

PHILOSOPHY AND TECHNOLOGY

Readings in the philosophical problems of technology

edited with an introduction by

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THE LAST CENTURY, we all realize, has witnessed a radical transformation in the entire human environment, largely as a result of the impact of the mathematical and physical sciences upon technology. This shift from an empirical, tradition-bound technics to an experimental scientific mode has opened up such new realms as those of nuclear energy, supersonic transportation, computer intelligence, and instantaneous planetary communication.

In terms of the currently accepted picture of the relation of man to technics, our age is passing from the primeval state of man, marked by his invention of tools and weapons for the purpose of achieving mastery over the forces of nature, to a radically different condition, in which he will not only have conquered nature but detached himself completely from the organic habitat. With this new megatechnology, man will create a uniform, all-enveloping structure, designed for automatic operation. Instead of functioning actively as a tool-using animal, man will become a passive, machine-serving animal whose proper functions, if this process continues unchanged, will either be fed into a machine or strictly limited and controlled for the benefit of depersonalized collective organizations. The ultimate tendency of this development was correctly anticipated by Samuel Butler,¹ the satirist, more than a century ago: but it is only now that his playful fantasy shows many signs of becoming a far-from-playful reality.

My purpose in this paper is to question both the assumptions and the predictions upon which our commitment to the present form of technical and scientific progress, as an end itself, has been based. In particular, I find it necessary to cast doubts upon the generally accepted theories of man's basic nature which have been implicit during the past century in our constant overrating of the role of tools and machines in the human economy. I shall suggest that not only was Karl Marx in error in giving the instruments of production a central place and a directive function in human development, but that even the seemingly benign interpretation by Teilhard de Chardin reads back into the whole story of man the narrow technological rationalism of our own age, and projects into

Technics and the Nature of Man

Lewis Mumford

From *Knowledge Among Men*, ed. Paul H. Dehser (New York: Simon & Schuster, 1966). Copyright © 1966 by Simon & Schuster, Inc. Reprinted by permission of the publisher.

the future a final state in which all the further possibilities of human development would come to an end, because nothing would be left of man's original nature, which had not been absorbed into, if not suppressed by, the technical organization of intelligence into a universal and omnipotent layer of mind.

Since the conclusions I have reached require, for their background, a large body of evidence . . . I am aware that the following summary must, by its brevity, seem superficial and unconvincing.² At best, I can only hope to show that there are serious reasons for reconsidering the whole picture of both human and technical development upon which the present organization of Western society is based.

Now we cannot understand the role that technics has played in human development without a deeper insight into the nature of man: yet that insight has itself been blurred, during the last century, because it has been conditioned by a social environment in which a mass of new mechanical inventions had suddenly proliferated, sweeping away many ancient processes and institutions, and altering our very conception of both human limitations and technical possibilities.

For more than a century man has been habitually defined as a tool-using animal. This definition would have seemed strange to Plato, who attributed man's rise from a

primitive state as much to Marsyas and Orpheus as to Prometheus and Hephaestus, the blacksmith-god. Yet the description of man as essentially a tool-using and tool-making animal has become so firmly accepted that the mere finding of the fragments of skulls, in association with roughly shaped pebbles, as with Dr. L. S. B. Leakey's Australopithecines, is deemed sufficient to identify the creature as a protohuman, despite marked anatomical divergences from both earlier apes and men and despite the more damaging fact that a million years later no notable improvement in stone chipping had yet been made.

By fastening attention on the surviving stone artifacts, many anthropologists have gratuitously attributed to the shaping and using of tools the enlargement of man's higher intelligence, though the motor-sensory coordinations involved in this elementary manufacture do not demand or evoke any considerable mental acuteness. Since the subhominids of South Africa had a brain capacity about a third of that of *homo sapiens*, no greater indeed than that of many apes, the capacity to make tools neither called for nor generated early man's rich cerebral equipment, as Dr. Ernst Mayr has recently pointed out.³

The second error in interpreting man's nature is a less pardonable one, and that is the current tendency to read back into prehistoric times modern man's own overwhelming interest in tools, machines, technical mastery. Early man's tools and weapons were common to other primates—his own teeth, nails, fists—and it was long before he could fabricate any stone tools that were functionally more efficient than these organs. The possibility of surviving without extraneous tools gave early man, I suggest, the leeway he needed to develop those non-material parts of his culture which eventually greatly enriched his technology.

In treating toolmaking as central to the paleolithic economy from the beginning, anthropologists have underplayed or neglected a mass of devices—less dynamic but no less ingenious and adroit—in which many other species were for long far more resource-

ful than man. Despite the contrary evidence put forward by R. U. Sayce,⁴ C. Daryll Forde,⁵ and Leroi-Gourhan,⁶ there is still a Victorian tendency to give tools and machines a special status in technology and to completely neglect the equally important role of utensils. This practice overlooks the role of containers: hearths, storage pits, huts, pots, traps, baskets, bins, byres, and later, ditches, reservoirs, canals, cities. These static components play an important part in every technology, not least in our own day, with its high-tension transformers, its giant chemical retorts, its atomic reactors.

