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TOWARDS A LIBERATORY TECHNOLOGY

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[inside front cover]

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Is man destined to be enslaved by technology and technological modes of thought, or can the revolutionary changes in technology in this generation *humanize* society and contribute to the creation of new relationships between man and man? This is the question which Lewis Herber (author of the article on Ecology and Revolutionary Thought in ANARCHY 69) discusses in this issue.

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Towards a liberatory technology

LEWIS HERBER

NOT SINCE THE DAYS OF THE INDUSTRIAL REVOLUTION have popular attitudes toward technology fluctuated as sharply as in the past few decades. During most of the twenties and even well into the thirties, public opinion generally welcomed technological innovation and identified man's welfare with the industrial advances of the time. This was a period when Soviet apologists could justify Stalin's most brutal methods and worst crimes merely by describing him as the "industrializer" of modern Russia. It was also a period when the most effective critique of capitalist society could rest on the brute facts of economic and technological stagnation in the United States and Western Europe. To many people, there seemed to be a direct, one-to-one relationship between technological advances and social progress—a fetishing of the word "industrialization" that excused the most abusive of economic plans and programmes.

Today, we would regard these attitudes as naive. Except perhaps for the technicians and scientists who design the "hardware", the feeling of most people toward technological innovation could be described as schizoid, divided by a gnawing fear of nuclear extinction on the one hand, and by a yearning for material abundance, leisure, and security on the other. Technology, too, seems to be at odds with itself: the bomb is pitted against the power reactor, the intercontinental missile against the communications satellite. The same technological discipline tends to appear as much a foe as a friend of humanity, and even traditionally man-oriented sciences, such as medicine, occupy an ambivalent position, as witness the promise opened by recent advances in chemotherapy and the threat created by recent research in biological warfare.

It should not be surprising, then, to find that this tension between promise and threat is increasingly resolved in favour of threat, by a blanket rejection of technology and the technological spirit. To an ever-growing extent, we find that technology is viewed as a demon, imbued with a sinister life of its own, that is likely to mechanize man if it fails to exterminate him. The deep pessimism this view tends to produce is often as simplistic as the optimism that prevailed in earlier decades. There is a very real danger, today, that we will lose our perspective toward technology, neglect its liberatory tendencies, and worse, fatalistically submit to its use for destructive ends.

If we are not to be paralyzed by this new form of social fatalism, a balance must be struck. The purpose of this article is to explore three questions: What is the liberatory *potential* of modern technology, both materially and spiritually? What tendencies, if any, are reshaping the

machine for use in an organic, man-oriented society? And finally, how can the new technology and resources be used in an ecological manner, that is, to promote the balance of nature, the full, lasting development of natural regions, and the creation of organic, humanistic communities?

The emphasis in the above remarks should be placed on the word "potential". I make no claim that technology is necessarily liberatory or consistently beneficial to man's development. But I surely do not believe that man is destined to be enslaved by technology and technological modes of thought, as Juenger and Elul seem to imply in their books on the subject.* To the contrary, I shall try to show that an organic mode of life, deprived of its inorganic, technological components (be they a plentitude of raw materials or machines), would be as non-functional as a man deprived of his skeleton. Technology, I submit, must be conceived as the basic structural support of a society, the indispensable frame on which hang all the living institutions of a dynamic social organism.

TECHNOLOGY AND FREEDOM

The year 1848 stands out as a turning point in the history of modern revolutions—the year when Marxism made its debut as a distinct ideology in the pages of the *Communist Manifesto* and when the proletariat, represented by the Parisian workers, made its debut as a distinct political force on the barricades of June. It could also be said that 1848, a year close to the halfway mark of the nineteenth century, represents the culmination of the traditional steam-powered technology initiated by the Newcomen engine a century and half earlier.

What strikes us about the convergence in a single year of these ideological, political, and technological milestones is the extent to which the revolutionary goals in the *Communist Manifesto* and the socialist ideals that permeated the thinking of the Parisian workers were in advance of the industrial possibilities of the time. In the 1840's, the Industrial Revolution was limited primarily to three areas of the economy: textile production, iron-making, and transportation. The invention of Arkwright's spinning machine, Watt's steam engine, and Cartwright's power loom, had brought the factory system to the textile industry, and a number of striking innovations in iron-making technology assured the high-quality, inexpensive metals needed to sustain the expansion of the factories and of a newly discovered means of transportation, the railways. But these innovations, important as they were, were not accompanied by commensurable changes in other areas of technology. For one thing, the common run of steam engines used at the time rarely yielded more than 15 horse-power, compared with the enormously powerful steam turbines in use today, and the best blast furnaces provided little more than 100 tons of iron a week, a mere

* Both Juenger and Elul seem to believe that the debasement of man by the machine is intrinsic to the development of technology, and they conclude their works on a grim, unrelieved note of resignation. Their works reflect the social fatalism I have in mind—especially Elul, whose views are more symptomatic of the contemporary human condition. Cf. Friedrich Georg Juenger, *The Failure of Technology* (written in the pre-World War II period) and Jacques Elul, *The Technological Society* (written in the 1960's).

fraction of the two to three thousand tons produced daily by modern furnaces. More important still, the remaining areas of the economy had barely been affected by technological innovation. The mining techniques underpinning the new metals technology, for example, had changed very little since the days of the Renaissance. The miner still worked the ore face with a hand-pick and crowbar, and drainage pumps, ventilation systems, and hauling techniques, were not greatly improved over the descriptions we find in Agricola's classic on mining, written three centuries earlier. Agriculture was only first emerging from its centuries-old sleep. Although a great deal of land had been cleared for food cultivation, soil studies were still a novelty, and so heavy was the weight of tradition and conservatism, that most harvesting was still done by hand, despite the fact that a mechanical reaper had been perfected as early as 1822. Buildings, despite their massiveness and ornateness, were erected primarily by sheer muscle power–the hand-crane and windlass still occupying the mechanical centre of the construction site. Steel was a relatively rare metal. As late as 1850, it was priced at $250 a ton and, until the discovery of the Bessemer converter, steel-making techniques had stagnated for centuries. Finally, although precision tools had made great forward strides, it is worth noting, after all, that Charles Babbage's efforts to build a mechanical computer were completely thwarted by the inadequate machining techniques of the time.

I have reviewed these technological developments because both their promise and limitations exercised a profound influence on nineteenth century revolutionary concepts of freedom. The innovations in textile and iron-making technology provided a new sense of promise, indeed a qualitatively unique stimulus to socialist and utopian thought. To the revolutionary theorist, it seemed that for the first time in history, he could anchor his dream of a liberatory society in the visible prospect of material abundance and increased leisure for the mass of humanity. Socialism, he argued, could be based on the self-interest of man rather than on his dubious nobility of mind and spirit. Technological innovation had transmuted the socialist ideal from a vague, humanitarian hope into a practical programme, superior in its realism to all prevailing modes of bourgeois thought.

By the same token, this new sense of realism compelled many socialist theorists, particularly Marx and Engels, to deal with the technological limitations of their time. They were faced with a strategic issue: In all previous revolutions, technology had not developed to a level where men could be freed from material want, from toil, and from the struggle over the necessities of life. However glowing and lofty were the revolutionary ideals of the past, the vast majority of the people, burdened by material want, had to depart from the stage of history, return to work, and deliver the management of society to a new, leisured class of exploiters. Indeed, any attempt to equalize the wealth of society at a low level of technological development would not have eliminated want, but would have merely made it into a general. overall feature of society as a whole, thereby recreating all the conditions for a new struggle over the material things of life, new forms of property, and

eventually, a new system of class domination. "A development of the productive forces is the absolutely necessary practical premise [of Communism]," wrote Marx in 1846, "because without it want is generalized, and with want the struggle for necessities begins again, and that means that all the old shit must revive."

And the truth is that virtually all the utopias, theories, and revolutionary programmes of the early nineteenth century turned on the problematical axis of necessity—on the two poles of want and toil. The problem of necessity—the formulation of theories that would answer to the need to allocate labour and equitably distribute material goods at a relatively low level of technological development—permeated revolutionary thought with an intensity comparable only to the problem of original sin in Christian theology. The fact that men would have to devote a substantial portion of their time to toil, for which they would get scant returns, formed a major premise of all socialist ideology, be it authoritarian or libertarian, utopian or scientific, Marxist or anarchist. Implicit in the Marxist notion of a planned economy is the fact, incontestably clear in Marx's day, that socialism would still be burdened by relatively scarce resources. Men would have to plan—in effect, restrict—the distribution of goods and rationalize—in effect, intensify—the use of labour. Toil, under socialism, would be regarded as a duty, a responsibility which every able-bodied individual had to undertake. Even the great libertarian Proudhon advanced the same view when he wrote: "Yes life is a struggle. But this struggle is not between man and man—it is between man and Nature; and it is each one's duty to share it." This austere, almost Biblical emphasis on struggle and duty reflects the harsh quality of socialist thought during the Industrial Revolution.

The problem of dealing with want and work—an age-old problem perpetuated by the early Industrial Revolution—produced the great divergence in revolutionary ideas between socialism and anarchism. Freedom would still be circumscribed by necessity in the event of a revolution. How was this world of necessity to be "administered"? How would the allocation of goods and duties be decided? Marx left this decision to a state power, a transitional, "proletarian" state power, to be sure, but nevertheless a coercive body, established above and beyond society. According to Marx, the state would "wither away" as technology developed and enlarged the domain of freedom, granting humanity material plenty and the leisure to control its affairs directly. This strange calculus of necessity and freedom, mediated of all things by the state, differs very little politically from the common run of radical bourgeois-democratic opinion in the last century. The anarchist hope for an immediate abolition of the state rested largely on a belief in the viability of man's social instincts. In Bakunin's mind, to be sure, custom would compel anti-social individuals to abide by collectivist values and needs without obliging society to use coercion. But Kropotkin, who exercised more influence among anarchists in this area of speculation, invoked man's propensity for mutual aid—essentially a social instinct—as the guarantor of solidarity in an anarchist community, a concept which he hardheadedly derived from his study

of animal and social evolution.

