

TREND IS NOT DESTINY

by René Dubos

People who are worried about where Western civilization is heading usually ask, "Where is technology taking us?" They should begin to ask, "Where do we *want* science and technology to take us?"

I was raised in farming villages of the Ile de France, close to Picardy and Normandy—on a land which has been under cultivation for some 4,000 years. It is a beautifully humanized land, very different from the primeval forest out of which it was shaped by neolithic and medieval farmers. It remains highly fertile despite 40 centuries of intensive use. It supports a great variety of human settlements—hamlets, towns, and cities—in which human life continues to evolve culturally and to enrich civilization.

These observations on my native country apply just as well, of course, to other parts of the world. Many ancient lands of Europe and Asia remain beautiful and fertile despite the constant pressure of high population densities over more than a thousand years. Even in North America, some of the most attractive and prosperous farmlands are found in areas that have been continuously under cultivation since they were created out of the forest three centuries ago, for example in the Pennsylvania Dutch country. All over the world man has thus been able to transform the wilderness into lands that are ecologically sound, economically profitable, and propitious to the development of civilization. With proper care, furthermore, such humanized lands and the villages, towns, and cities they nurture can be maintained in a healthy state seemingly forever.

And yet! Human history is replete with ecological disasters; the most famous places of antiquity seem to have been struck by a kind of malediction. Mesopotamia, Persia, Egypt, West Pakistan were once the seats of flourishing civilizations which remained powerful and wealthy for long periods of time, but they are now among the poorest countries of the world. Their lands are desert, many of their ancient cities abandoned; and most of their people are so poor, malnourished, and diseased that they have no opportunity to become aware of their magnificent past. Since much the same is true for large parts of India, China, Southeast Asia, and Latin America, there is extensive evidence for the thesis that all civilizations are mortal. Prolonged occupation by large numbers of men has caused in most cases a wearing out of the land through overuse or misuse, and a destruction of human settlements through civil strife, warfare, famine, and disease.

Unwise management of nature, technology, and human life can destroy civilization in any climate and land, under any political system.



*René Dubos, Professor of The Rockefeller University, Department of Environmental Biomedicine, is a microbiologist and experimental pathologist with a distinguished career in medical research. His intense concern with the effects that environmental forces exert on human life has involved him in the socio-medical problems of underprivileged communities, as well as in those created by economic affluence in industrialized countries. Dubos is well known as a lecturer and author and received the Pulitzer Prize in 1969 for his book *So Human an Animal*. "Trend Is Not Destiny" is adapted from a talk given by Dubos at a Conference on Technological Change and the Human Environment, held at Caltech October 19-21.*

These contrasting views of the relationships between civilization and the environment may not be as incompatible as they appear to be. All great Eastern civilizations which have died along with their worn-out lands were located in arid and semiarid zones. Their demise has been attributed to the fact that, in these parts of the world, agriculture depends on continuous irrigation which—slowly but almost inexorably—causes irreversible damage to the land. In contrast, Western Europe and Japan (and certain other parts of Asia) are blessed with a much greater and more constant rainfall, which enables the land to recover rapidly even when it has been impoverished or damaged by ecological mismanagement.

Climatic conditions, however, cannot entirely account for the sudden disappearance of the Maya, Khmer, and other great civilizations that once flourished in tropical, humid countries. Nor do they account for the rapid deterioration of land, air, water, and cities that is now occurring in many parts of the technological world, irrespective of soil and climatic conditions. Unwise management of nature, technology, and human life can destroy civilization in any climate and land, under any political system.

But there have been many forms of human interventions into nature that we regard as having had beneficial effects. Ever since neolithic times and all over the world, social institutions have created artificial systems which have proved ecologically sound and humanly desirable.

Much of the world in temperate climates used to be covered with forests and marshes which were progressively converted into farmlands—each area developing its own agricultural specialization, social structure, and esthetic quality. The process of change, furthermore, continues as new technical or human needs develop. For example, the enclosure landscapes, so characteristic of eastern England and of French Picardy, are entirely man-made. They were created a few centuries ago for very special agricultural and social reasons.

The temperate forest can undergo desirable humanized transformations other than being converted into farmlands. In Europe parts of the primeval forest have remained forests, but have been carefully cropped and managed for several centuries without decreasing productivity in timber. In Scotland and eastern England, lumbering and grazing slowly pursued over several centuries have progressively transformed forests into moors, which may not be economically productive but have added romance and poetry to English literature. In the United States, fires

set by the preagricultural Indians converted part of the primeval forest into the prairies.