In any comprehensive definition of technics, it should be plain that many insects, birds, and mammals had made far more radical innovations in the fabrication of containers than man's ancestors had achieved in the making of tools until the emergence of *homo sapiens*: consider their intricate nests and bowers, their beaver dams, their geometric beehives, their urbanoid anthills and termitaries. In short, if technical proficiency were alone sufficient to identify man's active intelligence, he would for long have rated as a hopeless duffer alongside many other species. The consequences of this perception should be plain: namely, that there was nothing uniquely human in early technology until it was modified by linguistic symbols, social organization, and esthetic design. At that point symbol making leaped far ahead of toolmaking and, in turn, fostered neater technical facility.

At the beginning, then, I suggest that the human race had achieved no special position by reason of its tool-using or tool-making propensities alone. Or, rather, man possessed one primary all-purpose tool that was more important than any later assemblage: namely, his own mind-activated body, every part of it, not just those sensory-motor activities that produced hand axes and wooden spears. To compensate for his extremely primitive working gear, early man had a much more important asset that widened his whole technical horizon: a body not specialized for any single activity, but, precisely because of its extraordinary lability and plasticity, more effective in using an increasing portion of both his external environment and his equally rich internal psychical resources.

Through man's overdeveloped, incessantly active brain, he had more mental energy to tap than he needed for survival at a purely animal level; and he was, accordingly, under the necessity of canalizing that energy, not just into food getting and reproduction, but into modes of living that would convert this energy more directly and constructively into appropriate cultural—that is, symbolic—forms. Life-enhancing cultural "work" by necessity took precedence over utilitarian manual work. This wider area involved far more than the discipline of hand, muscle, and eye in making and using tools: it likewise demanded a control of all man's biological functions, including his appetites, his organs of excretion, his upsurging emotions, his widespreading sexual activities, his tormenting and tempting dreams. Even the hand was no mere horny work tool; it stroked a lover's body, held a baby close to the breast, made significant gestures, or expressed in ordered dance and shared ritual some otherwise inexpressible sentiment, about life or death, a remembered past, or an anxious future. Tool technics and our derivative machine technics are but specialized fragments of biotechnics: and by biotechnics one means man's total equipment for living.

On this interpretation one may well hold it an open question whether the standardized patterns and the repetitive order which came to play such an effective part in the development of tools from an early time on, as Robert Braidwood has pointed out, derive solely from toolmaking.⁷ Do they not derive quite as much, perhaps even more, from the forms of ritual, song, and dance—forms that exist in a state of perfection among primitive peoples, often in a far more exquisitely finished state than their tools. There is, in fact, widespread evidence, first noted by A. M. Hocart,⁸ that ritual exactitude in ceremony long preceded mechanical exactitude in work; and that even the rigorous division of labor came first through specialization in ceremonial offices. These facts may help to explain why simple peoples, who easily get bored by purely mechanical tasks that might improve their physical well-being, will nevertheless repeat a meaningful ritual over and over, often to the point of exhaustion. The debt of technics to play and to play toys, to

myth and fantasy, to magic rite and religious rote, which I called attention to in *Technics and Civilization*,⁹ has still to be sufficiently recognized, though Johann Huizinga, in *homo ludens*, has gone so far as to treat play itself as the formative element in all culture.

Toolmaking in the narrow technical sense may, indeed, go back to our hominid African ancestors. But the technical equipment of Clactonian and Acheulian cultures remained extremely limited until a more richly endowed creature, with a nervous system nearer to that of *homo sapiens* than to any primeval hominid predecessors, had come into existence, and brought into operation not alone his hands and legs, but his entire body and mind, projecting them, not just into his material equipment, but into more purely symbolic nonutilitarian forms.

In this revision of the accepted technical stereotypes, I would go even further: For I suggest that at every stage, man's technological expansions and transformations were less for the purpose of directly increasing the food supply or controlling nature than for utilizing his own immense internal resources, and expressing his latent superorganic potentialities. When not threatened by a hostile environment, man's lavish, hyperactive nervous organization—still often irrational and unmanageable—was possibly an embarrassment rather than an aid to his survival. If so, his control over his psychosocial environment, through the elaboration of a common symbolic culture, was a more imperious need than control over the external environment—and, as one must infer, largely predated it and outpaced it.

On this reading, the emergence of language—a laborious culmination of man's more elementary forms of expressing and transmitting meaning—was incomparably more important to further human development than would have been the chipping of a mountain of hand axes. Beside the relatively simple coordinations required for tool using, the delicate interplay of the many organs needed for the creation of articulate speech was a far more striking advance, and must

have occupied a great part of early man's time, energy, and mental concentration, since its collective product, language, was infinitely more complex and sophisticated at the dawn of civilization than the Egyptian or Mesopotamian kit of tools. For only when knowledge and practice could be stored in symbolic forms, and passed on by word of mouth from generation to generation, was it possible to keep each fresh cultural acquisition from dissolving with the passing moment or the dying generation. Then and then only did the domestication of plants and animals become possible. Need I remind you that the latter technical transformation was achieved with no better tools than the digging stick, the ax, and the mattock? The plow, like the cart wheel, came much later as a specialized contribution to the large-scale field cultivation of grain.