The fact remains, however, that in both cases—the Marxist and anarchist—the answer to the problem of want and work is shot through with ambiguity. The realm of necessity was brutally present; it could not be conjured away by mere theory and speculation. The Marxists could hope to administer it by means of a state; the anarchists, to digest it through free communities. But given the limited technological development of the last century, both schools depended in the last analysis on an act of faith to cope with the problem of want and work. Anarchists could argue that any transitional state-power, however revolutionary its rhetoric and democratic its structure, would be self-perpetuating; it would tend to become an end-in-itself, to preserve the very material and social conditions it had been created to remove. For such a state-power to "wither away", that is, to promote its own dissolution, would require that its leaders and bureaucracy be people of superhuman moral qualities. The Marxists, in turn, could invoke history as evidence that custom and mutualistic propensities were never effective barriers to the pressures of material need, to the onslaught of property, and finally, to the development of exploitation and class domination. Accordingly, they dismissed anarchism as an ethical doctrine, reviving the mystique of the natural man and his inborn social virtues. The problem of want and work—the realm of necessity—was never satisfactorily resolved by either body of doctrine in the last century. It is to the lasting credit of anarchism that it uncompromisingly retained its high ideal of freedom—the ideal of spontaneous organization, community, and the abolition of all authority—although this amounts to saying that it remained an ideology of man's future, of the time when technology could eliminate the realm of necessity entirely. Marxism increasingly compromised its ideal of freedom, painfully qualifying it with transitional stages and political expediencies, until today it is an ideology of naked power, pragmatic efficiency, and social centralization, almost indistinguishable from ideologies of modern-day state capitalism.*

In retrospect, it is astonishing to consider how long the problem of want and work lingered at the core of revolutionary theory. In a span of only nine decades—the years between 1850 and 1940—Western society created, passed through, and evolved beyond two major epochs of technological history—the paeotechnic age based on coal and steel, and the neotechnic age based on electric power, synthetic chemicals, electricity, and internal combustion engines. Ironically, both ages of technology seemed to enhance the importance of toil in society. As the number of industrial workers increased in

* It is my own belief that the development of the "workers' state" in Russia thoroughly supports the anarchist critique of Marxist statism. Indeed, modern Marxists would do well to consult Marx's own discussion of commodity fetishism in *Capital* to better understand how everything tends to become an end-in-itself under conditions of commodity exchange. On the other hand, the Marxist critique of anarchist communitarianism has been grossly oversimplified. For an excellent discussion of this problem see Buber's *Paths in Utopia* (London: Routledge; New York: Beacon Press).

proportion to other social classes, labour—more precisely, toil—acquired an increasingly high status in revolutionary thought. During this period, the propaganda of the socialists often sounded like a paean to toil; the workers were extolled as the only useful individuals in the social fabric. They were imparted with a superior instinctive ability that rendered them into the arbiters of philosophy, art, and social organization. This curious emphasis on toil, this Puritanical work ethic of the left, instead of diminishing with the passage of time, acquired a new sense of urgency by the 1930's. Mass unemployment made the job and the social organization of labour *the* central theme of socialist propaganda. Instead of focusing their message on the emancipation of man from toil, socialists tended to depict socialism as a beehive of industrial activity, humming with work for all. The Communists incessantly pointed to Russia as a model of a socialist land, where every able-bodied individual was employed, indeed, where labour was continually in demand. Surprising as it may seem today, the fact is that little more than a generation ago, socialism was equated with a work-oriented society and liberty with the material security provided by full employment. The world of necessity, in effect, had subtly invaded and corrupted the ideal of freedom.

If the socialist notions of the last generation now seem to be anachronisms, this is due not to any superior insights that prevail today. The last three decades, particularly the years of the late 1950's, mark a turning-point in technological development—a technological revolution that negates all the values, political schemes, and social perspectives held by mankind throughout all previous recorded history. After thousands of years of torturous development, the countries of the Western world, and potentially all of humanity, are confronted by the possibility of an affluent, workless era —an epoch in which all the means and luxuries of life can be provided almost entirely by machines. As we shall see in the following section, a new technology has been developed that could replace the realm of necessity by the realm of freedom. So obvious is this fact to millions of people in the United States and Europe, that it no longer requires elaborate explanations or theoretical exegesis. This technological revolution and the prospects it holds for society as a whole form the premises of radically new life-styles among many young people, a generation no longer burdened by the values and age-old, work-oriented traditions of their elders. Even current demands for a guaranteed annual income irrespective of whether the recipient is engaged in work or not, sound like faint echoes of a new reality that currently permeates the thinking of young people today. Owing to the development of a cybernated technology, the notion of a toil-less mode of life has become an article of faith to an increasing number of young people in the 1960's.

In fact, the real issue we face today is not whether this new technology can provide us with the means of life in a workless society, but whether it can *humanize* society, whether it can contribute to the creation of new relationships between man and man. The demand for a guaranteed annual income is still anchored in the *quantitative* promise of a cybernated technology—the possibility of satisfying essential

material needs without toil. I submit that this quantitative type of solution, if such it can be called, is already lagging behind technological developments that carry a new, *qualitative* promise—the promise of decentralized, communitarian life-styles, or what I prefer to call ecological forms of human association.*

What I am asking, in effect, is a question that differs from what is ordinarily posed with respect to modern technology: Is this technology staking out a new dimension in human freedom, in the liberation of man? Can it lead man not only to freedom from want and work, but aid directly in shaping a harmonious, balanced human community—a community that would provide man with the soil for the unrestricted development of his potentialities? Can it not only eliminate the age-old struggle for existence, but nourish the desire for creation, both communally and individually?

THE POTENTIALITIES OF MODERN TECHNOLOGY

Let me try to answer these questions by pointing to a decisive feature of modern technology: For the first time in history, technology has reached an open end. What I mean by an "open end" is that the potential for technological development, for providing machines as substitutes for labour is essentially unlimited. Technology has finally passed from the realm of *invention* into that of *design*, from fortuitous discoveries into systematic innovations.

The meaning of this qualitative advance has been stated in a rather free-wheeling way by Dr. Vannevar Bush, the former director of the Office of Scientific Research and Development:

> Suppose, fifty years ago, that someone had proposed making a device which would cause an automobile to follow a white line down the middle of the road, automatically and even if the driver fell asleep … He would have been laughed at, and his idea would have been called preposterous. So it would have been then. But suppose someone called for such a device today, and was willing to pay for it, leaving aside the question of whether it would actually be of any genuine use whatever. Any number of concerns would stand ready to contract and build it. No real invention would be required. There are thousands of young men in the country to whom the design of such a device would be a pleasure. They would simply take off the shelf some photocells, thermionic tubes, servo-mechanisms, relays and, if urged, they would build what they call a breadboard model, and it would work. The point is that the presence of a host of versatile, cheap, reliable gadgets, and the presence of men who understand fully all their queer ways, has rendered the building of automatic devices almost straightforward and routine. It is no longer a question of whether they can be built, it is rather a question of whether they are worth building.

* An exclusively quantitative approach to the new technology, I may add, is not only economically archaic, but morally regressive. It partakes of the old moral principle of *justice*, as distinguished from the new moral principle of *liberation*. Historically, justice is derived from the world of material necessity and toil; it implies a domain of relatively scarce resources which are apportioned by a moral principle that is either "just" or "unjust". Justice, even "equal" justice, is a concept of *limitation*, involving the denial of goods and the sacrifice of time and energy to production. Once we transcend the concept of justice, of limitation—indeed, once we pass from the *quantitative* to the *qualitative* potentialities of modern technology—we enter the unexplored domain of liberation, of unrestricted freedom based on spontaneous organization and unlimited access to the means of life.

Bush focuses, here, on the two most important features of the new, so-called "second industrial revolution": The potentialities of modern technology and the cost-oriented, non-human limitations imposed upon them. I shall not belabour the fact that the cost factor—the profit motive, to state it bluntly—inhibits the use of technological innovations as well as promoting their application in many industries. It is fairly well established that in many areas of the economy it is often cheaper to use labour than machines. Instead, I would like to review several developments which have brought us to an open-end in technology and deal with a number of practical applications that have profoundly affected the role of labour in industry and agriculture.

Perhaps the most obvious development leading to the new technology has been the increasing interpenetration of scientific abstraction, mathematics, and analytic methods with the concrete, pragmatic, and rather mundane tasks of industry. This new order of relationships is relatively new. Traditionally, speculation, generalization, and rational activity had been sharply divorced from technology—a chasm created by the sharp split between the leisured and working classes of ancient and medieval society. Although a number of bridges had been created between the two domains, these structures were largely the inspired but episodic works of a few rare men, the pioneers of early applied science. Actually, applied science did not come into its own until the Renaissance and it began to really flourish in the nineteenth century, when scientific knowledge—the growing corpus of man's generalizations about the physical world—fertilized the mundane world of technology. The authentic personification of this new interplay between scientific generalization and technology is not the inventor, the James Watt or Thomas Edison, but the systematic investigator with catholic interests, the Michael Faraday, who almost simultaneously adds both to man's knowledge of scientific principles and to engineering. In our own day the synthesis embodied by the work of a single, inspired genius now reposes in the anonymous team of specialists—the co-operative activity of physicists, biologists, engineers, and technicians—with its clear-cut advantages, to be sure, but also with the resulting lack of vision, imagination, and inspiration so characteristic of bureaucratic modes of organization.

A second development, often less obvious, is the impact produced by industrial growth itself. This development is not always technological in the sense that a machine replaces labour. One of the most effective means of increasing output, in fact, has been the continual reorganization of the labour process, the extension and sophistication of the division of labour. Ironically, by an inner dialectic of its own, the steady breakdown of tasks to an ever-inhuman dimension, to an intolerably minute, fragmented series of operations, to a cruel simplification of the work process, suggests the machine that will recombine all the separate tasks of many workers into a single mechanized operation. Historically, it would be difficult to understand how mechanized mass manufacture emerged, how the machine increasingly displaced labour, without tracing its development from craftsmanship, where an independent, highly skilled worker engaged in many diverse operations on a single

commodity, through the purgatory of the factory, where these diverse tasks were parcelled out among a multitude of unskilled or semi-skilled employees, to the highly mechanized mill, where the tasks of many were largely taken over by machines, manipulated by a few operatives, and finally the automated and cybernated plant, where operatives are now replaced by supervisory technicians and highly skilled maintenance men.

Looking further into the matter, we find still another development—the evolution of the machine from an extension of human muscles into an extension of the human nervous system. In the past, both tools and machines enhanced man's muscular power over raw materials and natural forces. The mechanical devices and engines developed during the eighteenth and nineteenth centuries did not replace human biceps but rather extended their effectiveness. Although the machines increased output enormously, the worker's muscles and brain were still required to operate them, even for fairly routine tasks. The calculus of technological advance could be formulated in the strict terms of labour productivity: One man, using a given machine, produced as many commodities as five, ten, fifty, or a hundred before the machine was employed. Nasrnyth's steam hammer, exhibited in 1851, for example, could shape iron beams with only a few blows, an effort that would have required many man-hours of labour. But the hammer required the muscles and judgement of a half-dozen able-bodied men to pull, hold, and remove the casting. In time, much of this work was diminished by the invention of handling devices, but the labour and judgement involved in operating the machines formed an indispensable part of the productive process.

To develop fully automatic machines for complex mass-manufacturing operations requires the successful application of at least three technological principles: A built-in ability of the machine to correct its own errors; next, sensory devices for replacing the visual, auditory, and tactile senses of the worker; and finally, devices that provide an approximation of the worker's mental faculties—judgement, skill, and memory. The effective use of these three principles, to be sure, presupposes that we have also developed the technological means, the effectors, if you will, for applying the sensory, control, and mind-like devices to everyday industrial operations; that we can adapt existing machines or develop new ones for handling, shaping, assembling, packaging, and transporting semi-finished and finished products.

