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ADAPTATION AND THE TECHNOLOGICAL SOCIETY: A VALUE CONTEXT FOR TECHNOLOGY ASSESSMENT

by Mark W. Lipsey

The National Academy of Sciences in its 1969 report on technology to the House of Representatives began by noting widespread concern "that continuation of certain technological trends would pose grave dangers for the future of man."[1] Such critics of modern technology as Jacques Ellul, Lewis Mumford, Herbert Marcuse, René Dubos, and Theodore Roszak have described some of those dangers in graphic detail and often brought a note of profound pessimism to the discussion.[2] The well-known Club of Rome studies have depicted some of the alarming, worldwide consequences that may be extrapolated from developments now under way, and Robert L. Heilbroner's recent work amplifies that theme.[3] One need consider only the effects of advanced technology on the natural environment to confront some of the grave dangers of which the academy speaks.[4] We clearly have much reason to be concerned about "certain technological trends."

If we grant, desite the critics' skepticism, that humankind still has

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the ability and might find the will to regulate technological development, two preliminary and closely interrelated tasks present themselves. One requires a determination of the range and nature of the consequences for human life that can follow from technological applications. No rational control is possible without some notion of the types of possible effects to expect, both the glaring and the subtle, the short-term and the long-term. The other task is the elaboration of a value framework that yields standards by which to evaluate those consequences. Whatever future humanity chooses for itself will depend, at least in part, on the standards fed into the decision-making process by which technological development is guided. To fail to reach any consensus about the values that should govern technological development is to risk what some critics fear most, that unchecked technology itself will be the determinant of human values.

Various commentators who have addressed the psychological and social effects of technology and the industrialization it supports have called attention foremost to its effects on our health, our own survival, and the survival of our species. In addition they have been concerned with the impact of technological applications on human values, sensitivities, and psychological well-being. Similarly the implicit standards by which these effects have been assessed rest on valuation of survival and mental and physical health, the worth of which seems almost beyond dispute. In broader biological perspective, however, survival and health are only aspects of the overall adaptation of individual and species to the environment in which they exist. It is the theme of this paper that a thorough exploration of the concept of adaptation and its requirements helps distinguish and categorize the various aspects of technological consequences and aids in the identification of those standards relevant to the evaluation and control of technological development.

The concept of adaptation, of course, does not itself provide an absolute standard for judging technological applications. It certainly supplies no magical solution to the age-old question of how to conduct human affairs. However, it does furnish us with a broad practical footing on which to attempt to erect some social consensus about the standards appropriate for guiding technological development. We thus skirt the issue of ultimate justification and, in the spirit of T. L. Thorson's logic of recommendation, seek a sensible basis of broad appeal from which to derive guidelines for directing technological growth.[5] The concept of adaptation provides an attractive basis because it encompasses matters of such immediacy and importance—survival and the quality of survival—that they cannot be ignored easily.

The intent of what follows is to outline briefly an adaptational view of human behavior which expands the concept of adaptation beyond the almost universally acknowledged issues of morbidity, physical health, life expectancy, and so forth, to more subtle aspects of human experience. The implications of that view for assessing the effects of technology can be examined then by cataloging at least four domains within which humans' present or future adaptation is vulnerable to technologically induced disruption. These domains serve to summarize the various threats discussed by a wide range of commentators on the relationship between the technological society and human functioning. At the same time they provide some basis for judging technological applications as contributing to human adaptation or endangering it.

An Adaptational View of Human Behavior

Adaptation, at its simplest, refers to the relationship which holds between a population of organisms and an ecological niche when the organisms possess those structural and behavioral characteristics that generally allow them to extract the means of life and avoid getting into fatal trouble in that environment. Adaptation implies a basic duality—the environment to which adaptation is made, on the one hand, and the organism or population of organisms making the adaptation, on the other. This duality allows us to distinguish two interrelated paths by which the adaptive relationship may break down. Most obviously, changes in the environment which go beyond the ability of a population of organisms to maintain life may take place. Both intense, short-term conditions, such as forest fires, and less intense, longer-term conditions, such as the extensive glaciation during the Pleistocene ice age, can have such effects.

Severe environmental changes are not the only way in which the adaptive relationship may be disrupted. Changes in the characteristics of an adapted organism itself, in the absence of significant environmental alteration, may have the same effect. A simple instance is spontaneous gene mutations in reproductive cells, the vast majority of which produce offspring that are not viable. Similar but more immediate circumstances occur when there is an organic failure of one of an organism's vital life systems, such as respiration or heartbeat.