These few examples illustrate that man has often created new and desirable environments by accidental or willful interventions into nature. I repeatedly use the word *desirable* to acknowledge my anthropomorphic attitude in ecologic judgments. Ecologic purists notwithstanding, I believe that in the final analysis all ecology is anthropomorphic. When the ecologist laments that modern technological civilization transforms urban areas into environments which are fit only for rats, roaches, and ragweeds, he obviously judges the situation from man's point of view, not from that of rat, roach, or ragweed. Except in the case of absolute wilderness, most of the earth's surface has now been transformed by human activities to serve human ends. In this sense, man is a component of ecological systems; ecology is to a very large extent human ecology. The problem is not whether man will or will not transform nature, but how he will do it. Sound ecological management always implies long-range considerations so as to maintain nature—humanized nature—in a condition suitable for the welfare of generations to come.

Man's interventions into the natural world have progressively led to technological civilization, which in turn has brought about the present environmental crisis. But this unfortunate course was not inevitable and is only the consequence of failure to understand the role of technology in human life.

This role includes the choice of goals, which is as important a part of technology as is the development of tools and methods. Increasingly, however, the technological enterprise proceeds as if its end were growth for growth's sake rather than human welfare. The environmental problems of industrialized societies are largely the product of undisciplined technological growth; they do not arise from technology per se, only from man's surrender to its destructive demon.

The present popularity of ecological thinking is due to the widespread awareness that many things that can be done should not be done because they threaten the quality of our life and our environment. The most important problem today is not to produce more goods and services but rather to reorient technological activity toward the satisfaction of real human needs.

The guidebook to the Chicago World's Fair of 1933 provided an interesting illustration of the extent to which many reasonable and well-meaning people believe that man exists for the sake of technology rather than vice versa, thus implicitly but unconsciously accepting goals that are incompatible with the welfare of mankind. On the assumption that technological development is the same thing as human progress, the writers of the guidebook confidently affirmed that "all races would fall in step with . . . science and industry"; they summarized this shocking social philosophy with the formula

Science finds
Industry applies
Man conforms.

Acceptance of the view that man will *fall into step* and will *conform* implies that we must adjust to the environment as created by industry, instead of designing living conditions and environments really suited to man's nature.

Environmentalists are often accused of being soft-headed and unrealistic daydreamers when they assert that continued technological growth is incompatible with the maintenance of a world suitable for man, unless it is redirected to more suitable goals. Fortunately, there are built into the physical world certain constraints that will inevitably limit technological growth. Shortages of natural resources are the most obvious of these constraints. But the availability of power will almost certainly be the first limiting factor, even if new kinds of low-cost fuel become available and if the production of clean nuclear energy by fusion becomes technologically possible. The limitation will come, not from shortages of energy sources, but from the fact that the injection of excessive amounts of energy into natural systems inevitably disturbs their operations and commonly leads to ecological upsets resulting in unpleasant living conditions.

The population avalanche is, of course, one of the important factors in the ecologic crisis, but it is not the most immediate danger in the countries of Western civilization for the following reasons. The population of the United States is increasing at a rate of approximately 1 percent a year. In contrast, the consumption of electric energy and the accumulation of wastes are increasing at the rate of 6-8 percent a year—which means that they will double in less than ten years! In view of these facts, environmental degradation and loss in the quality of life will continue to accelerate very rapidly in the United States even if we succeed in achieving zero population growth, which is a practical impossibility for several decades.

The impact of technology constitutes a more immediate threat to the quality of human life than the population bomb, and it will be far more destructive in the long run because many of its effects will be irreversible.

The impact of technology therefore constitutes a more immediate threat to the quality of human life than the population bomb, and it will be far more destructive in the long run because many of its effects will be irreversible.

The present trends of technological civilization are clear enough for anyone to see, and even the village fool knows that maintaining them would lead to the destruction of mankind. And yet the writings of sociologists or technologists rarely reflect awareness of this fact.

Futurists write learned books and fanciful articles about the mechanized and synthetic world of the year 2000. But direct extrapolations from the present into the future have a very low order of probability. Indeed, history gives little support to the current belief that the technological forces set in motion during the past few decades will shape the rest of our lives.

It is wise to remember, for example, that the sophisticated administrative structure of the Roman Empire was rapidly upset by the meek Christians and then by the uncouth barbarians; that the overambitious towers and ogives of Gothic cathedrals were rejected by the Renaissance architects; that the academic art and bourgeois conventions of 19th-century France were destroyed by a small band of Bohemians in Paris.