The use of automatic, self-correcting control devices in industrial operations is not new. James Watt's flyball governor, invented in 1788, provides an early mechanical example of how steam engines were self-regulated. Attached by metal arms to the engine valve, the governor essentially consists of a thin, rotating rod supporting two freely mounted metal balls. If the engine begins to operate too rapidly, the increased rotation of the rod impels the balls outward by centrifugal force, closing the valve; conversely, if the valve does not admit sufficient steam to operate the engine at the desired rate, the balls collapse inwardly, opening the valve further. A similar principle is involved in the operation of thermostatically controlled heating equipment. The thermostat, manually preset by a dial to a desired temperature level, automatically starts up heating equipment when the temperature falls and turns off the equipment when it rises. Both control devices illustrate what is now called the "feedback principle". In modern electronic equipment, the deviation of a machine from a desired level of operation produces electrical signals which are then used by the control device to correct the deviation or error. The electrical signals induced by the error are amplified and fed back by the control system to other devices which adjust the machine. A control system in which a departure from a norm is actually used to adjust a machine is called a *closed* system. This may be contrasted with an *open* system—say, a manually operated wall switch or the arms that automatically rotate an electric fan—in which the control operates without regard to the function of the device. Thus, if the wall switch is flicked, electric lights go on or off quite aside from whether it is night or day; similarly, the electric fan will rotate at the same speed whether a room is very warm or relatively cool. The fan may be automatic in the popular sense of the term, but it is not self-regulating in terms of its function.

Obviously, an important step toward developing self-regulating control mechanisms is the discovery of sensory devices. Today, these consist of thermocouples, photo-electric cells, x-ray machines, television cameras, and radar transmitters. Together or singly, they provide machines with an amazing degree of autonomy. Even without computers, these sensory devices make it possible for man to engage in extremely hazardous operations by remote control, placing a great deal of distance between the worker and the job. They can also be used to turn many traditional open systems into closed ones, thereby expanding the scope of automatic operations. For example, an electric light controlled by a clock represents a fairly simple open system; its effectiveness depends entirely upon mechanical factors. Regulated by a photo-electric cell that turns it off when daylight approaches, the light becomes a highly sophisticated and flexible device that responds to daily variations in sunrise and sunset. It is now meshed directly with its function.

With the advent of the computer, we enter into an entirely new dimension of industrial control systems. The computer is capable of performing all the routine tasks that ordinarily burdened the mind of the worker a generation or so ago. Basically, the modern digital computer is an electronic calculator, capable of performing arithmetical operations enormously faster than the human brain.* This element of speed is a crucial fact: the enormous rapidity of computer operations —a quantitative superiority of computer over human calculations—has a profound qualitative significance. By virtue of its speed, the computer can perform advanced, highly sophisticated mathematical and logical operations. Supported by memory units that store millions of bits of

* There are two broad classes of computers in use today: the analogue computer and the digital. The analogue computer has a fairly limited use in industrial operations. My discussion on computers in this article will deal entirely with digital computers.

information, and using binary arithmetic (the substitution of the digits 0 and 1 for the digits 0 through 9), a properly programmed digital computer can perform operations that approximate many highly developed logical activities of the mind. It is arguable whether computer "intelligence" is, or ever will be, creative or innovative, although every few years brings sweeping, often revolutionary changes in computer technology and programming. But there is no doubt that the digital computer is capable of taking over all the onerous and distinctly uncreative mental tasks of man in industry, science, engineering, information retrieval, record-keeping, and transportation. Modern man, in effect, has produced an electronic "mind" for co-ordinating, guiding, and evaluating most of his routine industrial operations. Properly used within the sphere of competence for which they are designed, computers are faster and more efficient than man himself.

Taken as a whole, what is the concrete significance of this new industrial revolution? What are its immediate and foreseeable implications for work? Let us trace the impact of the new technology on the work process by examining its application to the manufacture of automobile engines at the Ford plant in Cleveland. This single instance of technological sophistication in about a decade of development will help us assess the liberatory potential of the new technology in all manufacturing industries.

Until the advent of cybernation in the automobile industry, the Ford plant required about 300 workers, using a large variety of tools and machines, to turn an engine block into an engine. The process from foundry casting to a fully machined and complete engine took more than three weeks. With the development of what we commonly call an "automated" machine system, the time required to transform the casting into an engine was reduced from three weeks to less than 15 minutes.

Aside from a few monitors to watch the automatic control panels, the original 300-man labour force was entirely eliminated. Later a computer was added to the machining system, turning it into a truly closed, cybernated system. The computer regulates the entire machining process, operating on an electronic pulse that cycles at a rate of three-tenths of a millionth of a second.

But even this system is obsolete. "The next generation of computing machines operates a thousand times as fast—at a pulse rate of one in every three-tenths of a billionth of a second." observes Alice Mary Hilton. "Speeds of millionths and billionths of a second are not really intelligible to our finite minds. But we can certainly understand that the advance has been a thousand-fold-within a year or two. A thousand times as much information can be handled or the same amount of information can be handled a thousand times as fast. A job that takes more than 16 hours can be done in one minute! And without any human intervention! Such a system does not control merely an assembly line but a complete manufacturing and industrial process!"

There is no reason why the basic technological principles involved in cybernating the manufacture of automobile engines cannot be applied to every area of mass manufacture—from the metallurgical industry to

the food processing industry, from the electronics industry to the toy-making industry, from the manufacture of prefabricated bridges to the manufacture of prefabricated houses. Many phases of steel production, of tool- and die-making, of electronic equipment manufacture, of industrial chemical production—the list, in fact, is nearly endless—are now partly or wholly automated. What tends to delay the advance of complete automation to every phase of modern industry is largely the enormous cost involved in replacing existing industrial facilities by new, more sophisticated ones and, partly, the innate conservatism of many major corporations. Finally, as I mentioned before, it is still cheaper to use labour instead of machines in many industries.

Every industry, to be sure, has its own peculiar problems and the application of a workless technology to a specific plant would doubtless reveal a multitude of kinks that would require careful, painstaking solution. It would be necessary in many industries to alter the shape of a product and the layout of a plant so that the manufacturing process lends itself to automated techniques. But to argue from these problems that the application of a fully automated technology to a specific industry is impossible would be as preposterous as to have argued, years ago, that flight was impossible because the propeller of an experimental airplane did not revolve fast enough or the frame was too fragile to withstand buffeting by the wind. There is no industry that cannot be fully automated if we are willing to redesign the product, the plant, the manufacturing procedures, and the handling methods. In fact, any difficulty in describing how, where, or when a given industry will be automated arises not from the unique problems we can expect to encounter, but rather from the enormous leaps that occur every few years in modern technology. Almost every account of applied automation, today, must be regarded as provisional, for no sooner do we commit a description of an automated industry to paper but that we learn of remarkable advances which render our description obsolete.

There is one area of the economy, however, in which any form of technological advance is worth describing—the area of work that is most brutalizing and degrading for man. If it is true, as radical thinkers have argued, that the moral level of a society can be gauged by the way it treats women, its sensitivity to human suffering can be gauged by the working conditions it provides for people in raw materials industries, specifically in mines and quarries. In the ancient world, mining was often a form of penal servitude, reserved primarily for the most hardened criminals, the most intractable slaves, and the most hated prisoners of war. The mine is the day-to-day actualization of man's image of hell—dismal to the eye, stunting the body and spirit, a deadened inorganic world, a treacherous cavern that demands pure mindless toil. "Field and forest and stream and ocean are the environment of life: the mine is the environment alone of ores, minerals, metals," writes Lewis Mumford.

…In hacking and digging the contents of the earth, the miner has no eye for the forms of things: what he sees is sheer matter, and until he gets to his vein it is only an obstacle which he breaks through stubbornly and sends up to the surface. If the miner sees shapes on the

walls of his cavern, as the candle flickers, they are only the monstrous distortions of his pick or his arm: shapes of fear. Day has been abolished and the rhythm of nature broken: continuous day-and-night production first came into existence here. The miner must work by artificial light even though the sun be shining outside; still further down in the seams, he must work by artificial ventilation, too: a triumph of the "manufactured environment".

The abolition of mining as a sphere of human activity would represent, in its own way, the token of a liberatory technology. That we can point to this achievement already, even in a single case at this writing, presages the freedom from toil implicit in the technology of our time. The first major step in this direction. at least so far as the coal industry is concerned, was taken by the continuous miner, a giant cutting machine with 9-foot blades that slices up eight tons of coal a minute from the coal face. It was this machine, together with mobile loading machines, power drills, and roof bolting that reduced mine employment in areas like West Virginia to about a third of the 1948 employment levels—at the same time nearly doubling individual output. The coal mine still required miners to place and operate the machines. The most recent technological advances, however, replace the operators by radar sensing-devices and eliminate the miner completely.

By adding sensing devices to automatic machinery we could easily remove the worker not only from the large, productive mines needed by the economy, but also from forms of agricultural activity patterned on modern industry. Although the wisdom of industrializing and mechanizing agriculture is highly questionable (I shall return to this subject at a later point), the fact remains that if society so chooses, it can easily automate large areas of modern agriculture, from cotton-picking to rice harvesting. We could operate almost any machine, be it a giant shovel in an open-strip mine or a grain harvester in the Great Plains, either by cybernated sensing devices or by remote control with television cameras. The amount of work needed to operate these devices and machines at a safe distance, in comfortable quarters, would be minimal, assuming that a human operator were required at all. It is easy to foresee a time, by no means remote, when a rationally organized economy could automatically manufacture small "packaged" factories without human labour; when parts could be produced with so little effort that most maintenance tasks would be reduced to the simple act of removing a defective unit from a machine and replacing it by another, a job no more difficult than pulling out and putting in a tray; when machines, in short, would make and repair most of the machines required to maintain a highly industrialized economy. Such a technology, oriented entirely toward human needs and freed from all considerations of profit and loss, would provide humanity with an abundance of goods unprecedented even by modern Western standards of material affluence. The machines at man's disposal would eliminate the *ponos* of want and toil, the penalty inflicted in the form of denial, suffering and inhumanity exacted by a society based on scarcity and labour.

In these circumstances, the issues raised by a cybernated technology

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would be transformed from the satiation of man's material needs to the re-integration of society. It would be our responsibility, now, to determine how the machine, the factory, and the mine could be used to foster human solidarity, a balanced relationship with nature, and a truly organic community. Would our new technology be employed on a large scale, based on a national economy and vested in giant industrial enterprises? This type of industrial organization—an extension, in effect, of the Industrial Revolution—would require a centralized system of national planning, the delegation of authority to economic and political representatives with strategic, decision-making powers—powers strengthened by the control they exercise over a large, socialized industrial plant, national in scope and anonymous in character. Large-scale industry by its very nature is the breeding ground of bureaucratic modes of administration, be it privately owned or under "workers control". To the degree that it is socialized in the regressive sense that it transcends the human scale, it becomes the strongest material support for the centralized, authoritarian state.