To consider man as primarily a tool-making animal, then, is to skip over the main chapters of human prehistory in which a decisive development actually took place. Opposed to this tool-dominated stereotype, the present view holds that man is preeminently a mind-using, symbol-making, and self-mastering animal; and the primary locus of all his activities lies in his own organism. Until man had made something of himself, he could make little of the world around him.

In this process of self-discovery and self-transformation, technics in the narrow sense, of course, served man well as a subsidiary instrument, but not as the main operative agent in his development; for technics was never till our own age dissociated from the larger cultural whole, still less did technics dominate all other institutions. Early man's original development was based upon what André Varagnac¹⁰ happily called "the technology of the body": the utilization of his highly plastic bodily capacities for the expression of his still unformed and uninformed mind, before that mind had yet achieved, through the development of symbols and images, its own more appropriate etherealized technical instruments. From the beginning the creation of significant modes of symbolic expression, rather than more effective tools, was the basis of *homo*

sapiens' further development.

Unfortunately, so firmly were the prevailing nineteenth-century conceptions committed to the notion of man as primarily *homo faber*, the toolmaker, rather than *homo sapiens*, the mind maker, that, as you know, the first discovery of the art of the Altamira caves was dismissed as a hoax, because the leading paleoethnologists would not admit that the Ice Age hunters, whose weapons and tools they had recently discovered, could have had either the leisure or the mental inclination to produce art—not crude forms, but images that showed powers of observation and abstraction of a high order.

But, when we compare the carvings and paintings of the Aurignacian or Magdalenian finds with their surviving technical equipment, who shall say whether it is art or technics that shows the higher development? Even the finely finished Solutrean laurel-leaf points were a gift of esthetically sensitive artisans. The classic Greek usage for *technics* makes no distinction between industrial production and art; and for the greater part of human history these aspects were inseparable, one side respecting objective conditions and functions, the other responding to subjective needs and expressing sharable feelings and meanings.¹¹

Our age has not yet overcome the peculiar utilitarian bias that regards technical invention as primary, and esthetic expression as secondary or even superfluous; and this means that we have still to acknowledge that, until our own period, technics derived from the whole man in his intercourse with every part of the environment, utilizing every aptitude in himself to make the most of his own biological, ecological, and psychosocial potentials.

Even at the earliest stage, trapping and foraging called less for tools than for sharp observation of animal habits and habitats, backed by a wide experimental sampling of plants and a shrewd interpretation of the effects of various foods, medicines, and poisons upon the human organism. And in those horticultural discoveries which, if Oakes Ames¹² was right, must have preceded by many thousands of years the active domestication of plants, taste and formal beauty played a part no less than their food

value; so that the earliest domesticates, other than the grains, were often valued for the color and form of their flowers, for their perfume, their texture, their spiciness, rather than merely for nourishment. Edgar Anderson has suggested that the neolithic garden, like gardens in many simpler cultures today, was probably a mixture of food plants, dye plants, medicinals, and ornamentals—all treated as equally essential for life.¹³

Similarly, some of early man's most daring technical experiments had nothing whatever to do with the mastery of the external environment: they were concerned with the anatomical modification or the superficial decoration of the human body, for sexual emphasis, self-expression, or group identification. The Abbé Breuil¹⁴ found evidence of such practices as early as the Mousterian culture, which served equally in the development of ornament and surgery.

Plainly, tools and weapons, so far from always dominating man's technical equipment, as the stone artifacts too glibly suggest, constituted only a small part of the biotechnic assemblage; and the struggle for existence, though sometimes severe, did not engross the energy and vitality of early man, or divert him from his more central need to bring order and meaning into every part of his life. In that larger effort, ritual, dance, song, painting, carving, and above all discursive language must for long have played a decisive role.

At its point of origin, then, technics was related to the whole nature of man. Primitive technics was life-centered, not narrowly work-centered, still less production-centered or power-centered. As in all ecological complexes, a variety of human interests and purposes, along with organic needs, restrained the overgrowth of any single component. As for the greatest technical feat before our own age, the domestication of plants and animals, this advance owed almost nothing to new tools, though it necessarily encouraged the development of clay containers, to hold and preserve its agricultural abundance. But neolithic domestication owed much, we now begin to realize, since Eduard Hahn and Levy,¹⁵ to an intense subjective concentration on

sexuality in all its manifestations, expressed first in religious myth and ritual, still abundantly visible in cult objects and symbolic art. Plant selection, hybridization, fertilization, manuring, seeding, castration were the products of an imaginative cultivation of sexuality, whose first evidence one finds tens of thousands of years earlier in the emphatically sexual carvings of paleolithic woman: the so-called Venuses.¹⁶