Time and time again the logic of historical and technological trends has had to yield to the choices and decisions of individual men. Similarly, one can anticipate that changes in life style, and the influence of a few strong personalities—and perhaps acts of collective sabotage—will direct our civilization into channels incompatible with the predictions of technocratic futurists, based as they are on extrapolations from present trends. Furthermore, it is almost certain that the kinds of scientific and technological knowledge now being

developed will have much less influence on the future course of civilization than the new kinds of knowledge and the new ways of life we shall have to develop if we are to overcome the ecologic and social dangers now threatening mankind.

Stating the problem in its most general way, it is certain that all ecological systems, whether man-made or natural, must be managed in such a way that they are self-regenerating with regard to both energy and materials. We cannot afford to delay much longer the development of a nearly closed system—a dynamic steady state—in which materials will retain their value throughout the system by being recycled instead of discarded.

The concept of “dynamic steady state” is so different from the social philosophy of endless quantitative growth which has guided Western civilization during the past two centuries that it will certainly cause public alarm—a fear that it spells stagnation eventually to be followed by decadence. Yet a dynamic steady state is compatible with *creative* changes of a qualitative nature, provided we accept a reorientation of the scientific and technological enterprise.

The present trends of technological civilization are certainly destructive; but they are not irreversible. On many occasions in the past, the course of social events has been changed by willful acts; this has occurred even in the very recent past, for example, during the two world wars and the space race. Men need not be passive before the technological enterprise. Trend is not destiny.

But a range of qualitative changes are made imperative by the environmental crisis and demand creativeness from ecologists, technologists, and social planners. For example, the use of the land is governed at present by the crassest economic considerations instead of by biological common sense. We must learn to recognize the limitations and potentialities of the land in the various areas of the earth. Since we have enormous latitude in changing the face of the earth, we can, unfortunately, expect that hasty and massive transformations of the earth's surface will occur frequently in the near future. A new kind of ecological science is therefore needed to provide rational guides as substitutes for the empirical and unconscious adjustments that the lapse of time used to make possible in the past.

Classical ecology will not be sufficient. The traditional ecologist tends to be satisfied with studying the natural evolution of systems toward their state of

equilibrium—what he calls a climax or mature ecosystem. But in reality the concept of ecologic climax is a postulate that hardly ever fits reality. Final and stable ecological communities are exceptional in nature; ecological systems continuously change, even under natural conditions.

All over the world, natural ecosystems are being destroyed by human activities, and yet human intervention need not be ecologically destructive. There is strong evidence that, in the past, developmental ecosystems (as contrasted with climax and deteriorating ecosystems) have resulted from careful agricultural husbandry. The ancient civilizations that have survived and become wealthier with time are probably the ones which learned, empirically, to manage their ecosystems according to a developmental pattern.

Traditional ecology must be supplemented by the kind of knowledge that will help to predict the likely consequences of technological and other interventions by man. One can safely assume that developmental ecology with man as a major component of the system will increasingly become more important than climax ecology.

New scientific knowledge will be needed also for creating environments really suited to man's biological and psychological needs, which are easier to understand when it is realized that the cradle of *Homo sapiens* was on the plateaus of East Africa. More than a million years ago the human species emerged in a land of hills and valleys, of springs and streams, of varied forest trees, shrubs, and herbs. Our early homes were probably alluvial plains and rock shelters in cliffs. The climate was subtropical, with alternating rainy and dry seasons and with growing and resting periods of vegetation. All in all, this was a type of landscape, vegetation, and climate that most people still associate with pleasant living conditions.

Despite the tremendous changes in the ways of life and in the technological environment that have been constantly occurring during the past 10,000 years, there is no evidence that the genetic constitution of *Homo sapiens* has changed significantly. Modern man still operates with the equipment of genes that governed the life of the paleolithic hunter during the Ice Age and of the neolithic farmer after the ice had retreated. This genetic constancy still conditions all aspects of human life and probably accounts for the fact that human tastes concerning landscape and climate still reflect the natural characteristics of the savannah regions in which *Homo sapiens* achieved his biological identity. Take, for the sake of illustration, man's temperature requirements, his response to crowding, and his need for sensual perceptions.

Temperature requirements. Physiologically, man is still a subtropical animal. Wherever he goes, he tries to

create around himself a microclimate as similar as possible to that which prevailed in his evolutionary cradle on the East African plateaus. This is true even of the Eskimos.