Or does the new technology lend itself to small-scale production, based on a regional economy and physically structured on a human scale? This type of industrial organization tends to place all strategic economic decisions in the hands of the local community, with its popular assemblies and with its technical boards clearly within the purview of the individual communitarian. To the degree that material production is decentralized and localized, to that degree is the primacy of the community asserted over national institutions, assuming that any develop to a significant extent. Primary authority belongs to the popular assembly of the community, convened in a face-to-face democracy; the authority of the assembly is qualitatively strengthened by the fact that it has exclusive command over all the material resources of society.

The question. in effect, is whether society would be organized around technology or whether technology would be organized around society. Our answer can be obtained only by examining the new technology itself with a view toward determining if it can be scaled to human dimensions.

THE NEW TECHNOLOGY AND THE HUMAN SCALE

In 1945, J. Presper Eckert, Jr., and John W. Mauchly of the University of Pennsylvania unveiled ENIAC, the first digital computer to be designed entirely along electronic principles. Commissioned for use in solving ballistic problems, ENIAC required nearly three years of work to design and build. The computer was enormous. It occupied 1,500 square feet of floor space and weighed more than 30 tons: it contained 18,800 vacuum tubes with 500,000 connections (these connections took Eckert and Mauchly two-and-a-half years to solder), a vast network of resistors, and miles of wiring. The computer required a large air-conditioning unit to cool its electronic components and it broke down often or behaved erratically, entailing time-consuming repairs. Yet by all previous standards of computer development, ENIAC was an electronic marvel. It could perform 5,000 computations a second, generating electrical pulse signals that cycled at 100,000 a

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second. None of the mechanical or electro-mechanical computers in use at the time could approach this rate of computational speed.

Some 20 years later, the Computer Control Company of Framingham, Massachusetts, offered the DDP-124 for public sale. The DDP-124 is a small, compact computer that closely resembles a bedside AM-FM radio receiver: together with a typewriter and memory unit, the entire ensemble comfortably occupies a typical office desk. The DDP-124 performs over 285,000 computations a second. It has a true stored programme memory that can be expanded to retain nearly 33,000 words (the "memory" of ENIAC, by contrast, progressed according to preset plug wires and lacked anything near the flexibility of present-day computers); its pulses cycle at 1.75 billion per second. The DDP-124 does not require any air-conditioning unit, it is completely reliable, and it creates very few maintenance problems. It can be built at a minute fraction of the cost required to construct ENIAC.

The difference between ENIAC and the DDP-124 is basically one of degree rather than kind. If we leave aside their memory units, both digital computers operate according to the same basic electronic principles. ENIAC, however, was composed primarily of traditional electronic components (vacuum tubes, resistors, etc.) and thousands of feet of wire; the DDP-124, on the other hand, relies primarily on microcircuits. These microcircuits are generally very small electronic units —squares a mere fraction of an inch in size—that pack the equivalent of many of ENIAC's key electronic components.

Paralleling the miniaturization of computer components is the remarkable sophistication of traditional forms of technology—a degree of sophistication that yields ever-smaller machines of all types. To cite one example: A fascinating breakthrough has already been achieved in reducing the size of continuous hot-strip steel rolling-mills. A typical mill of this kind is one of the largest and costliest facilities in modern industry. It may be regarded as a single machine, nearly a half mile in length, capable of reducing a ten-ton slab of steel about six inches thick and 50 inches wide to a thin strip of sheet metal, a tenth or a twelfth of an inch thick. A hot-strip mill runs the steel slab through scale-breaker stands, roughing stands with huge vertical rollers, and a series of finishing stands. The entire installation, including heating furnaces, coilers, long roller tables, and buildings, may cost in excess of 50 million dollars and occupy 50 acres. It produces 300 tons of steel sheet an hour. To be used efficiently, a continuous hot-strip mill must be operated together with large batteries of coke ovens, open-hearth furnaces, blooming mills, etc. These facilities, in conjunction with hot and cold rolling mills, may cover several square miles. It is a modern steel complex, geared to a national division of labour, to highly concentrated sources of raw materials (located at a great distance from the complex), and geared toward large national and international markets. Even if totally automated, its operating needs and management far transcend the capabilities of a small, decentralized community. The type of administration it requires is essentially national in scope. Its economic weight, in effect, is thrown in support of centralistic institutions.

Fortunately, we now have a number of alternatives—in many respects, more efficient alternatives—to the modern steel complex. We can replace blast and open-hearth furnaces with electric furnaces. These are generally quite small and produce excellent pig iron and steel; they operate not only with coke as a reducing agent, but also with anthracite coal, charcoal, and even lignite. Or we can choose the HyL process, a batch process in which high-grade ores or concentrates are reduced to sponge iron by means of natural gas. Or we can turn to the Wiberg process in which reduction is achieved by the use of carbon monoxide and a little hydrogen. In any case, we can eliminate the need for coke ovens, blast furnaces, open hearth furnaces, and possibly even solid reducing agents.

But the most important step in the direction of scaling down the size of the steel complex to community dimensions is the development of the planetary mill by T. Sendzimir. The planetary mill reduces the typical continuous hot-strip mill to a single planetary stand and a light finishing stand. Hot steel slabs, 2¼ inches thick, pass through two small pairs of heated feed rolls and a set of work rolls, mounted in two circular cages, which also contain two back-up rolls. By operating the cages and back-up rolls at different rotational speeds, the work rolls are made to turn in two directions. This gives the steel slab a terrific mauling and reduces it to a thickness of only one-tenth of an inch. Sendzimir's technique can be regarded as a stroke of engineering genius; the small work rolls, turning on the two circular cages, are given a force that can only be achieved by four huge roughing stands and six finishing stands in a continuous hot-strip mill.

What this means is that the rolling of hot steel slabs requires a much smaller operational area than that occupied by a continuous hot-strip mill. With continuous casting, moreover, we can produce steel slabs without the need for large, costly slabbing mills. Taken altogether: Several electric furnaces, the use of continuous casting, a planetary mill, and a small, continuous cold-reducing mill, occupying little more than an acre or two, would be fully capable of meeting the steel needs of a moderate-sized community. This small, highly sophisticated complex would produce an extremely high grade of steel and involve substantially lower heat costs and scale losses. Without automation, it would still require fewer men to operate, even if we account for its lower output level, than a conventional steel complex. It could reduce lower grade ores more efficiently and with less difficulty. And finally, since the planetary mill produces a shiny and clean strip for cold rolling merely with high-pressure water, it eliminates acid-pickling and the need to dispose of waste-pickling liquor—a major source of stream pollution caused by conventional steel plants.

The complex I have described is not designed to meet the needs of a national market of the kind that exists in the United Slates today. It is suited for meeting the steel requirements of small- or moderate-sized communities and industrially undeveloped countries. Most electric furnaces produce about 100 to 250 tons of molten iron a day, compared with new large blast furnaces that produce 3,000 tons daily. A planetary mill can roll only a hundred tons of steel strip an hour,

roughly a third of the output of a continuous hot-strip mill. Yet the very productive scale of our hypothetical steel complex constitutes one of its most desirable features. Owing to the more durable steel produced by our complex, the community's need to continually replenish its steel products is appreciably reduced. Since the complex requires ore, fuel, and reducing agents in only small batches, many communities can rely on local resources for their raw materials, conserving the more concentrated resources of centrally located sources of supply, strengthening the independence of the community itself vis-a-vis the traditional centralized economy, and reducing the expense of transportation. What may seem to be a costly, inefficient duplication of effort that could be solved by a few centralized steel complex would prove, in the long run, to be more efficient as well as socially more desirable.

The new technology has produced not only miniaturized electronic components and strategic alternatives to centralized forms of production, but also highly versatile, multi-purpose machines. For more than a century, the trend in machine design moved increasingly toward technological specialization and single-purpose devices, reflecting the intensive division of labour that tightened its grip around industry. The operation was subordinated to the product. In time, this narrow pragmatic approach "led industry far from the rational line of development in production machinery," observe Eric W. Leaver and John J. Brown. "It has led to increasingly uneconomic specialization … Specialization of machines in terms of end product requires that the machine be thrown away when the product is no longer needed. Yet the work the production machine does can be reduced to a set of basic functions-forming, holding, cutting, and so on-and these functions, if correctly analyzed, can be packaged and applied to operate on a part as needed."

Ideally, a Leaver and Brown drilling machine would be able to produce a hole small enough to hold a thin wire or large enough to admit a pipe. Machines with this operational range were once regarded as economically prohibitive. By the mid-1950's, however, a number of these machines were actually designed and put to use. In 1954, for example, a horizontal boring mill was built in Switzerland for the Ford Motor Company's River Rouge Plant in Dearbon, Michigan. The boring mill would qualify beautifully as a Leaver and Brown machine. Equipped with five optical microscopic-type illuminated control-gauges, it drills holes smaller than a needle's or larger than a man's fist. The holes are accurate to a ten-thousandth of an inch.

The importance of machines with this kind of operational range can hardly be overestimated. They make it possible to produce a dazzling variety of products in a single plant. A small- or moderate-sized community using multipurpose machines could satisfy many of its needs for a limited number of goods without burdening itself with underused industrial facilities. There would be less loss in scrapping tools for the older single-purpose machines and less of a need for single-purpose plants. The economy of the community, in effect, would become more compact and versatile, more rounded and autarchal

than anything we find today in industrially advanced countries. The effort that goes into retooling machines for new products would be enormously reduced. Retooling would generally involve changes in dimensioning rather than in the design and type of machine required for the job. This might merely mean changing the drill in a boring machine or the cutting tool in a lathe. Finally, multipurpose machines with a wide operational range are relatively easy to automate. The changes required to use these machines in a cybernated industrial facility would generally involve changes in circuitry and programming rather than in machine form and structure.

Single-purpose machines, of course, would continue to exist and they would be used for much the same function they have today: the mass manufacture of widely used non-durable goods. At the present time we have striking examples of highly automatic, single-purpose machines, often small installations, that can be employed with very little modification by decentralized communities. Bottling and canning machines, for example, are compact, automatic, and highly rationalized installations. We could expect to see smaller automatic textile, chemical processing and food processing machines after decentralized communities are established. A major shift from conventional automobiles, buses and trucks, to electric vehicles would undoubtedly lead to industrial facilities much smaller in size than existing automotive plants. Many remaining centralized facilities could be effectively decentralized by making them as small as possible and sharing their use among several communities.

I do not profess to claim that all of man's economic activities can be completely decentralized, but the majority surely can be scaled to human and communitarian dimensions. *It is enough to say that we can shift the overwhelming weight of the economy from national lo communitarian bodies, from centralized bureaucratic forms to local, popular assemblies in order to secure the sovereignty of the free community on solid industrial foundations*. This shift would comprise a historic change of qualitative proportions, a revolutionary social change of vast proportions, unprecedented in man's technological and social development.

THE ECOLOGICAL USE OF TECHNOLOGY

I have tried, thus far, to deal with a number of tangible, clearly objective issues: the possibility of eliminating toil, material insecurity, and centralized economic control. In the present section, I would like to deal with a problem that may seem somewhat subjective, but one which is nonetheless of compelling importance: the need to make man's dependence upon the natural world a visible and living part of his culture.