The duality of organism and environment has an especially interesting character for human beings. For them, both the adapting organism and the environment of adaptation are social. Individuals have fellow creatures who constitute part of their total ecological surround and, as such, can be benign or menacing just as any aspect of the physical environment. But no person exists solely as an individual.

All are bound into some social group or another which acts in an organized way to provide the means of life for its members. In many regards then it is this entire social group that functions as the adapting organism. For humans and a few other social animals, therefore, the social group is involved in both sides of the environment-organism duality.

The social mode of adaptation for humans is especially distinctive for the extent to which their adaptive behavior is guided by the habits, prescriptions, values, and knowledge of their culture rather than by biological structure or instinctive patterns of behavior. Such social guidelines serve to coordinate the behavior of the group in ways that generally allow individuals to fulfill their basic needs more nearly completely than they, acting alone, can. In this fashion the social group amplifies the power of the individual to attain adaptive goals.[6] Donald T. Campbell, for instance, has described the adaptive advantages that a few simple social values and norms might confer on early gregarious humans as they skirted the ragged edge of survival.[7] Honesty and trust, at least within the group, would allow efficient communication so that individuals could share the experiences of others without having to endure personally each learning situation. Altruism and group loyalty would make possible mutual defense—an organized group can rout a predator that would dispatch an individual easily. Industriousness and specialization would permit a division of labor in which the total output of the group could become more than the sum of what each individual could accomplish alone. The traditional moral imperatives against killing, stealing, and so on, along with such cultural universals as the incest taboo, serve the social group by maintaining its cohesiveness.[8]

Knowledge, in contrast to values and norms, provides similar advantages. Indeed science and technology themselves provide the clearest examples of how socially organized information about the natural world can be used to develop tools and techniques that alter the environment and humans' behavior in the environment in ways that can further the adaptive relationship. This process has been so successful in some industrialized countries that basic adaptation issues are far removed from the awareness of many of their residents—food, shelter, clothing, and health are things they take for granted.

Individual motives and strivings need not be consciously directed toward adaptation in order to meet its demands. The focus of much of our everyday attention and, for that matter, much of the attention of social science is upon the gratification or distress that accompanies our experience. Freud, for example, asserted that what people seek in life "can hardly be in doubt": "They strive after happiness; they want

to become happy and to remain so. This endeavor has two sides, a positive and a negative aim. It aims, on the one hand, at the absence of pain and unpleasure, and, on the other, at the experiencing of strong feelings of pleasure."[9] Averaged over many instances and many individuals, pursuing gratification and avoiding pain generally result in behavior that is adaptive. This surely is no coincidence. Pleasurable feelings often are aroused when we accomplish something of biological value such as eating. In this case we might speculate quite reasonably that the correlated sensations of pleasure reflect the trial-and-error evolution of a nervous system shaped by the demands of survival. For example, in an environment where sweet substances, such as ripe fruit, are a regularly recurring, nutritionally sound foodstuff natural selection produces a taste system that "prefers" sweet substances to other potential edibles. Seeking the pleasure of the taste becomes an adequate substitute for seeking nutritional foodstuff; the taste buds become vicarious representations of the environment.[10] From this view sensory pleasure constitutes an internal signal that certain adaptationally satisfactory conditions have been obtained, just as physical pain indicates adaptationally unsatisfactory conditions. To be guided by those signals then is generally to exhibit adaptationally successful behavior.

The behavior of human beings, of course, is not guided solely by simple biological sensations of pleasure and pain; reason, personality, values, and the preferences of others in the social group all have their influence. As with biological pleasure and pain, we can ask if these influences reflect, even partially, the demands of adaptation. It is plausible that they do in many instances, particularly in the case of those influences associated with the social group.[11] The values and norms of the group and the social rewards granted to actions that express those values are part of the system of social control that coordinates group behavior. The social mode of adaptation depends upon such coordination, and its minimal result is to nudge group activities in the direction of adaptive action or, at least, steer it away from severely maladaptive practices. To those who function within the prescribed range of behavior the society provides rewards and gratification in the form of social approval if not something more tangible. Thus even without much biological basis pursuing social rewards, like pursuing biological rewards, is often tantamount to seeking adaptational competence.