But at the point where history, in the form of the written record, becomes visible, that life-centered economy, a true polytechnics, was challenged and in part displaced in a series of radical technical and social innovations. About five thousand years ago a monotecnics, devoted to the increase of power and wealth by the systematic organization of workaday activities in a rigidly mechanical pattern, came into existence. At this moment, a new conception of the nature of man arose, and with it a new stress upon the exploitation of physical energies, cosmic and human, apart from the processes of growth and reproduction, came to the fore. In Egypt, Osiris symbolizes the older, fecund, life-oriented technics: Atum-Re, the Sun God, who characteristically created the world out of his own semen without female cooperation, stands for the machine-centered one. The expansion of power, through ruthless human coercion and mechanical organization, took precedence over the nurture and enhancement of life.

The chief mark of this change was the construction of the first complex, high-powered machines; and therewith the beginning of a new regimen, accepted by all later civilized societies—though reluctantly by more archaic cultures—in which work at a single specialized task, segregated from other biological and social activities, not only occupied the entire day but increasingly engrossed the entire lifetime. That was the fundamental departure which, during the last few centuries, has led to the increasing mechanization and automation of all production. With the assemblage of the first collective machines, work, by its systematic

dissociation from the rest of life, became a curse, a burden, a sacrifice, a form of punishment: and by reaction this new regimen soon awakened compensatory dreams of effortless affluence, emancipated not only from slavery but from work itself. These ancient dreams, first expressed in myth, but long delayed in realization, now dominate our own age.

The machine I refer to was never discovered in any archeological diggings for a simple reason: it was composed almost entirely of human parts. These parts were brought together in a hierarchical organization under the rule of an absolute monarch whose commands, supported by a coalition of the priesthood, the armed nobility, and the bureaucracy, secured a corpselike obedience from all the components of the machine. Let us call this archetypal collective machine—the human model for all later specialized machines—the *Megamachine*. This new kind of machine was far more complex than the contemporary potter's wheel or bow drill, and it remained the most advanced type of machine until the invention of the mechanical clock in the fourteenth century.

Only through the deliberate invention of such a high-powered machine could the colossal works of engineering that marked the Pyramid Age in both Egypt and Mesopotamia have been brought into existence, often in a single generation. This new technics came to an early climax in the Great Pyramid at Giza: that structure exhibited, as J. H. Breasted¹⁷ pointed out, a watchmaker's standard of exact measurement. By operating as a single mechanical unit of specialized, subdivided, interlocking parts, the one hundred thousand men who worked on that pyramid could generate ten thousand horsepower. This human mechanism alone made it possible to raise that colossal structure with the use of only the simplest stone and copper tools—without the aid of such otherwise indispensable machines as the wheel, the wagon, the pulley, the derrick, or the winch.

Two things must be noted about this power machine because they identify it through its whole historic course down to the present.

The first is that the organizers of the machine derived their power and authority from a cosmic source. The exactitude in measurement, the abstract mechanical order, the compulsive regularity of this labor machine sprang directly from astronomical observations and abstract scientific calculations: this inflexible, predictable order, incorporated in the calendar, was then transferred to the regimentation of the human components. By a combination of divine command and ruthless military coercion, a large population was made to endure grinding poverty and forced labor at dull repetitive tasks, in order to ensure "life, prosperity, and health" for the divine or semidivine ruler and his entourage.

The second point is that the grave social defects of the human machine—then as now—were partly offset by its superb achievements in flood control, grain production, and urban building, which plainly benefited the whole community. This laid the ground for an enlargement in every area of human culture: in monumental art, in codified law, and in systematically pursued and permanently recorded thought. Such order, such collective security and abundance as were achieved in Mesopotamia and Egypt—later, in India, China, in the Andean and Mayan cultures—were never surpassed until the Megamachine was reestablished in a new form in our own time. But, conceptually, the machine was already detached from other human functions and purposes than the increase of mechanical power and order. With mordant symbolism, the Megamachine's ultimate products in Egypt were tombs, cemeteries, and mummies, while later in Assyria and elsewhere the chief testimonial to its dehumanized efficiency was, again typically, a waste of destroyed cities and poisoned soils.

In a word, what modern economists lately termed the Machine Age had its origin, not in the eighteenth century, but at the very outset of civilization. All its salient characteristics were present from the beginning in both the means and the ends of the collective machine. So Keynes's acute prescription of "pyramid building" as an essential means of coping with the insensate productivity of a highly mechanized technology, applies both

to the earliest manifestations and the present ones; for what is a space rocket but the precise dynamic equivalent, in terms of our present-day theology and cosmology, of the static Egyptian pyramid? Both are devices for securing at an extravagant cost a passage to heaven for the favored few, while incidentally maintaining equilibrium in an economic structure threatened by its own excessive productivity.

