 3; "What's Wrong at Chrysler?" and "What's Right at American Motors?" *Forbes*, December 1, 1973, 28–33. (In June, 1975, Chrysler announced it was abandoning the large car market entirely, and rumors had the company being sold to *Volkswagenwerke*.) For a detailed analysis of the problem of allocating responsibility *internally* among multiple managers, see Sayles and Chandler, *op. cit.* (n. 15), pp. 298–321.

39. Galbraith, *The New Industrial State*, Boston: Houghton Mifflin, 1967; New York: Mentor, 1968, pp. 46–108. See Morton Mintz and Jerry S. Cohen, *op. cit.* (n. 18), *America, Inc.*, New York: Dell, 1971, pp. 59–108.

40. New York: Lyle Stuart, 1968; Bantam, 1969.

41. Charles W. Powers, ed., *People/Profits: The Ethics of Investment*, New York: Council on Religion and International Affairs, 1972; "Focus on Social Responsibility: Reflections on Law, Morality and Equal Justice," *Trusts and Estates* 114 (April 1975), 209–12+; Philip I. Blumberg, "Introduction to the Politicalization of the Corporation," *The Record* 26 (May 1971) 369–85.

42. An important exception to this exclusion of the managerial or strategic level from ethical considerations was Anatol Rapaport's *Strategy and Conscience*, New York: Harper & Row, 1964. See Andrew Wilson, *The Bomb and the Computer*, New York: Delta, 1968, pp. 177–83, and Charles Hampden-Turner, *Radical Man*, Garden City, N.Y.: Anchor, 1971, pp. 361–410; Hans Jonas, "Technology and Responsibility: Reflections on the New Tasks of Ethics," *Social Research* 40 (Spring 1973), 31–54. The dissipation of managerial responsibility here at issue was foreseen by Norbert Wiener as a likely consequence of the increasing automation of the office. See his commentary on C. P. Snow's "Scientists and Decision-Making," in *Computers and the World of the Future*, ed. Martin Greenberger, Cambridge: MIT, 1962, p. 26. Compare, however, Sayles and Chandler, *op cit.* (n. 5), esp. pp. 173, 201, 278–281, 306 ff.; R. R. Ritti, *The Engineer in the Industrial Corporation*, New York: Columbia Univ., 1971.

43. Loren Eiseley, *The Invisible Pyramid*, New York: Scribners, 1970, pp. 16–17.

44. *Investigation into Electronic Battlefield Program*. Hearings Before, and Report of the Electronic Battlefield Subcommittee of the Senate Subcommittee on Preparedness Investigation. Hearings Nov. 18, 19, 24, 1970, 91st Congress, 2nd Session., Washington: U.S. GPO, 1970. Report, 92nd Congress, 1st Sess., Washington: U.S. GPO, 1971.

45. Andrew Wilson, *op. cit.*, pp. 201–10. In this connection, the Pentagon Papers hardly need additional commentary. They may be supplemented, however, by Noam Chomsky, *American Power and the New Mandarins*, New York: Random House Pantheon, 1967; "On Changing the World," *Problems of Knowledge and Freedom*, New York: Vintage, 1971, pp. 53–111; David Halberstam, *The Best and the Brightest*, New York: Random House, 1972; Wilfred G. Burchett, *Vietnam: Inside Story of the Guerilla War*, New York: International, 1965; Harold L. Wilensky, *Organizational Intelligence*, New York: Basic Books, 1967, pp. 24–34, 188–89.

46. See Amitai Etzioni, *The Active Society*, New York: Free Press, 1968, pp. 197–222; Paul Dickson, *Think Tanks*, New York: Atheneum, 1971; Adam Yarmolinsky, *The Military Establishment*, New York: Harper & Row, 1971, pp. 237–323. "Power," of course, here means the resultant of a vector of forces which taken together may be thought of as an "Establishment." This is well illustrated by the classic case of the emergence of NASA in the 1960's: Enid Curtis Bok Schoettle, "The Establishment of NASA," *Knowledge and Power*, ed. S. A. Lakoff, New York: Free Press, 1966, pp. 162–270. See also Jerome R. Ravetz, *Scientific Knowledge and its Social Problems*, Oxford: Clarendon, 1971.

47. See Chaim I. Waxman, ed., *The End of Ideology Debate*, New York: Simon and Schuster Clarion, 1969; Paul E. Sigmund, Jr., *The Ideologies of the Developing Nations*, New York: Praeger, 1963.

48. *Eupsychian Management: A Journal*, Homewood, Ill.: Irwin-Dorsey, 1965. See also Maslow, "Criteria for Judging Needs to be Instinctoid," in *Human Motivation: A Symposium*, ed. M. R. Jones, Lincoln: Univ. of Nebraska, 1965.