The immediate and controlling goals of much of our everyday activity, therefore, are various forms of biological and psychosocial gratification. But behind that gratification stand a biological and a social system arranged by necessity so that, while seeking those goals, the

demands of adaptation are met. To say, as Freud does, that people strive after happiness is correct, just as it is correct to say that a racing greyhound chases the mechanical rabbit. But it omits mention of the broader drama in which securing pleasure, like nabbing the rabbit, is not really the point. The prerequisite of life is that organisms strive, consciously or unconsciously, for competence—successful coping with the environment.[12] As George Allen, former coach of the Washington Redskins, put it, "We are not here to be happy; we are here to be tested."

Of humans' various biological and psychosocial characteristics there is one very important aspect that goes beyond the issues of immediate survival or simple adaptation that have been discussed so far. Continued survival requires not only adaptation but the ability to remain adapted when circumstances change; continued survival requires flexibility as well as the satisfaction of immediate needs, what Edgar S. Dunn, Jr., calls adaptability.[13] Dunn's account of adaptability greatly increases the range of actions that can be brought into an adaptational context.

A simple but basic sort of adaptability, of course, is provided by the relatively undifferentiated and unspecialized body structure and, for that matter, brain structure of human beings. But adaptability is also nourished by creativity, intelligence, dissent, tolerance, knowledge production, and all those other behavior forms which, while perhaps of little immediate adaptive advantage, contribute to the capability of the individual and the society to cope with unknown future circumstances. Because the cultural resources appropriate to the future cannot be predicted with certainty and because specifying the direction in which creativity is to be expressed is to stifle creativity, there is long-term advantage not only in tolerating but in encouraging those expressions of human ingenuity and playfulness that are not demonstrably dysfunctional. Such encouragement nurtures the innovations that become the basis for further adaptive change in the social system.

Adaptability is humankind's prime advantage in having behavior guided as much by social values and knowledge as by fixed biological or genetic structure. Achieving that advantage, however, requires cultural rather than biological transmission between generations. The cultural transmission of knowledge and values, in turn, requires that neophytes to the society be receptive to the transmitted information. There can be no doubt that humans are sufficiently receptive. Unlike other animal young, human infants are capable of little except learning and they remain in that dependent but receptive condition for an unusually long period. The result is one of the more conspicuous

characteristics of human beings—their development of behavior patterns distinctive to their society rather than patterns distinctive to their species as with other animals.[14]

The receptivity of humans to the values, knowledge, and behavior patterns extant in the culture extends as well to the attribution of meaning to experience in that culture.[15] Unlike the other animals with their complement of instincts and perceptual releasers for whom we can imagine that every rustling leaf and stalking predator has intrinsic "meaning," humans derive both meaning and their own character from interaction with the world in the context of their culture's interpretation of those interactions; unlike the stickleback fish, people must be told the meaning of a red belly. Human beings have no a priori, genetically given structures to which to assimilate most of the world—they are prepared to receive it in whatever form it is presented.[16] The facile responsiveness of humans to behavior patterns, knowledge, values, and even the meanings of their culture shows them to be the most impressionable of all species. Social chameleons, the human creatures readily take on the characteristics of their own social surround, often lacking the means or the will to determine the validity of those social forms. In particular, infants and children, the prime targets of much social influence, experience society's images at a time when they are equipped by neither intellect nor experience to dispute them.

From an adaptational perspective, therefore, four broad and interrelated sets of issues are central to human existence. In shorthand we might label them (1) adaptation, (2) competence in contrast to pleasure, (3) adaptability, and (4) human impressionability in contrast to fixed human nature. Adaptation signifies the "fit" between organism or society and environment, a fit that can be compromised by deleterious changes in either. Successful adaptation reflects a conscious or unconscious striving for basic biological and social competence by individual participants whose survival and well-being depend upon adequately coping with the environment. But successful coping is guided often by feelings of pleasure or satisfaction and not any explicit recognition of the underlying adaptive advantages. Adaptability, on the other hand, encompasses those behaviors and conditions that serve to keep the individual and the society flexible and open to change. In this domain fall the development of art and scientific knowledge, the fostering of individual growth to creative potential, social tolerance, diversity, freedom, dissent, experimentation, and other such "democratic" activity.[17] Humans' facile adaptability is made possible by a basic impressionability, particularly early in life, which results in humans mirroring the forms of their society, however those forms may be patterned.

Current evaluations of the social effects of technology invariably appeal either to basic survival itself or to some concept of the "good life" that reflects, at the minimum, simple adaptation. When these concepts are located in a broader adaptational context, their implications for the control of technology become clearer and more extensive. What follows is a preliminary attempt to examine technology from an adaptational perspective and to extract some general criteria by which technological impact on society may be assessed.