The problem is unique to our highly urbanized and industrialized society. In nearly all pre-industrial cultures, man's relationship to his natural environment required very little clarification; the relationship was well-defined, viable, and sanctified by the full weight of tradition and myth. Changes in season, variations in rainfall, the life cycles of the plants and animals on which humans depended for food and clothing, the distinctive features of the area occupied by the community—all were

familiar, comprehensible, and evoked in men a sense of religious awe, of oneness with nature, and more pragmatically, a sense of respectful dependence. Looking back to the earliest civilizations of the Western world, we rarely encounter a system of social tyranny so overbearing and ruthless that it ignored this relationship. Barbarian invasions and, more insidiously, the development of commercial civilizations may have destroyed the gains achieved by established agrarian cultures, but the normal development of agricultural systems, however exploitative they were of men, rarely led to the destruction of the soil and terrain. During the most oppressive periods in the history of ancient Egypt and Mesopotamia, the ruling classes tried to keep the irrigation dikes in good repair and promote rational methods of food cultivation. Even the ancient Greeks, heirs to a thin, mountainous forest soil that suffered heavily from erosion, shrewdly reclaimed much of their arable land by turning to orchardry and viticulture. Throughout the Middle Ages the heavy soils of Europe were slowly and superbly reworked for agricultural purposes. Generally, it was not until commercial agricultural systems and highly urbanized societies developed that the natural environment was unsparingly exploited. Some of the worst cases of soil destruction in the ancient world were provided by the giant, slave-worked commercial farms of North Africa and the Italian peninsula.

In our own time, the development of technology and the growth of cities has brought man's alienation from nature to a breaking point. Western man finds himself confined to a largely synthetic urban environment, far removed physically from the land, his relationship to the natural world mediated by machines. Not only does he lack familiarity with how most of his goods are produced, but his foods bear only the faintest resemblance to the animals and plants from which they were derived. Boxed into a sanitized urban milieu (almost institutional in form and appearance), modern man is denied even a spectatorial role in the agricultural and industrial systems that satisfy his material needs. He is a pure consumer, an insensate receptacle. It would be cruel to say that he is disrespectful toward his natural environment; the fact is that he scarcely knows what ecology means or what his environment requires to remain in balance.

The balance must be restored—not only in nature but between man and nature. Elsewhere, I tried to show that unless we establish some kind of equilibrium between man and the natural world, the viability of the human species will be placed in grave jeopardy.* Here, I shall try to show how the new technology can be used ecologically to crystalize man's sense of dependence upon the environment; how, by reintroducing the natural world into the human experience, we can contribute to the achievement of human wholeness.

The classical utopians fully realized that the first step in this direction must be to remove the contradiction between town and country. "It is impossible," wrote Fourier nearly a century and a half

* See Lewis Herber: "Ecology and Revolutionary Thought" in ANARCHY 69, November, 1966.

ago, "to organize a regular and well-balanced association without bringing into play the labours of the field, or at least gardens, orchards, flocks and herds, poultry yards, and a great variety of species, animal and vegetable." Shocked by the social effects of the Industrial Revolution, Fourier added: "They are ignorant of this principle in England, where they experiment with artisans, with manufacturing labour alone, which cannot by itself suffice to sustain social union."

To argue that the modern urban dweller should once again enjoy "the labours of the field" might well seem like gallows humour. A restoration of the peasant agriculture prevalent in Fourier's day is neither possible nor desirable. Charles Gide was surely correct when he observed that agricultural labour "is not necessarily more attractive than industrial labour; to till the earth has always been regarded … as the type of painful toil, of toil which is done with 'the sweat of one's brow'." Fourier does not remove this objection by suggesting that his Phalansteries will mainly cultivate fruits and vegetables instead of grains. If our vision were to extend no further than prevailing techniques of land management, the only alternative to peasant agriculture would seem to be a highly specialized and centralized form of farming, its techniques paralleling the methods used in present-day industry. In fact, far from achieving a balance between town and country, we would be faced with a synthetic environment that had totally assimilated the natural one.

If we grant that the land and the community must be reintegrated physically, that the community must exist in an agricultural matrix which renders man's dependence upon nature explicit, the problem we face is how to achieve this transformation without imposing "painful toil" on the community. How, in short, can husbandry, ecological forms of food cultivation, and farming on a human scale be practised without sacrificing mechanization? Some of the most promising technological advances in agriculture made since World War II are as suitable for small-scale, ecological forms of land management as they are for the immense, industrial-type commercial units that have become prevalent over the past few decades. Let us consider a few examples:

The augermatic-feeding of livestock illustrates a cardinal principle of rational farm mechanization — the deployment of conventional machines and devices in a way that virtually eliminates arduous farm labour. By linking a battery of silos with augers, for instance, different nutrients are mixed and transported to feed pens by merely pushing some buttons and pulling a few switches. A job that may have required the labour of five or six men, working a half day with pitchforks and buckets, can now be performed in a few minutes. This type of mechanization is intrinsically neutral: it can be used to feed immense herds or just a few hundred head of cattle; the silos may contain natural feed or synthetic, harmonized nutrients; the feeder can be employed on relatively small farms with mixed livestock or on large beef-raising ranches, or on dairy farms of all sizes. In short, augermatic-feeding can be placed in the service of the most abusive kind of commercial exploitation or the most sensitive applications of ecological principles.

This holds true for most of the farm machines that have been designed (in many cases, simply redesigned to achieve greater versatility) in recent years. The modern tractor, for example, is a work of superb mechanical ingenuity. Garden-type models can be used with extraordinary flexibility for a large variety of tasks; light and extremely manageable, they can follow the contour of the most exacting terrain without damaging the land. Large tractors, especially those used in hot climates, are likely to have air-conditioned cabs; in addition to pulling equipment, they may have attachments for digging post-holes, for doing the work of forklift trucks, or even providing power units for grain elevators. Ploughs have been developed to meet every contingency in tillage. Advanced models are even regulated hydraulically to rise and fall with the lay of the land. Mechanical planters are available for virtually every kind of crop. On this score, "minimum tillage" is achieved by planters which apply seed, fertilizer, and pesticides (of course!) simultaneously, a technique that telescopes several different operations into a single one and reduces the soil compaction often produced by the recurrent use of heavy machines.

The variety of mechanical harvesters bas reached dazzling proportions. Harvesters have been developed for many different kinds of orchards, berries, vine and field crops, and of course, grains. Barns, feed pens, and storage units have been totally revolutionized by augers, conveyor belts, air-tight silos, automatic manure removers, climate-control devices, *ad infinitum*. Crops are mechanically shelled, washed, counted, preserved by freezing or canning, packaged, and crated. The construction of concrete-lined irrigation ditches is reduced to a simple mechanical operation that can be performed by one or two excavating machines. Terrain with poor drainage or subsoil can be improved by earth-moving equipment and by tillage devices that penetrate well beyond the true soil.

Although a great deal of agricultural research is devoted to the development of harmful chemical agents and nutritionally dubious crops, there have been extraordinary advances in the genetic improvement of food plants. Many new grain and vegetable varieties are resistant to insect predators, plant diseases, and cold weather. In many cases, these varieties are a definite improvement over natural ancestral types and they have been used to open large areas of intractable land to food cultivation. The tree shelter programme, feebly initiated during the 1920's, is slowly transforming the Great Plains from a harsh, agriculturally precarious region into one that is ecologically more balanced and agriculturally more secure. The trees act as windbreaks in the winter and as refuges for birds and small mammals in warm weather. They promote soil and water conservation, help control insects, and prevent wind damage to crops in summer months. Programmes of this type could be used to make sweeping improvements in the natural ecology of a region. So far as America is concerned, the tree shelter programme (much of which has been carried out without any state aid) represents a rare case where man, mindful of the unfulfilled potentialities of a region, has vastly improved a natural environment.

Let us pause, at this point, to envision how our free community is

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integrated with its natural environment. We suppose the community has been established after careful study has been made of its natural ecology — its air and water resources, its climate, its geological formations, its raw materials, its soils, and its natural flora and fauna. The population of the community is consciously limited to the ecological carrying capacity of the region. Land management is guided entirely by ecological principles so that an equilibrium is maintained between the environment and its human inhabitants. Industrially rounded, the community forms a distinct unit within a natural matrix, socially and artistically in balance with the area it occupies.

Agriculture is highly mechanized but as mixed as possible with respect to crops, livestock, and timber. Floral and faunal variety is promoted as a means of controlling pest infestations and enhancing scenic beauty. Large-scale farming is permitted only where it does not conflict with the ecology of the region. Owing to the generally mixed character of food cultivation, agriculture is pursued by small farming units, each demarcated from the other by tree belts, shrubs, and where possible, by pastures and meadows. In rolling, hilly or mountainous country, land with sharp gradients is covered by timber to prevent erosion and conserve water. The soil on each acre is studied carefully and committed only to those crops for which it is most suited.

Every effort is made to blend town and country without sacrificing the distinctive contribution that each has to offer to the human experience. The ecological region forms the living social, cultural, and biotic boundaries of the community or of the several communities that share its resources. Each community contains many vegetable and flower gardens, attractive arbours, park land, even streams and ponds which support fish and aquatic birds. The countryside, from which food and raw materials are acquired, not only constitutes the immediate environs of the community, accessible to all by foot, but also invades the community. Although town and country retain their identity and the uniqueness of each is highly prized and fostered, nature appears everywhere in the town, and the town seems to have caressed and left a gentle, human imprint on nature.

I believe that a free community will regard agriculture as husbandry, an activity as expressive and enjoyable as crafts. Relieved of toil by agricultural machines, communitarians will approach food cultivation with the same playful and creative attitude that men so often bring to gardening. Agriculture will become a living part of human society, a source of pleasant physical activity and, by virtue of its ecological demands, an intellectual, scientific, and artistic challenge. Communitarians will blend with the world of life around them as organically as the community blends with its region. They will regain the sense of oneness with nature that existed in humans from primordial times. Nature and the organic modes of thought it always fosters will become an integral part of human culture; it will reappear with a fresh spirit in man’s paintings, literature, philosophy, dances, architecture, domestic furnishings, and in his very gestures and day-to-day activities. Culture and the human psyche will be thoroughly suffused by a new animism.

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The region will never be exploited but it will be used as fully as possible. This is vitally important in order to firmly root the dependence of the community on its environment, to restore in man a deep, abiding respect for the needs of the natural world—a respect identified with human survival and well-being. Every attempt will be made to satisfy the community's requirements locally—to use the region's energy resources, minerals, timber, soil, water, animals and plants as rationally and humanistically as possible, and without violating ecological principles. In this connection, we can foresee that the community will employ new techniques that are being developed today, many of which lend themselves superbly to a regionally based economy. I refer, here, to methods for extracting trace and diluted resources from the earth, water, and air; solar, wind, hydro-electric, and geothermal energy; the use of heat pumps, vegetable fuels, solar ponds, thermo-electric convertors, and eventually controlled thermo-nuclear reactions.