49. The theory of evolution formed the backdrop to Marx's *Capital* which in fact was dedicated to Darwin. As with Marx, so do current writers find it congenial to express value preferences with regard to industrial development by taking a stand on the chicken-or-egg question of whether tools or brains came first in time. See Clifford Geertz, "The Impact of the Concept of Culture on the Concept of Man," in *New Views of the Nature of Man*, ed. J. R. Platt, Chicago and London: Univ. of Chicago, 1965, pp. 93–118; Lewis Mumford, *The Myth of the Machine: Technics and Human Development*, New York: Harcourt Brace Jovanovich, 1967, pp. 22–54.

50. See John Passmore, *Man's Responsibility for Nature*, New York: Scribners, 1974, pp. 73–126, 173–81; David L. Sills, *op. cit.* (n. 3), 22–24. With regard to the chemistry of consciousness, see William Braden, *The Private Sea*, Chicago: Quadrangle, 1967; Alan W. Watts, *The Joyous Cosmology*, New York: Vintage, 1962; R. E. L. Masters and Jean Houston, *The Varieties of Psychedelic Experience*, New York: Delta, 1966, esp. pp. 151–83. For a more alimentary view of our dependence on nature, see Donald E. Carr, *The Deadly Feast of Life*, Garden City, N.Y.: Doubleday, 1971.

51. See Claude Lévi-Strauss, *Totemism*, Boston: Beacon, 1963; *The Savage Mind*, Chicago: Univ. of Chicago, 1966.

52. Butler, "The Book of the Machines," in *Erewhon*, 1872; New York: Airmont, 1967, pp. 143–65. The modern classic along these lines is undoubtedly Isaac Asimov's *I, Robot*, New York: Gnome, 1950, and its now famous laws of robotics.

53. Scopes v. Tennessee, 152 Tenn. 424, 278 SW 57; 154 Tenn. 105, 289 SW 363.

54. See Richard Hofstadter, *Social Darwinism in American Thought*, rev. ed., Boston: Beacon, 1955.

55. *Man's Place in the Dybosphere*, Englewood Cliffs, N.J., 1966. See also Harold Sackman, *Computers, System Science, and Evolving Society*, New York: Wiley, 1967; John David Garcia, *The Moral Society*, New York: Julian, 1971; Dennis Gabor, *Inventing the Future*, New York: Knopf, 1971, esp. ch. 8, "Men and Machines."

56. "The Fourth Discontinuity," *Technology and Culture* 8 (January 1967); reprinted in *Perspectives on the Computer Revolution*, ed. Z. W. Pylyshyn, Englewood Cliffs, N.J.: Prentice-Hall, 1970, pp. 195–207. Compare, however, Laurence H. Tribe, "Technology Assessment and the Fourth Discontinuity: The Limits of Instrumental Rationality," *Southern California Law Review* 46 (June 1973), 617–60.

57. This approach is, of course, commonplace among advocates of more technology, e.g., Herbert A. Simon, *The Shape of Automation for Men and Management*, New York: Harper & Row, 1965. But humanist observers, including Karl Marx with regard to industry, Marshall McLuhan with regard to electronics, and Norman Mailer with regard to Project Apollo, have attempted as much. More cautious affirmations include Loren Eiseley, *The Invisible Pyramid, supra*, and Lewis Mumford, *Technics and Civilization*, New York: Harcourt, Brace, 1934. See also, with regard to nineteenth-century American writers and statesmen, Leo Marx, *The Machine in the Garden*, Oxford: University Press, 1964.

58. Michael Crichton, *The Terminal Man*, New York: Knopf, 1972.

59. By thus identifying freedom of choice as the operationally distinguishing characteristic of a human being, I associate myself somewhat more closely with concerns of the legal profession than with those of academicians who have wondered prolifically if machines can think, as in Alan Ross Anderson, ed., *Minds and Machines*, Englewood Cliffs, N.J.: Prentice-Hall, 1964. I readily acknowledge the influence of the existentialists at this point, as well as the related, though more scholastic, stance of Mortimer J. Adler, *The Difference of Man and the Difference It Makes*, New York: Holt, Rinehart and Winston, 1967. See also the theological approach of Harold E. Hatt, *Cybernetics and the Image of Man: A Study of Freedom and Responsibility in Man and Machine*, Nashville and New York: Abingdon, 1968.

60. See Marya Mannes, *Last Rights*, New York: Morrow, 1974; Elisabeth Kübler-Ross, *On Death and Dying*, New York: Macmillan, 1969.

61. New York: Scribners, 1968, pp. 170 ff.

62. Gardner Murphy, "Three Kinds of Human Nature," *Human Potentialities*, New York: Basic Books, 1958, pp. 15–25.

63. Jay Katz, ed., *Experimentation with Human Beings*, New York: Russell Sage Foundation, 1972 pp. 283–321 ff.

64. *Ibid.*, *passim* and esp. pp. 523–608 and 690–92.