Some Implications for the Assessment of Technology

The National Academy of Sciences' 1969 report on the assessment of technology deplored the "relatively narrow frame of reference for evaluation" within which the processes of assessment usually take place. It noted: "In the formulation of issues for assessment and in the attribution of value to alternative outcomes, those [assessment] processes too often ignore the broader social and environmental contexts in which their effects are felt."[18] The Academy attributed those shortcomings chiefly to conceptual and institutional problems. It is proposed here that an adaptational perspective on human functioning offers some conceptual advantage both for identifying important issues relevant to technology assessment and for determining the value stance from which those issues should be considered. We can explore this claim by drawing some implications for evaluating technological applications from each of the four overlapping notions previously labeled adaptation, competence, adaptability, and impressionability.

Adaptation. Though most current commentary on technology deals with the fundamental issue of immediate adaptation, that concept is rarely explicitly recognized. Doing so emphasizes the two different sides of the issue. The duality implied by adaptation—the physical and social environment to which adaptation is made on the one hand and the organism or society of organisms making the adaptation on the other—calls attention to the two somewhat separable domains within which technology may have effects. Technology may alter the environment positively so that adaptation to it becomes easier or negatively so that adaptation becomes more difficult or impossible. Similarly, technological change may affect human beings or human society favorably so that they are more capable of adapting to the existing environment or unfavorably so that they are less capable of such adaptation.

Defenders of technology can point to beneficial technological achievements in both categories. Beginning many centuries ago, human beings, aided increasingly by technology, began transforming

the face of the environment to make it easier to get along with. Farm lands have been cleared, waterways constructed, mountains leveled, rodents exterminated, and sanitation improved. Houses, skyscrapers, airports, and telephone poles were added to the landscape, which was crisscrossed with roads and railroad tracks. Oil, hydroelectricity, and nuclear reactors have released previously unknown energies into the environment, and cloud seeding, air conditioning, and plastic domes have brought local change even to the climate.

Concurrently, technological innovation on various fronts has improved humans' ability to adapt. Immunization, surgery, artificial organs, pharmaceuticals, and, maybe soon, genetic engineering have increased the hardiness of our bodies and the likelihood of restoring them after trauma. Warm clothing, scuba gear, and space suits have expanded the range of environmental conditions we can tolerate, and tools, machines, and vehicles have given us expanded motor behavior. Computers and information archives have augmented our mental abilities and electron miscroscopes and hearing aids amplified our perceptual powers. Television, telephones, and radio have provided increased communication range, while the pill has given us control over evolution's most important process, reproduction.

Critics of technology, on the other hand, have little difficulty showing that its effects while making the environment more livable in some ways have made it less livable in others and that while making humans more adaptive in some ways in others it has made them less adaptive. Smog, water pollution, nuclear wastes, noise, and the proliferation of carcinogens, not to mention the hazards of automobiles, aerosol sprays, and plastic explosives, have made the physical environment increasingly dangerous. More broadly the exhaustion of resources, inadvertent changes in climate, disruption of food chains, extinction of species, and shortage of wilderness have begun in some instances to make the natural ecology threateningly unstable.

Institutional controls and evaluations of technology in recent years have been concerned almost exclusively with this latter category of adaptive issues involving deleterious environmental effects. The actions of the Audubon Society, Food and Drug Administration, Wilderness Society, and Sierra Club provide well-known examples. The United Nations Conference on the Human Environment which met in Stockholm in 1972 was directed largely toward the issue of environmental effects.[19] The 1969 National Environmental Policy Act (NEPA), while making some mention of "unquantified environmental amenities and values," is concerned almost entirely with physical degradation of the natural environment.[20] The legislation creating the Office of Technology Assessment in 1973 cited as one purpose secur-

ing "information concerning the effects, physical, economic, social, and political, of the applications of technology," but, though its actual operating mode seems somewhat unformed, its top priority, too, appears to be investigation of potentially traumatic environmental impact.[21]

A lesser amount of systematic institutional attention has been given to assessing the negative effects of technology on humans' ability to adapt. Concerns in this category, however, are readily identified. While medical science protects and restores bodies, it may also weaken the human gene pool by allowing the survival and reproduction of those with genetic defects. Its pharmacology has produced drugs in widespread use that addict and dehumanize their users. The mass communication media have raised expectations and inculcated commercial values that cannot possibly be met in a world of limited resources. Electronic surveillance, data banks, and techniques of behavior control have the potential to foster a static conformity ill suited to a rapidly changing world. And finally the possibility that humans will become thoroughly alienated from a world in which they have diminished responsibility threatens the social solidarity and cultural cohesion that have been some of their prime modes of adaptation at least since the days of the primitive big-game hunters.[22]