Unfortunately, though the labor machine lent itself to vast constructive enterprises, which no small-scale community could even contemplate, much less execute, the most conspicuous result has been achieved through military machines, in colossal acts of destruction and human extermination; acts that monotonously soil the pages of history, from the rape of Sumer to the blasting of Warsaw and Hiroshima. Sooner or later, I suggest, we must have the courage to ask ourselves: Is this association of inordinate power and productivity with equally inordinate violence and destruction a purely accidental one?

Now the misuse of Megamachines would have proved intolerable had they not also brought genuine benefits to the whole community by raising the ceiling of collective human effort and aspiration. Perhaps the most dubious of these advantages, humanly speaking, was the gain in efficiency derived from concentration upon rigorously repetitive motions in work, already indeed introduced in the grinding and polishing processes of neolithic toolmaking. This inured civilized man to long spans of regular work, with possibly a higher productive efficiency per unit. But the social byproduct of this new discipline was perhaps even more significant; for some of the psychological benefits hitherto confined to religious ritual were transferred to work. The monotonous repetitive tasks imposed by the Megamachine, which in a pathological form we would associate with a compulsion neurosis, nevertheless served, I suggest, like all ritual and restrictive order, to lessen anxiety and to defend the worker himself from the often demonic promptings of the unconscious, no longer held in check by the traditions and customs of the neolithic village.

In short, mechanization and regimentation, through labor armies, military armies, and

ultimately through the derivative modes of industrial and bureaucratic organization, supplemented and increasingly replaced religious ritual as a means of coping with anxiety and promoting psychical stability in mass populations. Orderly, repetitive work provided a daily means of self-control: a moralizing agent more pervasive, more effective, more universal than either ritual or law. This hitherto unnoticed psychological contribution was possibly more important than quantitative gains in productive efficiency, for the latter too often was offset by absolute losses in war and conquest. Unfortunately, the ruling classes, which claimed immunity from manual labor, were not subject to this discipline; hence, as the historic record testifies, their disordered fantasies too often found an outlet into reality through insensate acts of destruction and extermination.

Having indicated the beginnings of this process, I must regrettably pass over the actual institutional forces that have been at work during the past five thousand years and leap, all too suddenly, into the present age, in which the ancient forms of biotechnics are being either suppressed or supplanted, and in which the extravagant enlargement of the Megamachine itself has become, with increasing compulsiveness, the condition of continued scientific and technical advance. This unconditional commitment to the Megamachine is now regarded by many as the main purpose of human existence.

But if the clues I have been attempting to expose prove helpful, many aspects of the scientific and technical transformation of the last three centuries will call for reinterpretation and judicious reconsideration. For at the very least, we are now bound to explain why the whole process of technical development has become increasingly coercive, totalitarian, and—in its direct human expression—compulsive and grimly irrational, indeed downright hostile to more spontaneous manifestations of life that cannot be fed into the machine.

Before accepting the ultimate translation

of all organic processes, biological functions, and human aptitudes into an externally controllable mechanical system, increasingly automatic and self-expanding, it might be well to reexamine the ideological foundations of this whole system, with its overconcentration upon centralized power and external control. Must we not, in fact, ask ourselves if the probable destination of this system is compatible with the further development of specifically human potentialities?

Consider the alternatives now before us. If man were actually, as current theory still supposes, a creature whose manufacture and manipulation of tools played the largest formative part in his development, on what valid grounds do we now propose to strip mankind of the wide variety of autonomous activities historically associated with agriculture and manufacture, leaving the residual mass of workers with only the trivial tasks of watching buttons and dials, and responding to one-way communication and remote control? If man indeed owes his intelligence mainly to his tool-making and tool-using propensities, by what logic do we now take his tools away, so that he will become a functionless, workless being, conditioned to accept only what the Megamachine offers him: an automaton within a larger system of automation, condemned to compulsory consumption, as he was once condemned to compulsory production? What, in fact, will be left of human life, if one autonomous function after another is either taken over by the machine or else surgically removed—perhaps genetically altered—to fit the Megamachine.

But if the present analysis of human development in relation to technics proves sound, there is an even more fundamental criticism to be made. For we must then go on to question the basic soundness of the current scientific and educational ideology, which is now pressing to shift the locus of human activity from the organic environment, the social group, and the human personality to the Megamachine, considered as the ultimate expression of human intelligence—divorced from the limitations and qualifications of organic existence. That man

metaphysics invites replacement: in both its ancient Pyramid Age form and its Nuclear Age form it is obsolete. For the prodigious advance of knowledge about man's biological origins and historic development made during the last century massively undermines this dubious underdimensioned ideology, with its specious social assumptions and "moral" imperatives, upon which the imposing fabric of science and technics, since the seventeenth century, has been based.