65. See Earl F. Murphy, *Man and His Environment: Law*, New York: Harper and Row, 1971; Norman J. Landau and Paul D. Rheingold, *The Environmental Law Handbook*, New York: Friends of the Earth/Ballantine, 1971; and Malcolm Baldwin and James K. Page, Jr., eds., *Law and the Environment*, New York: Walker, 1970, valuable both for its discussion of changes within the legal profession and for its annotated bibliography, pp. 375–412; John E. Bryson and Angus Macbeth, "Public Nuisance, the Restatement (Second) of Torts, and Environmental Law," *Ecology Law Quarterly* 2 (Spring 1972), 241–81. See also Christopher D. Stone, *Should Trees Have Standing? Toward Legal Rights for Natural Objects*, Los Altos, Cal.: Kaufman, 1974.

66. Hardin, *Exploring New Ethics for Survival*, New York: Viking, 1972; Baltimore: Penguin, 1973, pp. 102, 103. This cybernetic, or systems, concept of responsibility, which focuses on environmental impact of decisions, is only remotely related to that presented for purposes of allocating responsibility within corporate management by Sayles and Chandler, *loc. cit.*, *supra* (n. 38). Compare, however, the recent trend in law towards managerial liability, with the resulting development of, and issues surrounding, managerial liability insurance. See "Should Shareholders be Personally Liable for the Torts of their Corporations?" *Yale Law Journal* 76 (May 1967), 1190–1204; John S. Morrison, "Factors That Limit the Negligence Liability of a Corporate Executive or Director," *Univ. of Illinois Law Forum* 1967 (Summer) 341–50; William E. Knepper, "Corporate Identification and Liability Insurance for Corporation Officers and Directors," *Southwestern Law Journal* 25 (May 1971), 240–63; "Officers and Directors: Identification and Liability Insurance—An Update," *Business Lawyer* 30 (April 1975), 951–67. See also Emil F. Sos, Jr., "Liability of Engineer for Defective Design," *Cleveland State Law Review* 19, (January 1970) 184–93.

67. Hardin, *op. cit.*, p. 134. See, however, Panel on Technology Assessment, *op cit.* (n. 5), pp. 37–38, 65.

68. Hardin, *op cit.*, pp. 135–40.

69. See Mintz/Cohen, *op cit.* (n. 18), pp. 294–313; William H. Rodgers, Jr., *Corporate Country: A State Shaped to Suit Technology*, Emmaus, Pa.: Rodale, 1973; Joseph C. Goulden, *The Superlawyers*, New York: Dell, 1973. This alleged inefficacy of administrative agencies is compounded by similar complaints with regard to Congress' benign approach to its oversight function. See Ferdinand Lundberg, *The Rich and the Super-Rich*, New York: Bantam, 1969, pp. 584–678; Panel on Technology Assessment, *op. cit.* (n. 5), pp. 9–10, 26–27. Compare, however, *Federal Agencies and the Public Interest: New Directions in Administrative Practice*, Proceedings of the ABA National Institute, *Administrative Law Review* 26 (Fall 1974); Robert E. Jordan, III, "Alternatives Under NEPA: Toward an Accommodation," *Ecology Law Quarterly* 3 (Fall 1973), 705–57.

70. Katz, *op. cit.*, pp. 736–93, 856–82. See also *How Safe Is Safe? The Design of Policy on Drugs and Food Additives*, Washington: National Academy of Sciences, 1974. With regard to citizen involvement, see Panel on Technology Assessment, *op. cit.* (n. 5), pp. 41, 70–71, 83.

71. A working paper on research policy in the field of genetic engineering was adopted in February, 1975, by an international group of molecular biologists meeting at Asilomar State Park near Monterey, California. Then an official summary statement of their report to the Assembly of Life Sciences of NAS was approved by the latter's Executive Committee on May 20, 1975, and subsequently published in *Science*, *Nature*, and *Proceedings of the National Academy of Sciences*. See *Science News* 107 (March 8, 1975), 148–149, 156; (June 7, 1975), 366; Paul Berg, *et al.*, "Asilomar Conference on Recombinant DNA Molecules," *Science* 186 (June 6, 1975), 991–94. By way of background, see Joshua Lederberg, "The Freedoms and the Control of Science: Notes from the Ivory Tower," *Southern California Law Review* 45 (Spring 1972), 596–614.

72. See Hasan Ozbekhan, "The Emerging Methodology of Planning," *Fields Within Fields*, 1973, pp. 63–73; Harold Gilliam, "The Fallacy of Single-Purpose Planning," *Daedalus* 96 (Fall 1967), 1142, 1143.

73. "Environment as Programmed Happening," in *Knowledge and the Future of Man*, ed. Walter J. Ong, New York: Holt, Rinehart and Winston, 1968, pp. 113–24. See also C. A. Van Peursen, *The Strategy of Culture*, New York: American Elsevier, 1974, pp. 189–90, 192, 196.