Not only is the mode of adaptation for humans social, but the environment of adaptation is largely social as well. One clear threat to the quality of the social environment is population expansion and the constraints that the consequent crowding and competition for resources produce. The use of technology also must take into consideration other influences on the social environment. Good social design should foster adaptation to the social milieu by helping achieve harmonious and gratifying social relations and helping avoid the social dysfunctions represented by rising crime rates, terrorism, random violence, rampant unfriendliness, and warfare.

Of potentially great importance for indexing the quality of social adaptation would be a demonstration that many aspects of social experience have direct physiological or "health" correlates, thus making their empirical assessment much easier. Psychosocial stress, for example, has been shown to result in various symptoms of physiological deterioration.[23] Crowding, in animals at least, has been related to clear-cut mortality changes and physical degeneration, and there is at least some weak evidence that the quality of an individual's social relationships may manifest itself in physiological symptoms.[24]

Recognizing that the concept of adaptation is at the core of many current concerns about the effects of technological applications thus has several advantages over existing, less systematic formulations. It

distinguishes between the effects of technology on the natural environment and its effects on the ability of human beings to cope with the environment and thus facilitates a more comprehensive evaluation. Furthermore, it calls attention to humankind's total ecological surround and emphasizes the need to evaluate the effects of technology on humans' adaptation to the social environment, their fellow human beings, as well as to the physical and biological environment.

Competence. Coping successfully with the environment is a demonstration of adaptive competence, but, as I have noted, it is often attained by seeking not competence but some form of gratification, Freud's "happiness." When such feelings are associated with adaptive behavior, pursuing gratification, whether biological or psychosocial, amounts to the same thing as pursuing competence, even though the source of the pleasurable feelings may be distinctively secondary when their evolutionary history is taken into account.

Great danger lurks in this situation, where physiological and psychosocial rewards provide the tokens for which people labor in a game whose ultimate issue is adaptive competence. If the correlation between actions that result in pleasure and genuinely adaptive behavior breaks down, the organism that continues to pursue pleasure becomes increasingly maladapted; the pleasure indicator no longer reliably signals the performance of adaptive behavior. In an environment of lollipops and chocolate, seeking taste-bud pleasure guides one to rotten teeth, not ripe bananas.

The products of a technological society have intruded into the physiological pleasure system in ways that are both beneficial and harmful. For example, birth-control technology has allowed the separation of the pleasures of sex from the hazards of a reproduction rate that fosters dangerous population expansion. And communication technology has made possible enriched auditory and visual experiences that fuel imagination, inform thinking, and extend awareness while posing none of the problems, limitations, and potential perils of actually experiencing the events represented.

On the other hand, technology's methods in many cases have short-circuited the connection between the response of our senses and adaptive behavior. Highly processed foods, while still acceptable to our obsolete taste buds, are often proving less adequate to good health than what our ancestors consumed hundreds of years ago. Technology has made possible the use of sexual enticements to sell toothpaste and other less necessary commodities and allowed the mass production of drugs that dupe the naive into experiences of paradise while the body atrophies. And, as N. Tinbergen has noted, technolog-

ical warfare and violence have put so much distance between killer and victim that what few inhibiting sensitivities humans possess may have been disengaged effectively from the experience.[25]

The danger of slippage between gratifying behavior and adaptive response is not limited to physiologically based pleasure sensations. In the way that eating can be directed to pleasure rather than nutrition, engaging in less biologically basic behavior can be directed toward obtaining social rewards and approval from other members of the cultural group. Since the values and norms upon which giving such rewards is based are often transmitted culturally without realization of their adaptive significance, it is possible for social rewards, like pleasure signals, to guide individuals in behavior that is no longer adaptive because of changed circumstances.