There is a kind of industrial archeology that reveals in many areas the evidence of a once-burgeoning economic activity long abandoned by our predecessors. From the Hudson Valley to the Rhine. from the Appalachians to the Pyrenees, we find the relics of mines and highly developed metallurgical crafts, the fragmentary remains of local industries, and the outlines of long-deserted farms — all, vestiges of flourishing communities based on local raw materials and resources. In many cases, these communities declined because the products they once furnished were elbowed out by industries with national markets, based on mass production techniques and concentrated sources of raw materials. The old resources quite often are still available for use in the locality; "valueless" in a highly urbanized society, they are eminently suitable for decentralized communities and await the application of industrial techniques that are adapted for small-scale, quality production. If we were to seriously take an inventory of the resources available in many depopulated regions of the world, the possibility for communities satisfying their material need in these areas is likely to be greater than we ordinarily think.

Technology itself, by its continual development, tends to expand these local possibilities. As an example, let us consider how seemingly inferior, highly intractable resources are made available to industry by technological advances. Throughout the late nineteenth and early twentieth centuries, the Mesabi range in Minnesota provided the American steel industry with extremely rich ores. an advantage which led to the rapid expansion of the domestic metal industry. As these fine reserves declined, the country was faced with the problem of mining taconites, a low-grade ore that contains about 40 per cent iron. Mining taconites by conventional methods is virtually impossible; it takes a churn drill an hour to bite through only one foot. In recent years, however, the mining of taconites became feasible when a jet-flame drill was developed which cuts through the ore at the rate of 20 to 30 feet an hour. After holes are burned by the flame, the ore is blasted and processed for the steel industry by means of a series of newly perfected grinding, separating, and agglomerating operations.

When we reach the next technological horizon it may be possible to,

extract highly diffused or diluted minerals and chemicals from the earth, gaseous waste products, and the sea. Many of our most valuable metals, for example, are actually very common, but they exist in diffused or trace amounts. Hardly a patch of soil or a common rock exists that does not contain traces of gold, larger quantities of uranium, and progressively more amounts of industrially useful elements, such as magnesium, zinc, copper, and sulphur. About five per cent of the earth's crust is made of iron. How to extract these resources? The problem has been solved, in principle at least, by the very analytical techniques chemists use to detect them. As the highly gifted chemist Jacob Rosin argues, if they can be detected in the laboratory, there is every reason to hope that eventually they will be extracted on a sufficiently large scale to be used by decentralized communities.

For more than half a century, already, most of the world's commercial nitrogen has been extracted from the atmosphere. Magnesium, chlorine, bromine, and caustic soda are acquired from sea water; sulphur from calcium sulphate and industrial wastes. Large amounts of industrially useful hydrogen could be collected as a by-product of the electrolysis of brine, but normally it is burned or released in the air by chlorine-producing plants. Carbon could be rescued in enormous quantities from smoke and used economically (actually, the element is comparatively rare in nature), but it is dissipated together with other gaseous compounds in the atmosphere. The problem industrial chemists face in extracting valuable elements and compounds from the sea and ordinary rock, centres around sources of cheap energy. Two methods—ion exchange and chromatography—exist and, if further perfected for industrial uses, could be used to select or separate the desired resources from solutions; but the amount of energy involved to use these methods would be very costly to any society in terms of real wealth. Unless there is an unexpected breakthrough in extractive techniques, there is little likelihood that conventional sources of energy—fossil fuels such as coal and oil—will be used to solve the problem.

Actually, it is not that we lack energy *per se* to realize man's most extravagant technological visions, but we are just beginning to learn how to use the sources that are available in limitless quantity. The gross radiant energy striking the earth's surface from the sun is estimated to be 3,200 Q, more than 3,000 times the annual energy consumption of mankind today.* A portion of this energy is converted into wind or used in photosynthezing land vegetation, but a staggering quantity is theoretically available for domestic and industrial purposes. The problem is how to collect it, even if only to satisfy a portion of our energy needs. If solar energy could be collected for house-heating, for example, 20 to 30 per cent of the conventional energy resources we normally employ could be redirected to other purposes. If we could collect solar energy for all or most of our cooking, water heating, smelting, and power production, we would have relatively little need for fossil fuels. What is tantalizing about recent research in this area is the

* A "Q" is equal to 2.93 x 10^{14}kWh (kilowatt-hours).

fact that solar devices have been designed for nearly all of these functions. We *can* heat houses, cook food, boil water, melt metals, and produce electricity with devices that use the sun's energy exclusively, but we can't do it efficiently in every latitude of the earth inhabited by man and we are still confronted with a number of technical problems that can be solved only by crash research programmes.

At this writing, quite a few houses have been built that are effectively heated by solar energy. In the United States, the most well known of these are the MIT experimental buildings in Massachusetts, the Lof house in Denver, the Thomason homes in Washington, D.C., and the prize-winning solar-heated house built by the Association for Applied Solar Energy near Phoenix, Arizona. Thomason, whose fuel costs for a solar-heated house barely reaches $5 a year, seems to have developed one of the most practical systems at hand. Solar heat in a Thomason home is collected by a portion of the roof and transferred by circulating water to a storage tank in the basement. (The water, incidentally, can also be used for cooling the house and as an emergency supply for drinking purposes and fire.) Although the system is simple and fairly cheap, it is very ingeniously designed. Located in Washington near the 40th parallel of latitude, the house stands at the edge of the "solar belt"—the latitudes from 0 to 40 degrees North and South. This belt comprises the geographic area where the sun's rays can be used most effectively for domestic and industrial energy. That Thomason requires a miniscule amount of supplemental conventional fuel to heat his Washington homes comfortably augurs well for solar-heating in all areas of the world with similar or warmer climates.

This does not mean, to be sure, that solar house-heating is useless in northern and colder latitudes. Two approaches to solar house-heating are possible in these areas: the use of more elaborate heating systems which reduce the consumption of conventional fuel to levels approximating those of the Thomason homes, or the use of simple systems which involve the consumption of conventional fuel to satisfy anywhere from 10 to 50 per cent of the heating needs. In either case, as Hans Thirring observes with an eye toward costs and effort:

The decisive advantage of solar heating lies in the fact that no running costs arise, except the electricity bill for driving the fans, which is very small. Thus the one single investment for the installation pays once and for all the heating costs for the lifetime of the house. In addition, the system works automatically without smoke, soot, and fume production, and saves all trouble in stoking, refuelling; cleaning, repair, and other work. Adding solar heat to the energy system of a country helps to increase the wealth of the nation, and if all houses in areas with favourable conditions were equipped with solar heating systems, fuel saving worth millions of pounds yearly could be achieved. The work of Telkes, Hottel, Lof, Bliss, and other scientists who are paving the way for solar heating is real pioneer work, the full significance of which will emerge more clearly in the future.

It is significant that Thirring's words read like an appeal to a world strangled by considerations of profit (particularly those of industries enriched by the exploitation of conventional fuels)—indeed, that these words must seem like a justification for a shamefully neglected area of research.

The most widespread applications of solar energy devices, today, are cooking and water heating. Many thousands of solar stoves are used in underdeveloped countries, in Japan, and in the warm latitudes of the United States. A solar stove is simply an umbrella-like reflector, equipped with a grill that can broil meat or boil a quart of water in bright sunlight in only 15 minutes. Safe, portable, and clean, it does not require fuel or matches nor does it produce any annoying smoke. A portable solar oven delivers temperatures as high as 450 degrees and is even more compact and easy to handle than a solar stove. Solar water-heaters are employed to heat water for private homes, apartment buildings, laundries, and swimming pools. Some 25,000 of these units are used in Florida and are gradually coming into vogue in California.

In terms of technical know-how, some of the most impressive advances in the use of solar energy have occurred in industry, although the majority of these applications are marginal at best and largely experimental in nature. The simplest of these devices is the solar furnace. The collector is usually a single large parabolic mirror, or, more likely, a huge array of many parabolic mirrors mounted in a large housing. A heliostat—a smaller, horizontally mounted mirror that follows the movement of the sun—reflects the rays into the collector. Several hundred of these furnaces are currently in use. One of the largest, Dr. Felix Trombe's Mont Louis furnace, develops 75 kilowatts of electric power and is used primarily in high-temperature research. It makes a remarkable industrial smelter. Since the sun's rays do not contain any impurities, the furnace will melt a hundred pounds of metal without the contamination produced by conventional smelting techniques. A solar furnace built by the US Army Quartermaster Corps at Nattick, Massachusetts, develops 5,000 degrees C.—a temperature high enough to melt steel I beams. It looks like nothing more than a small, outdoor movie screen covered with a battery of concave mirrors.

Solar furnaces have many limitations but these are not necessarily insurmountable. Their efficiency can be appreciably reduced by haze, fog, clouds, atmospheric dust, and by heavy wind loadings which deflect equipment and interfere with the accurate focusing of the sun's rays. Attempts are being made to resolve some of these problems by sliding roofs, covering material for the mirrors, and firm, protective housings. On the other band, solar furnaces are clean, efficient when they are in good working order, and they produce extremely high-grade metals which none of the conventional furnaces currently in use can hope to match.

An equally promising area of research are the attempts made to convert solar energy into electricity. Theoretically, an area roughly a square yard in size, placed perpendicular to the sun's rays, receives energy equivalent to one kilowatt. "Considering that in the arid zones of the world many million millions of square meters (or yards) of desert land are free for power production," observes Thirring, "we find that by utilizing only 1 per cent of the available ground for solar power plants a capacity could be reached far higher than the present installed capacity of all fuel-operated and hydro-electric power plants in the world, which is about 200 million kilowatts." In practice, work along the lines suggested by Thirring has been inhibited by cost considerations, market factors (there is no large demand, today, for electricity in those underdeveloped, hot areas of the world where the project is most feasible), and essentially the conservatism of designers in the power field. The greatest research emphasis in converting solar power into electricity has been placed in recent years on the development of solar batteries, a result largely of work on the "space programme".

Solar batteries—devices that have been used most successfully in space travel—make use of the thermoelectric effect. If strips of antimony and bismuth are joined together in a loop, for example, a temperature differential, say by producing heat in one junction, yields electric power. The sophistication of solar batteries over the past decade or so has produced devices that have a power-converting efficiency as high as 15 per cent, and 20 to 25 per cent is quite attainable in the not too distant future. Grouped in large panels, solar batteries have been used to power electric cars, small boats, telephone lines, and singly or several in number, radios, phonographs, clocks, sewing machines, and other appliances. Eventually, it is expected, the cost of producing solar batteries will be diminished to a point where they will provide electric power for homes and even small industrial facilities.

Finally, the sun's energy can be used in still another way—by collecting heat in a body of water. For quite some time engineers have been studying ways of acquiring electric power from temperature differences produced in the sea by the sun's heat. If solar ponds are built to behave according to prescribed conditions, a body of water one square kilometer in size can yield 30 million kilowatt-hours of electricity annually, enough to match the output of a sizeable power station, operating more than 12 hours every day of the year. The power can be acquired without any fuel costs, or as Henry Tabor observes, "merely by the pond lying in the sun". Heat can be extracted from the bottom of the pond by passing the hot water over a heat exchanger and then returning the water to the pond. In warm latitudes, where solar ponds are likely to be most effective, 10,000 square miles committed to this method of power production might be able to provide enough electricity to satisfy the needs of 400 million people!