From our present vantage point, we can see that the inventors and controllers of the Megamachine, from the Pyramid Age onward, have in fact been haunted by delusions of omniscience and omnipotence—immediate or prospective. Those original delusions have not become less irrational, now that they have at their disposal the formidable resources of exact science and a high-energy technology. The Nuclear Age conceptions of absolute power, infallible computerized intelligence, limitless expanding productivity, all culminating in a system of total control exercised by a military-scientific-industrial élite, correspond to the Bronze Age conception of Divine Kingship. Such power, to succeed on its own terms, must destroy the symbiotic cooperations between all species and communities essential to man's survival and development. Both ideologies belong to the same infantile magico-religious scheme as ritual human sacrifice. As with Captain Ahab's pursuit of *Moby Dick*, the scientific and technical means are entirely rational, but the ultimate ends are mad.

Living organisms, we now know, can use only limited amounts of energy, as living personalities can utilize only limited quantities of knowledge and experience. "Too much" or "too little" is equally fatal to organic existence. Even too much sophisticated abstract knowledge, insulated from feeling, from moral evaluation, from historic experience, from responsible, purposeful action, can produce a serious unbalance in both the personality and the community. Organisms, societies, human persons are nothing less than delicate devices for regulating energy and putting it at the service of life.

To the extent that our Megatechnics ignores these fundamental insights into the

nature of all living organisms, it is actually prescientific, even when not actively irrational: a dynamic agent of arrest and regression. When the implications of this weakness are taken in, a deliberate, large-scale dismantling of the Megamachine, in all its institutional forms, must surely take place, with a redistribution of power and authority to smaller units, more open to direct human control.

If technics is to be brought back again into the service of human development, the path of advance will lead, not to the further expansion of the Megamachine, but to the deliberate cultivation of all those parts of the organic environment and the human personality that have been suppressed in order to magnify the offices of the Megamachine.

The deliberate expression and fulfillment of human potentialities requires a quite different approach from that bent solely on the control of natural forces and the modification of human capabilities in order to facilitate and expand the system of control. We know now that play and sport and ritual and dream fantasy, no less than organized work, have exercised a formative influence upon human culture, and not least upon technics. But make-believe cannot for long be a sufficient substitute for productive work: only when play and work form part of an organic cultural whole, as in Tolstoy's picture of the mowers in *Anna Karenina*, can the many-sided requirements for full human growth be satisfied. Without serious responsible work, man progressively loses his grip on reality.

Instead of liberation from work being the chief contribution of mechanization and automation, I would suggest that liberation for work, for more educative, mind-forming, self-rewarding work, on a voluntary basis, may become the most salutary contribution of a life-centered technology. This may prove an indispensable counterbalance to universal automation: partly by protecting the displaced worker from boredom and suicidal

desperation, only temporarily relievable by anesthetics, sedatives, and narcotics, partly by giving wider play to constructive impulses, autonomous functions, meaningful activities.

Relieved from abject dependence upon the Megamachine, the whole world of biotechnics would then once more become open to man; and those parts of his personality that have been crippled or paralyzed by insufficient use should again come into play, with fuller energy than ever before. Automation is indeed the proper end of a purely mechanical system; and, once in its place, subordinate to other human purposes, these cunning mechanisms will serve the human community no less effectively than the reflexes, the hormones, and the autonomic nervous system—nature's earliest experiment in automation—serve the human body. But autonomy, self-direction, and self-fulfillment are the proper ends of organisms; and further technical development must aim at re-establishing this vital harmony at every stage of human growth by giving play to every part of the human personality, not merely to those functions that serve the scientific and technical requirements of the Megamachine.

I realize that in opening up these difficult questions I am not in a position to provide ready-made answers, nor do I suggest that such answers will be easy to fabricate. But it is time that our present wholesale commitment to the machine, which arises largely out of our one-sided interpretation of man's early technical development, should be replaced by a fuller picture of both human nature and the technical milieu, as both have evolved together. That is the first step toward a many-sided transformation of man's self and his work and his habitat—it will probably take many centuries to effect, even after the inertia of the forces now dominant has been overcome.

dissociation from the rest of life, became a curse, a burden, a sacrifice, a form of punishment: and by reaction this new regimen soon awakened compensatory dreams of effortless affluence, emancipated not only from slavery but from work itself. These ancient dreams, first expressed in myth, but long delayed in realization, now dominate our own age.

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Two things must be noted about this power machine because they identify it through its whole historic course down to the present.

The first is that the organizers of the machine derived their power and authority from a cosmic source. The exactitude in measurement, the abstract mechanical order, the compulsive regularity of this labor machine sprang directly from astronomical observations and abstract scientific calculations: this inflexible, predictable order, incorporated in the calendar, was then transferred to the regimentation of the human components. By a combination of divine command and ruthless military coercion, a large population was made to endure grinding poverty and forced labor at dull repetitive tasks, in order to ensure "life, prosperity, and health" for the divine or semidivine ruler and his entourage.

The second point is that the grave social defects of the human machine—then as now—were partly offset by its superb achievements in flood control, grain production, and urban building, which plainly benefited the whole community. This laid the ground for an enlargement in every area of human culture: in monumental art, in codified law, and in systematically pursued and permanently recorded thought. Such order, such collective security and abundance as were achieved in Mesopotamia and Egypt—later, in India, China, in the Andean and Mayan cultures—were never surpassed until the Megamachine was reestablished in a new form in our own time. But, conceptually, the machine was already detached from other human functions and purposes than the increase of mechanical power and order. With mordant symbolism, the Megamachine's ultimate products in Egypt were tombs, cemeteries, and mummies, while later in Assyria and elsewhere the chief testimonial to its dehumanized efficiency was, again typically, a waste of destroyed cities and poisoned soils.