The increased rate of technologically induced social change within the last century may have left us on the verge of a technologically inspired breakdown in the correlation between the values and behavior to which we are socialized and the requirements of adaptive behavior. Like taste buds that no longer guide us to ripe fruit, some cultural values that were shaped in contexts that no longer exist have been handed down uncritically with the carrot of social approval for those who comply with them. The tribal hunting society has left us ethnocentrism and aggression, perhaps necessary once but now administered with devastating technological might in a nuclear world carved into vestigial hunting territories. It may have been that same hunting society which originated the concept of the subservient role of women conveyed still to a contemporary society in which it no longer makes any particular sense. The legacy of the agricultural society is a work ethic in a (Western) world that will soon have little work to be done and an acquisitiveness for multiple automobiles and electric can openers when all we started out keeping was the season's harvest for the coming winter.[26]

The evaluation of technology's effects on humanity therefore should take into consideration at least two aspects of human competence that are relevant to human adaptation. First, the possibility that there is a dysfunctional misuse of human physiological equipment should be examined. To defeat or override the evolutionarily derived "purposes" of the human nervous system may be to reduce dangerously its power to cope with an increasingly complex world. Second, it must be asked if an innovation is likely to be assimilated to an extant cultural value or behavior pattern which will become dysfunctionally transformed in the process. Many adaptationally tolerable human behavior patterns have become perilous when amplified by technology's power.

Adaptability. In an era of such rapid change that an item of military hardware can become obsolete between the time it is designed and the time it is constructed, any evaluation of technological innovation must take into consideration more than the consequences for immediate adaptation. Humanity's continued survival, especially continued comfortable survival, depends upon retaining the capacity to change in the face of unknown, unpredictable developments. On these grounds any technological affair is to be negatively valued, irrespective of its present utility, if it forecloses the use of potentially important modes of adaptation or if it too sharply circumscribes the cognitive, social, cultural, biological, and geographical diversity that is the seedbed of new forms of adaptive behavior. Moreover, given the rapid pace of change, technological development must be guided not simply to avoid constraining possible future response but to create and foster those conditions under which maximal flexibility and adaptability are maintained. Chief among those conditions may well be a slowing of the pace of change itself lest we reach the point where events overtake our ability to react.

Technology's contributions to adaptability are impressive, but so too are the limitations it has produced. Science and other research and development activities have facilitated the creation of a growing store of knowledge about the natural world that greatly transcends existing applications. It has provided information storage and processing capability for ready reference and use of those knowledge resources and communication systems to disseminate information widely and rapidly. Technological advances have helped make possible universal education and the leisure time to profit from it. They have created cultures in which diverse cognitive and social activity may be undertaken even though no contribution is made to primary production and have expanded the potential participation of citizens in the political process. Technology has helped make the future more predictable, has made available new and varied sources of energy for whatever tasks the future requires, and has diversified even the gene pool of many plants and animals through hybridization and selective breeding.

On the other side of the ledger, technological influence has in many ways reduced human flexibility to respond to change. It is responsible for a rate of change almost too rapid for response and for a population density and scarcity of resources that may foreclose irreversibly many routes of potential adaptation. It has given rise to a culture of highly specialized persons who are dependent on others for their simplest needs and thus extremely vulnerable to any disruption of the existing social patterns. In many domains technological developments

have emphasized function and efficiency to the detriment of creative diversity, and they have made nearly possible the enforcement of rigid conformity in the political system and subjugation to restrictive monopolies in the economic system. Though genetic innovations have been developed through hybridization, the genes of many plants and animals have dropped from the collective gene pool through extinction, and new techniques of cloning, selection of neonates' sex, and genetic engineering threaten to reduce the diversity and hence adaptive potential of the human gene pool as well.

Perhaps most important for the wise management of technology is the maintenance of social adaptability through active nurturance of flexible and creatively open-minded human beings. The provision of those opportunities and experiences that bring individuals to their maximal intelligence and creativity produce, at the same time, a vigorous and adaptable society. Much is already known about the conditions of varied experience, child-rearing practices, and habits of attention and self-awareness that lead to the development of capable, flexible individuals and, on the other hand, those conditions which constrict or stifle that development.[27]

Social institutions should also be capable of change to meet changed circumstances. Thorson has argued that governments must be pluralistic and "democratic" in order to retain the capacity to change.[28] A. Etzioni has described the multitiered, multifaceted exercise of knowledge, decision making, control, and power required of an "active" society.[29] J. Gardner made his plea for social institutions that were capable of "self-renewal" as the basis for social adaptability.[30] And Campbell has described some of the methods an "experimenting society" might use in its attempt to develop knowledge sufficient to guide rational change.[31]

Impressionability. The diversity and to a considerable extent the adaptability of human cultures have been due in large part to the relative ease with which humans acquire the habits, values, and knowledge of the social group into which they are born. This cultural learning has made possible a range of adaptive behaviors much greater than those that could be wired in genetically. Of particular importance is the relative ease with which culturally transmitted information can be modified. Significant biological change requires thousands of generations, while under favorable circumstances significant cultural change may occur in relatively few generations. In an increasingly fast-paced society this receptivity to new cultural patterns can be an important asset.