The ocean's tides represent still another untapped potential to which we could turn for electric power in many coastal areas. We could trap the ocean's waters at high tide in a natural basin—say, a bay or the mouth of a river—and release them through turbines at low tide. A number of highly suitable places exist where the tides are high enough to produce large blocks of electric power. The French have already built an immense tidal-power installation near the mouth of the Rance River at St. Malo with an expected yield of 820 kilowatt-hours annually. They also plan to build another dam in the bay of Mont Saint-Michel. In England, highly suitable conditions for a tidal dam exist above the confluence of the Severn and Wye Rivers. This dam could provide the electric power produced by a

million tons of coal annually. A superb locale for producing tide-generated electricity exists at Passaquoddy Bay on the frontier between Maine and New Brunswick. Good locales exist on the Mezen Gulf, a Russian coastal area opening into the Arctic Ocean, the Kola Peninsula, and the Okhotsk Sea. Argentina has plans for building a tidal dam across the estuary of the Deseado River near Puerto Desire on the Atlantic coast. Many other coastal areas could be used to generate electricity from tidal power, but except for France, no country has seriously initiated work on this resource.

We could use the differences of temperature in the sea or in the earth to generate electric power in sizeable quantities or as sources of heat for domestic purposes. A temperature differential as high as 17 degrees C. is not uncommon in the surface layers of tropical waters; along coastal areas of Siberia, winter differences of 30 degrees exist between the water below the ice crust and the air. The interior of the earth becomes progressively warmer as we descend, providing selective temperature differentials with respect to the surface. Heat pumps could be used to avail ourselves of these differentials in order to drive steam turbines for industrial purposes or merely to heat homes. The heat pump works like a mechanical refrigerator: a circulating refrigerant draws off heat from a medium, dissipates it, and returns to repeat the process. During winter months, the pumps, circulating a refrigerant in a shallow well, could be used to absorb subsurface heat and release it in a house. In the summer, the process could be reversed; heat, withdrawn from the house, could be dissipated in the house. In a centralized society, based entirely on coal, petroleum, or atomic power, the heat pump is regarded as too costly to operate; the price of electric power needed to work the pump is prohibitively expensive. In a humanistic, decentralized society, where solar or wind power is available and where "cost" is subordinated to human needs, the pump would be an ideal device for space heating in all north temperate and subarctic latitudes. The pumps do not require costly chimneys, they do not pollute the atmosphere, and they eliminate the nuisance of stocking furnaces and carrying out ashes. If we could acquire electricity or direct heat from solar energy, wind power, or temperature differentials, the heating system of a home or factory would be completely self-sustaining; it would not drain valuable hydrocarbon resources or require external sources of supply.

I have mentioned wind power as a possible source of energy. Actually, the winds could be used on an extensive scale to provide electric power in many areas of the world. About 90 Q of the solar energy reaching the earth is converted into wind. Although much of this goes into making the jet stream, thirty to forty thousand feet above sea-level, a great deal of wind energy is available a few hundred feet above the ground. A UN report, using monetary terms to gauge the feasibility of wind power, finds that efficient wind plants in many areas could produce electricity at an overall cost of 5 mills per kilowatt, a figure that approximates the price of electric power generated by the use of conventional fuels. Several wind generators have already been established and used with a high measure of

success. The famous 1,250 kilowatt generator at Grandpa's Knob, near Rutland, Vermont, successfully fed alternating current into the lines of the Central Vermont Public Service Co. until a shortage of parts during World War II made it difficult to keep the installation in good repair. Since then, larger, more efficient generators have been designed. P. H. Thomas, working for the Federal Power Commission, has designed a 7,500-kW. windmill that would involve an investment of $68 per kilowatt. Eugene Ayers notes that if the Thomas device were actually constructed and costs proved to be double the amount estimated by its designer, "wind turbines would seem nevertheless to compare favourably with hydro-electric installations which cost around $300 per kilowatt". The potential for generating electricity by means of wind power is probably enormous in many regions of the world. In England, for example, where a careful three-year survey was made of possible wind-power sites, it was found that the newer wind turbines could generate several million kilowatts and save from two to four million tons of coal annually.

Let there be no mistake about the extraction of trace minerals from rocks, solar and wind power, and the use of heat pumps: except for tidal power and the extraction of raw materials from the sea, these sources cannot supply man with the bulky quantity of raw materials and large blocks of energy needed to sustain densely concentrated populations and highly centralized industries. Solar devices, wind turbines, and heat pumps can be expected to produce power in relatively small quantities. Used locally and in conjunction with each other, they could amply meet all the power needs of a small community, but we cannot foresee a time when they will be able to furnish the electricity currently used by cities the size of New York, London, Paris, or similar megalopolitan areas.

This "limitation of scope", however, could well represent a profound advantage from an ecological point of view. The sun, the wind, and the earth are experiential realities to which men have responded sensuously and reverently from time immemorial. Out of these primal elements man developed his sense of dependence—and respect—for the natural environment—a dependence that kept his destructive activities in check. The Industrial Revolution and the urbanized world that followed it obscured their role in human experience—literally hiding the sun with a pall of smoke, blocking the winds with massive buildings, desecrating the earth with sprawling cities. Man's dependence on the natural world now became invisible. more precisely theoretical and intellectual in character, the subject-matter of text books, monographs, lectures, and laboratories. True, this theoretical dependence supplied us with insights (partial ones, at best) into the natural world, but its one-sidedness robbed us of all sensuous dependence, all visible contact and unity with nature. In losing our sensuous, visible dependence upon nature, we lost a part of ourselves as feeling animal beings. We became alienated from nature. Our technology and environment, in short, became totally inanimate, totally synthetic—a purely inorganic physical thing that promoted the de-animization of man and his thought.

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To bring the sun, wind, earth, indeed the world of life, back into technology, into the means of human survival, would represent a revolutionary renewal of man's ties to nature. To bring it back in a way that evokes a sense of regional uniqueness in the community, a sense not only of generalized dependence but of dependence on a specific region with distinct qualities of its own, would give this renewal a truly ecological context. And here we come to another advantage that derives from the "limitation of scope" since: it is very unlikely that solar energy alone, or wind power alone, or heat derived from the earth would suffice to meet all the energy needs of the free community, the community would have to use several of these resources in most cases, combining them in varying proportions, depending upon its latitude, prevailing wind loads, and geothermal reserves. Man's relationship to a given region would be reinforced by the ecology of his energy system.

I believe it will be a real ecological system, a delicately interlaced pattern of local resources, honoured by continual study and artful modification. As a sense of regionalism grows in the community, every resource will find its place in a natural, stable balance, a truly organic unity of social, technological, and natural elements. Art will assimilate technology in the deepest sense that art can exist—as social art, the art of the community as a living process. Small or of moderate size, the free community will be able to rescale the tempo of life, the work patterns of man, and its own architecture, systems of transportation and communication to completely human dimensions. The electric car, quiet, slow-moving, and clean, will come into its own as a form of intra-urban transportation, replacing completely the noisy, filthy, and high-speed automobile. Monorails will link community to community, replacing railroads and reducing the number of highways that scar the countryside. Crafts will regain their honoured position as supplements to the factory; they will become a form of domestic, day-to-day artistry. A high standard of excellence, I believe, will replace the strictly quantitative criteria of production that prevail today; a respect for the durability of goods and the conservation of raw materials will replace the shabby, huckster-oriented criteria that result in built-in obsolescence and an insensate consumer society. The community will become a beautifully moulded arena of life, a vitalizing source of culture and a deeply personal, ever-nourishing source of human solidarity.

TECHNOLOGY FOR LIFE

In a future revolution, the most pressing task assigned to technology will be to produce a surfeit of goods with a minimum of toil. The immediate purpose of this task will be to permanently open the social arena to the revolutionary people, *to keep the revolution in permanence*. Thus far, every social revolution has foundered because the peal of the tocsin could not be heard over the din of the workshop. Dreams of freedom and plenty were polluted by the mundane, workaday responsibility of producing the means of survival. Looking back at the brute facts of history, we find that as long as revolution meant continual sacrifice and denial for the people, the reins of power fell

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into the hands of the political "professionals", the mediocrities of Thermidor. How well the liberal Girondins of the French Convention understood this reality can be judged by the fact that they sought to reduce the revolutionary fervour of the Parisian popular assemblies—the great Sections of 1793—by decreeing that the meetings should close "at ten in the evening", or, as Carlyle tells us, "before the working people come …" from their jobs. The decree proved ineffective, but its aim was shrewd and unerring. Essentially, the tragedy of past revolutions has been that, sooner or later, their doors closed, "at ten in the evening". *The most critical function of modern technology must be to keep the doors of the revolution open forever*!

Nearly a half century ago, while Social Democratic and Communist theoreticians babbled about a society with "work for all", those magnificent madmen, the Dadaists, demanded unemployment for everybody. The decades have detracted nothing from this demand; to the contrary, they have given it form and content. From the moment toil is reduced to the barest possible minimum or disappears entirely, however, the problem of survival passes into the problem of life and it is certain that technology itself will pass from the servant of man's immediate needs into the partner of his creativity.

Let us look at this matter closely.

Much has been written about technology as an "extension of man". The phrase is misleading if it is meant to apply to technology as a whole. It has validity primarily for the traditional handicraft shop and, perhaps, for the early stages of machine development. The craftsman dominates the tool; his labour, artistic inclinations, and personality are the sovereign factors in the productive process. Labour is not merely an expenditure of energy but the personalized work of a man whose activities are sensuously directed toward preparing, fashioning, and finally decorating his product for human use. The craftsman guides the tool, not the tool the craftsman. Any alienation that may exist between the craftsman and his product is immediately overcome, as Friedrich Wilhelmsen emphasized, "by an artistic judgement—a judgement bearing on a thing to be made". The tool amplifies the powers of the craftsman as a *man*, as a *human*; it amplifies his power to impart his artistry, his very identity as a creative being, on raw materials.

The development of the machine tends to rupture the intimate relationship between man and the means of production. To the degree that it is a self-operating device, the machine assimilates the worker to preset industrial tasks, tasks over which he exercises no control whatever. The machine now appears as an alien force—apart from and yet wedded to the production of the means of survival. Starting out as an "extension of man", technology is transformed into a force above man, orchestrating his life according to a score contrived by an industrial bureaucracy; not *men*, I repeat, but *bureaucracies*, i.e., *social machines*. With the arrival of the fully automatic machine as the predominant means of production, man becomes an extension of the machine, not only of mechanical devices in the productive process but also of social devices in the social process. Man ceases to exist in

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almost any respect for his own sake. Society is ruled by the harsh maxim: production for the sake of production. The decline from craftsman to worker, from the active to the increasingly passive personality, is completed by man *qua* consumer—an economic entity whose tastes, values, thoughts, and sensibilities are engineered by bureaucratic "teams" in "think tanks". Man, standardized by machines, is finally reduced to a machine.