As the explorer Vilhjalmur Stefansson picturesquely stated in his book *The Tropical Life of the Polar Eskimos*: "During winter, the Eskimos lived in homes that were stationary tropics. When they went out of doors, they carried tropical warmth with them inside their clothes." And so do the astronauts in their space capsules. Whenever he can afford it, man is likely to seek some Mediterranean, California, or Florida shore if he can no longer cope effectively with the northern climate.

Early man was also conditioned during his evolutionary development by the diurnal and seasonal temperature cycles of the earth. These cycles are inscribed in his genetic constitution and thus govern his physiological and mental processes. The technology of air-conditioning, therefore, should be geared to the cosmic cycles reflected in man's biological nature.

Response to crowding. Man is a social animal. This suggests that early man lived in groups of fairly high density. Even when the total world population was extremely small, local population densities were commonly high. There were crowds in the paleolithic rock shelters and caves, in the neolithic settlements, in Imperial Rome, in the medieval towns, and also in the Pueblo villages. One can postulate, therefore, that most human beings are genetically capable of achieving adaptation to crowding. This does not mean, however, that they can successfully adapt to all the environmental insults which are associated with crowding in modern life. Indeed, it is likely that man will never be capable of achieving complete adaptation to stresses that the human species did not experience during its evolutionary development—such as certain forms of chemical pollution, high levels

Men need not be passive before the technological enterprise.
Trend is not destiny.

of noise (and of other unnatural stimuli), the rapid changes in population structure resulting from increased mobility, and the loss of opportunity to function as individual persons or as significant members of the group.

Much of social planning is bound to fail because it is based only on technological, social, or economic considerations, rather than on man's unchangeable biological and psychological needs.

Need for sensual perception. Recent experiments have shown that healthy human beings rapidly suffer mental breakdowns when deprived of stimuli—even when they are placed under otherwise optimum conditions. Sensory deprivation is incompatible with the maintenance of sanity and in fact results in profound and lasting disturbances of encephalographic patterns. Monotony is therefore much worse than simple boredom. Its consequences are truly antiphysiological in that they are reflected in disturbed organization of the brain and perhaps indirectly in abnormal functions of essential organs.

To live is to respond, and the diversity of stimuli thus becomes a part of functionalism in the design of human settlements. Human beings, furthermore, differ in their genetic endowment and therefore in the kind of environment most suitable to their existential expression. Diversity of environments may interfere at times with efficiency of administration. But diversity is more important than efficiency in the long run, because it provides the substratum out of which individual human beings and their societies create the multifarious expressions which exist potentially in the human species and can become expressed only when conditions are suitable.

Persons who are worried about the trends of Western civilization are prone to ask plaintively, "Where is technology taking us?" We should begin to ask instead, "Where do we want science and technology to take us?"

There probably cannot be any precise answer to this question because the future is always emergent and therefore cannot be completely planned. But we should acknowledge at least that passive acceptance of undisciplined technological growth is a form of social escapism which amounts to collective suicide. Until a few decades ago, it was still possible to believe that all technological innovations would eventually prove useful to mankind. But experience has now proven that this is not true and that as a consequence, feasibility is not a sufficient criterion for decision and action.

We must learn to regulate the interplay between man and his total environment. Unfortunately, successful regulation is far more difficult than increased production. For example, any competent engineer can learn to produce bigger and faster motor cars in ever greater numbers. But a much higher degree of technological imagination and social awareness is needed to make the automobile industry serve real human needs and values. The viability of our civilization clearly depends on a reorientation of science and technology, but such a necessity should cause no alarm about the future. One of the hopeful aspects of our times is the widespread acknowledgment that, if things are in the saddle, it is because we have put them there. And it is within our power to reverse that situation.

The general awareness of the defects in our present ways of life has already created beneath the surface a social climate that will enable the buried seeds of a richer human culture to root and grow. This does not imply that the past should be forgotten or rejected since the new growth can prosper only on the compost from many various cultures, including the technological culture. What it means, however, is that we must not consent to think of the future only as an extrapolation of present trends. Mankind will achieve salvation and continue to grow only by integrating the store of accumulated knowledge with the yearning for elemental modes of life. Scientific humanism can thus serve as a guide to technological man for a second chance to discover the good life, if he is willing to retrace the steps that led him on the dubious road that we now call progress.

Thoreau introduced his *Walden* with a statement of faith: "I do not propose to write an Ode to Dejection, but to brag as lustily as Chanticleer in the morning, standing on his roost, if only to wake my neighbors up." More prosaically, but in the same spirit, I repeat my own optimistic version of the humanistic faith: Trend is not destiny.