As Dubos has observed, however, such receptivity has its dangers as

well as advantages.[32] With few genetically prewired categories of perception or responses keyed to particulars of the species-appropriate environment, the human nervous system provides no automatic (or "instinctive") recognition of crippling and distorting conditions. Humans can adapt, in the short term, to almost any environment but in so doing may change their "nature" into something far different. This might happen in two ways. First, the demands of changed circumstances can distort the behavior and values of the human beings who must comply with those demands in order to retain their ability to adapt. Humans' fluid "nature" thus allows them to become what they must, savages or saints, in order to survive. But in doing so they may lose the tolerance, creativity, playfulness, and intellectual and material resources that make them open to future changes and indeed make them human. History is replete with examples of the short-term barbarism that can be induced in various groups with application of sufficient force. The danger is that technology's power may make it possible or, inadvertently, make it necessary to sustain such effects for a much longer period.

Second, the vary nature and qualities of the forces that make demands of humans may be picked up and mirrored in the character of humankind itself. The prisoners in the concentration camps described by Bruno Bettelheim came to mimic the swagger and brutality of the guards whose caprices shaped their daily lives.[33] In a world in which technology is the shaping force intrinsic human impressionability similarly may allow a technological character to be imprinted on humanity. Ellul, one of technology's foremost critics, has warned against the danger that the "technique" of a technological society will cease to be external to humans and become their very substance.[34] With similar concern Dubos notes that in a mechanical world humans risk becoming themselves mechanical.[35] In a chaotic world, we might add, they risk becoming irrational; in a totalitarian world, authoritarian; in a hostile world, loveless; in a material world, materialistic; in a simulated world, artificial; or, as the kids say these days, in a plastic world, plastic.

By the same reasoning, if we want a world of biologically and psychologically healthy people, creative and competent, we must create social forms that reflect those same characteristics. This requires any plan for managing society and technology to embody prior conceptions of the nature of the society and the character of the participating human beings which are desired. We must consciously design, along with the design of technological innovations, a world which, through its demands on us and by its intrinsic nature that we may

come to reflect, produces healthy, competent, adaptable human beings of the sort we autonomously would wish to be.

The Lamarckian Alternative

Understanding human adaptation by and large is the wisdom of hindsight. The forces that shape the continuing human relationship to the social, biological, and physical environment often seem beyond the ken of the participating individuals and produce effects that may be realized in retrospect but rarely are anticipated. With regard to technology the situation takes on an element of irony, for the shaping force itself has arisen unawares from the collective behavior of its victims. Perhaps it is an exercise of fantasy to suppose that it might be possible to anticipate the human effects of technological applications, assess them against both obvious and subtle requirements of continuing adaptation, and choose to forgo those that show potential for distorting or restricting adaptive human development. Such regulation would require levels of understanding, judgment, foresight, and social restraint well beyond what humans have exercised collectively in the past. It would require that we replace much of the blind, trial-and-error groping of our Darwinian social evolution with the foresightful, purposive, and self-creating processes of a Lamarckian social evolution—a formidable task but one that is beginning to look like the only hope.

NOTES

1. National Academy of Sciences, "Technology: Process of Assessment and Choice" (Report to the Committee on Science and Astronautics, U.S. House of Representatives, July 1969); excerpts reprinted in J. G. Burke, ed., *The New Technology and Human Values* (Belmont, Calif.: Wadsworth Publishing Co., 1972), pp. 255–66.

2. E.g., Jacques Ellul, *The Technological Society* (New York: Vintage Press, 1964); Lewis Mumford, *The Myth of the Machine* (New York: Harcourt, Brace & Co., 1967); Herbert Marcuse, *One-Dimensional Man* (Boston: Beacon Press, 1964); René Dubos, *Reason Awake: Science for Man* (New York: Columbia University Press, 1970); Theodore Roszak, *Where the Wasteland Ends* (Garden City, N.Y.: Doubleday & Co., 1973).

3. Donella H. Meadows et al., *The Limits to Growth* (New York: New American Library, 1972); M. Mesarovic and E. Pestel, *Mankind at the Turning Point* (New York: E. P. Dutton & Co., 1974); Robert L. Heilbroner, *An Inquiry into the Human Prospect* (New York: W. W. Norton & Co., 1974).