In a word, what modern economists lately termed the Machine Age had its origin, not in the eighteenth century, but at the very outset of civilization. All its salient characteristics were present from the beginning in both the means and the ends of the collective machine. So Keynes's acute prescription of "pyramid building" as an essential means of coping with the insensate productivity of a highly mechanized technology, applies both

to the earliest manifestations and the present ones; for what is a space rocket but the precise dynamic equivalent, in terms of our present-day theology and cosmology, of the static Egyptian pyramid? Both are devices for securing at an extravagant cost a passage to heaven for the favored few, while incidentally maintaining equilibrium in an economic structure threatened by its own excessive productivity.

Unfortunately, though the labor machine lent itself to vast constructive enterprises, which no small-scale community could even contemplate, much less execute, the most conspicuous result has been achieved through military machines, in colossal acts of destruction and human extermination; acts that monotonously soil the pages of history, from the rape of Sumer to the blasting of Warsaw and Hiroshima. Sooner or later, I suggest, we must have the courage to ask ourselves: Is this association of inordinate power and productivity with equally inordinate violence and destruction a purely accidental one?

Now the misuse of Megamachines would have proved intolerable had they not also brought genuine benefits to the whole community by raising the ceiling of collective human effort and aspiration. Perhaps the most dubious of these advantages, humanly speaking, was the gain in efficiency derived from concentration upon rigorously repetitive motions in work, already indeed introduced in the grinding and polishing processes of neolithic toolmaking. This inured civilized man to long spans of regular work, with possibly a higher productive efficiency per unit. But the social byproduct of this new discipline was perhaps even more significant; for some of the psychological benefits hitherto confined to religious ritual were transferred to work. The monotonous repetitive tasks imposed by the Megamachine, which in a pathological form we would associate with a compulsion neurosis, nevertheless served, I suggest, like all ritual and restrictive order, to lessen anxiety and to defend the worker himself from the often demonic promptings of the unconscious, no longer held in check by the traditions and customs of the neolithic village.

In short, mechanization and regimentation, through labor armies, military armies, and

ultimately through the derivative modes of industrial and bureaucratic organization, supplemented and increasingly replaced religious ritual as a means of coping with anxiety and promoting psychical stability in mass populations. Orderly, repetitive work provided a daily means of self-control: a moralizing agent more pervasive, more effective, more universal than either ritual or law. This hitherto unnoticed psychological contribution was possibly more important than quantitative gains in productive efficiency, for the latter too often was offset by absolute losses in war and conquest. Unfortunately, the ruling classes, which claimed immunity from manual labor, were not subject to this discipline; hence, as the historic record testifies, their disordered fantasies too often found an outlet into reality through insensate acts of destruction and extermination.

Having indicated the beginnings of this process, I must regrettably pass over the actual institutional forces that have been at work during the past five thousand years and leap, all too suddenly, into the present age, in which the ancient forms of biotechnics are being either suppressed or supplanted, and in which the extravagant enlargement of the Megamachine itself has become, with increasing compulsiveness, the condition of continued scientific and technical advance. This unconditional commitment to the Megamachine is now regarded by many as the main purpose of human existence.

But if the clues I have been attempting to expose prove helpful, many aspects of the scientific and technical transformation of the last three centuries will call for reinterpretation and judicious reconsideration. For at the very least, we are now bound to explain why the whole process of technical development has become increasingly coercive, totalitarian, and—in its direct human expression—compulsive and grimly irrational, indeed downright hostile to more spontaneous manifestations of life that cannot be fed into the machine.

Before accepting the ultimate translation

of all organic processes, biological functions, and human aptitudes into an externally controllable mechanical system, increasingly automatic and self-expanding, it might be well to reexamine the ideological foundations of this whole system, with its overconcentration upon centralized power and external control. Must we not, in fact, ask ourselves if the probable destination of this system is compatible with the further development of specifically human potentialities?

Consider the alternatives now before us. If man were actually, as current theory still supposes, a creature whose manufacture and manipulation of tools played the largest formative part in his development, on what valid grounds do we now propose to strip mankind of the wide variety of autonomous activities historically associated with agriculture and manufacture, leaving the residual mass of workers with only the trivial tasks of watching buttons and dials, and responding to one-way communication and remote control? If man indeed owes his intelligence mainly to his tool-making and tool-using propensities, by what logic do we now take his tools away, so that he will become a functionless, workless being, conditioned to accept only what the Megamachine offers him: an automaton within a larger system of automation, condemned to compulsory consumption, as he was once condemned to compulsory production? What, in fact, will be left of human life, if one autonomous function after another is either taken over by the machine or else surgically removed—perhaps genetically altered—to fit the Megamachine.

But if the present analysis of human development in relation to technics proves sound, there is an even more fundamental criticism to be made. For we must then go on to question the basic soundness of the current scientific and educational ideology, which is now pressing to shift the locus of human activity from the organic environment, the social group, and the human personality to the Megamachine, considered as the ultimate expression of human intelligence—divorced from the limitations and qualifications of organic existence. That machine-centered

metaphysics invites replacement: in both its ancient Pyramid Age form and its Nuclear Age form it is obsolete. For the prodigious advance of knowledge about man's biological origins and historic development made during the last century massively undermines this dubious underdimensioned ideology, with its specious social assumptions and "moral" imperatives, upon which the imposing fabric of science and technics, since the seventeenth century, has been based.

From our present vantage point, we can see that the inventors and controllers of the Megamachine, from the Pyramid Age onward, have in fact been haunted by delusions of omniscience and omnipotence—immediate or prospective. Those original delusions have not become less irrational, now that they have at their disposal the formidable resources of exact science and a high-energy technology. The Nuclear Age conceptions of absolute power, infallible computerized intelligence, limitless expanding productivity, all culminating in a system of total control exercised by a military-scientific-industrial élite, correspond to the Bronze Age conception of Divine Kingship. Such power, to succeed on its own terms, must destroy the symbiotic cooperations between all species and communities essential to man's survival and development. Both ideologies belong to the same infantile magico-religious scheme as ritual human sacrifice. As with Captain Ahab's pursuit of Moby Dick, the scientific and technical means are entirely rational, but the ultimate ends are mad.

Living organisms, we now know, can use only limited amounts of energy, as living personalities can utilize only limited quantities of knowledge and experience. "Too much" or "too little" is equally fatal to organic existence. Even too much sophisticated abstract knowledge, insulated from feeling, from moral evaluation, from historic experience, from responsible, purposeful action, can produce a serious unbalance in both the personality and the community. Organisms, societies, human persons are nothing less than delicate devices for regulating energy and putting it at the service of life.

To the extent that our Megatechnics ignores these fundamental insights into the

nature of all living organisms, it is actually prescientific, even when not actively irrational: a dynamic agent of arrest and regression. When the implications of this weakness are taken in, a deliberate, large-scale dismantling of the Megamachine, in all its institutional forms, must surely take place, with a redistribution of power and authority to smaller units, more open to direct human control.

If technics is to be brought back again into the service of human development, the path of advance will lead, not to the further expansion of the Megamachine, but to the deliberate cultivation of all those parts of the organic environment and the human personality that have been suppressed in order to magnify the offices of the Megamachine.

The deliberate expression and fulfillment of human potentialities requires a quite different approach from that bent solely on the control of natural forces and the modification of human capabilities in order to facilitate and expand the system of control. We know now that play and sport and ritual and dream fantasy, no less than organized work, have exercised a formative influence upon human culture, and not least upon technics. But make-believe cannot for long be a sufficient substitute for productive work: only when play and work form part of an organic cultural whole, as in Tolstoy's picture of the mowers in *Anna Karenina*, can the many-sided requirements for full human growth be satisfied. Without serious responsible work, man progressively loses his grip on reality.

Instead of liberation from work being the chief contribution of mechanization and automation, I would suggest that liberation for work, for more educative, mind-forming, self-rewarding work, on a voluntary basis, may become the most salutary contribution of a life-centered technology. This may prove an indispensable counterbalance to universal automation: partly by protecting the displaced worker from boredom and suicidal

desperation, only temporarily relievable by anesthetics, sedatives, and narcotics, partly by giving wider play to constructive impulses, autonomous functions, meaningful activities.

Relieved from abject dependence upon the Megamachine, the whole world of biotechnics would then once more become open to man; and those parts of his personality that have been crippled or paralyzed by insufficient use should again come into play, with fuller energy than ever before. Automation is indeed the proper end of a purely mechanical system; and, once in its place, subordinate to other human purposes, these cunning mechanisms will serve the human community no less effectively than the reflexes, the hormones, and the autonomic nervous system—nature's earliest experiment in automation—serve the human body. But autonomy, self-direction, and self-fulfillment are the proper ends of organisms; and further technical development must aim at re-establishing this vital harmony at every stage of human growth by giving play to every part of the human personality, not merely to those functions that serve the scientific and technical requirements of the Megamachine.

I realize that in opening up these difficult questions I am not in a position to provide ready-made answers, nor do I suggest that such answers will be easy to fabricate. But it is time that our present wholesale commitment to the machine, which arises largely out of our one-sided interpretation of man's early technical development, should be replaced by a fuller picture of both human nature and the technical milieu, as both have evolved together. That is the first step toward a many-sided transformation of man's self and his work and his habitat—it will probably take many centuries to effect, even after the inertia of the forces now dominant has been overcome.

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6. TECHNICS AND THE NATURE OF MAN

Lewis Mumford

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