4. See, e.g., P. R. Ehrlich and A. H. Ehrlich, *Population, Resources, Environment* (San Francisco: W. H. Freeman & Co., 1970).

5. T. L. Thorson, *The Logic of Democracy* (New York: Holt, Rinehart & Winston, 1962).

6. See also the discussion of Edgar S. Dunn, Jr., *Social and Economic Development* (Baltimore: Johns Hopkins Press, 1971).

7. Donald T. Campbell, "Ethnocentrism and Other Altruistic Motives," in *Nebraska Symposium on Motivation,* ed. M. R. Jones (Lincoln: University of Nebraska Press, 1965); idem., "On the Genetics of Altruism and the Counter-hedonic Components in Human Culture," *Journal of Social Issues* 28 (1972): 21–37.

8. An especially provocative elaboration of this point is provided by B. Gert, *The Moral Rules* (New York: Harper & Row, 1970).

9. Sigmund Freud, *Civilization and Its Discontents* (New York: W. W. Norton & Co., 1961).

10. This argument is derived from Donald T. Campbell's "Evolutionary Epistemology," in *The Philosophy of Karl Popper,* The Library of Living Philosophers, ed. P. A. Schilpp (La Salle, Ill.: Open Court Publishing Co., 1974), 14: 413–63.

11. Similar cases are made, e.g., by Dunn (n. 6 above) and C. H. Waddington, *The Ethical Animal* (Chicago: University of Chicago Press, 1960).

12. See also R. White, "Motivation Reconsidered," *Psychological Review* 66 (1959): 297–330.

13. Dunn (n. 6 above).

14. Numerous supporting examples regarding even seemingly biological behavior are provided by Clyde Kluckhohn, "Culture and Behavior," in *Handbook of Social Psychology,* ed. G. Lindzey (Reading, Mass.: Addison-Wesley Publishing Co., 1954), pp. 921–76.

15. See also the discussion by P. Berger and T. Luckmann, *The Social Construction of Reality* (Garden City, N.Y.: Doubleday & Co., 1967).

16. E. Becker, *The Structure of Evil* (New York: George Braziller, Inc., 1968), chap. 9, gives a much richer discussion of this aspect of human existence.

17. Thorson (n. 7 above) describes the important relationship between flexibility and democracy.

18. National Academy of Sciences (n. 1 above), p. 264.

19. A summary of the principles adopted by that group appears in D. Medford's *Environmental Harassment or Technology Assessment* (New York: Elsevier Publishing Co., 1973), pp. 338–52.

20. Also summarized in ibid., pp. 16–31.

21. The original bill is reproduced in ibid. pp. 58–91; "News and Comment," *Science* 179 (1973): 875–77.

22. For one such diagnosis of the troubled modern spirit, see R. N. Goodwin, "Sources of the Public Unhappiness," *New Yorker* (January 4, 1969), pp. 38–58.

23. H. Selye, *The Stress of Life* (New York: McGraw-Hill Book Co., 1956).

24. See e.g., R. Ashmore and J. McConahay, *Psychology and the Urban Dilemmas* (New York: McGraw-Hill Book Co., 1973), chap. 2, and L. Phillips, *Human Adaptation and Its Failures* (New York: Academic Press, 1968), chaps. 12 and 13.

25. N. Tinbergen, "On War and Peace in Animals and Man," *Science* 160 (1968): 1411–18.

26. Consider, e.g., the trends extrapolated by Daniel Bell, *The Coming of Post-Industrial Society* (New York: Basic Books, 1973).

27. See, e.g., J. Gardner, *Self-Renewal* (New York: Harper & Row, 1963).

28. Thorson (n. 5 above).

29. A. Etzioni, *The Active Society* (New York: Free Press, 1968).

30. See n. 27 above.

31. Donald T. Campbell, "Methods for the Experimenting Society" (paper delivered to the American Psychological Association, September 5, 1971).

32. René Dubos, *So Human an Animal* (New York: Charles Scribner's Sons, 1968).

33. Bruno Bettelheim, "Individual and Mass Behavior in Extreme Situations," *Journal of Abnormal and Social Psychology* 38 (1943): 417–52, and *The Informed Heart* (Glencoe, Ill.: Free Press, 1960).

34. See n. 2 above.

35. Dubos, *So Human an Animal.*