This is the trend. Man-the-machine is the bureaucratic ideal.* It is an ideal that is continually defied by the re-birth of life, by the reappearance of the young and by the contradictions that unsettle the bureaucracy. Every generation has to be assimilated again, and each time with explosive resistance. The bureaucracy, in turn, never lives up to its own technical ideal. Congested by mediocrities, it errs continually. Its judgement lags behind new situations; insensate, it suffers from social inertia and is always buffeted by chance. Any crack that opens in the social machine is widened by the forces of life.

How can we heal the fracture that separates living men from dead machines without sacrificing either men or machines? How can we transform the technology for survival into the technology for life? To answer any of these questions with Olympian assurance would be idiotic. Liberated man may choose from a large variety of mutually exclusive or combinable alternatives, all of which may be based on unforeseeable technological innovations. As a sweeping solution, they may simply choose to step over the body of technology. They may submerge the cybernated machine in a technological underworld, divorcing it entirely from social life, the community, and creativity.

All but hidden from society, the machines would work for man. Free communities would stand, in effect, at the end of a cybernated industrial assembly line with baskets to cart the goods home. Industry, like the autonomic nervous system, would work on its own, subject to the repairs that our own bodies require in occasional bouts of illness. The fracture separating man from the machine would not be healed. It would simply be ignored.

I do not believe that this is a solution to anything. It would amount to closing off a vital human experience: the stimulus of productive activity, the stimulus of the machine. Technology can play a very important role in forming the personality of man. Every art, as Lewis Mumford has argued, bas its technical side—the self-mobilization

* The "ideal man" of the police bureaucracy is a being whose innermost thoughts can be invaded by lie detectors, electronic listening devices, and "truth" drugs. The "ideal man" of the political bureaucracy is a being whose innermost life can be shaped by mutagenic chemicals and socially assimilated by the mass media. The "ideal man" of the industrial bureaucracy is a being whose innermost life can be invaded by subliminal and predictively reliable advertising. The "ideal man" of the military bureaucracy is a being whose innermost life can be invaded by regimentation for genocide.
Accordingly men are graded, fingerprinted, tested, mobilized in campaigns from "charity" to war. The horrible contempt for the human personality implied by these "ideals", tests, and campaigns provides the moral climate for mass murder, acts in which the followers of Stalin and Hitler are mere pioneers.

of spontaneity into expressed order, the need during the highest, most ecstatic moments of subjectivity to retain contact with the objective world, the counterposing of necessity to "disordered subjectivity" and a concreteness that responds with equal sensitivity to all stimuli—and therefore to none at all.*

A liberated society, I believe, will not want to negate technology—precisely because it is liberated and can strike a balance. It may well be that it will want to assimilate the machine to artistic craftsmanship. What I mean by this is that the machine will remove toil from the productive process, leaving its artistic completion to man. The machine, in effect, will participate in human creativity. "The potter's wheel, for example, increased the freedom of the potter, hampered as he had been by the primitive coil method of shaping pottery without the aid of a machine; even the lathe permitted a certain leeway to the craftsman in his fashioning of beads and bulges," observes Mumford. By the same token, there is no reason why automatic, cybernated machinery cannot be used in a way so that the finishing of products, especially those destined for personal use, is left to the community. The machine can absorb the toil involved in mining, smelting, transporting, and shaping raw materials, leaving the final stages of artistry and craftsmanship to the individual. We are reminded that most of the stones that make up a medieval cathedral were carefully squared and standardized to facilitate their laying and bonding — a thankless, repetitive, and boring task that can now be done rapidly and effortlessly by modern machines. Once the stone blocks were set in place, the craftsmen made their appearance; inhuman toil was replaced by creative, human work. In a liberated community the combination of industrial machines and the craftsman's tools could reach a degree of sophistication, of creative interdependence unparalleled by any period in human history. William Morris's vision of a return of the crafts would be freed of its nostalgic nuances. We could truly speak of a

* The phrase "disordered subjectivity" is Mumford's, but I will defend it to the death, even if it is offensive to those to whom I feel the closest affinity. I refer to the radical "underground"—the artists, poets, and revolutionaries who seek ecstatic, hallucinatory experiences, partly as a means of self-discovery, partly in rebellion against the demands of a grotesquely bureaucratized and institutionalized world. "Disordered subjectivity", *as a permanent state of being and as an end in itself, can be as dehumanizing as the most bureaucratic society in existence today*. A point can be reached where there is no intrinsic difference between the two, where they are joined under the precept: hallucination for its own sake. *The system has everything to gain by the mystification of existing reality.* What is more hallucinatory than production for the sake of production, consumption for the sake of consumption, the wanton accumulation of money, the cult of authority and the State, the fear of real life that pervades the soul of the petit bourgeois? Nature produces order dialectically, through spontaneity. The existing society, by trying to extinguish spontaneity and place man under bureaucratic control, produces disorder, violence, and cruelty. Let us distinguish order from bureaucracy and call this society what it really is: not orderly but bureaucratic, not practical but shot through with the hallucinatory symbols of power and wealth, not Real and Rational in Hegel's sense, but fetishistic and logical in the murderous sense of consistency without truth. A return to Dionysius and Orpheus—yes! A return to the cloisters and the Gothic—never!

qualitatively new advance in technics—a technology for life.

Having acquired a vitalizing respect for the natural environment and its resources, the free decentralized community will give a new interpretation to the word "need". Marx's "realm of necessity", instead of expanding indefinitely, will tend to contract; needs will be humanized and scaled by a higher valuation of life and creativity. Quality and artistry will supplant the current emphasis on quantity and standardization; durability will replace the current emphasis on expendability: an economy of cherished things, sanctified by a sense of tradition and by a sense of wonder for the personality and artistry of dead generations, will replace the mindless seasonal restyling of commodities; innovations will be made with a sensitivity for the natural inclinations of man as distinguished from the engineered pollution of taste by the mass media. Conservation will replace waste in all things. Freed of bureaucratic manipulation, men will rediscover the beauty of a simpler, uncluttered material life. Clothing, diet, furnishings, and homes will become more artistic, more personalized, and more Spartan. Man will recover a sense of the things that are *for* man, as against the things that have been *imposed* upon man. The repulsive ritual of bargaining and hoarding will be replaced by the sensitive act of making and giving. Things will cease to be the crutches for an impoverished ego and the mediators between aborted personalities; they will become the product of a rounded, creative individual and the gift of an integrated, developing self.

A technology for life can play the vital role of integrating one community with another. Rescaled to a revival of crafts and to a new conception of material needs, technology can also function as the sinews of confederation. The danger of a national division of labour and of industrial centralization is that technology begins to transcend the human scale, becomes increasingly incomprehensible, and lends itself to bureaucratic manipulation. To the extent that a shift away from community control occurs in real material terms, technologically and economically, to that extent do centralized institutions acquire real power over the lives of men and threaten to become sources of coercion. A technology for life must be *based* on the community; it must be tailored to the community and regional level. On this level, however, the sharing of factories and resources can actually promote solidarity between community groups: it can serve to confederate them on the basis not only of common spiritual and cultural interests, but also common material needs. Depending upon the resources and uniqueness of regions, a rational, humanistic balance can be struck between autarchy, industrial confederation, and a national division of labour; the economic weight of society, however, must rest overwhelmingly with communities, both separately and in regional groups.

Is society so "complex" that an advanced civilization stands in contradiction to a decentralized technology for life? My answer to this question is a categoric, *no*! Much of the social "complexity" of our time has its origin in the paperwork, administration, manipulation, and constant wastefulness of capitalist enterprise. The petty bourgeois stands in awe of the bourgeois filing system—the rows of cabinets filled

with invoices, accounting books, insurance records, tax forms—and the inevitable dossiers. He is spellbound by the "expertise" of industrial managers, engineers, style-mongers, manipulators of finance, and architects of market consent. He is totally mystified by the state—the police, courts, jails, federal offices, secretariats, the whole stinking, sick fat of coercion, control, and domination. Modern society is incredibly complex—complex even beyond human comprehension—if we grant that its premises consist of property, production for the sake of production, competition, capital accumulation, exploitation, finance, centralization, coercion, bureaucracy—in short, the domination of man by man. Attached to every one of these premises are the institutions that actualize them — offices, millions of "personnel", forms and staggering tons of paper, desks, typewriters, telephones, and of course, rows upon rows of filing cabinets. As in Kafka's novels, they are real but strangely dreamlike, indefinable, shadows on the social landscape. The economy has a greater reality to it and is easily mastered by the mind and senses. But it too is intricate if we grant that buttons must be styled in a thousand different forms, textiles varied endlessly in kind and pattern to create the illusion of innovation and novelty, bathrooms filled to overflowing with a dazzling variety of pharmaceuticals and lotions, kitchens cluttered with an endless number of imbecile appliances (one thinks, here, of the electric can-opener)—the list is endless.* If we single out of this odious garbage one or two goods of high quality in the more useful categories and if we eliminate the money economy, the state power, the credit system, the paperwork and policework required to hold society in an enforced state of want, insecurity, and domination, society would not only become reasonably human but also fairly simple.

I do not wish to belittle the fact that behind a single yard of high quality electric wiring lies a copper mine, the machinery needed to operate it, a plant for producing insulating material, a copper-smelting and shaping complex, a transportation system for distributing the wiring—and behind each of these complexes, other mines, plants, machine shops, and so forth. Copper mines, certainly of a kind that can be exploited by existing machinery, are not to be found everywhere, although enough copper and other useful metals can be recovered as scrap from the debris of our present society to provide future generations with all they need. But let us grant that copper will fall within a sizeable category of material that can be furnished only by a national division of labour. In what sense need there be a division of labour in the current sense of the term? Bluntly, there need be none at all. First, copper can be exchanged for other goods between the free, autonomous communities that mine it and those that require it. The exchange need not require the mediation of centralized bureaucratic institutions. Secondly, and perhaps more significantly, a community that lives in a region with ample copper resources will not be a mere mining community. Copper mining will be one of many economic

* For supplemental reading, consult the advertising pages of the *Ladies Home Journal* or *Good Housekeeping*.

activities in which it is engaged, a part of a larger, rounded, organic economic arena. The same will hold for communities whose climate is most suitable for growing specialized foods or whose resources are rare and uniquely valuable to society as a whole. Every community will approximate, perhaps in many cases achieve, local or regional autarchy. It will seek to achieve wholeness, not only because wholeness provides material independence (important as this may be), but also because it produces complete, rounded men who live in a symbiotic relationship with their environment. Even if a substantial portion of the economy falls within the sphere of a national division of labour, the overall economic weight of society will still rest with the community. If there is no distortion of communities, there will be no sacrifice of any portion of humanity to the interests of humanity as a whole.

A basic sense of decency, sympathy, and mutual aid lies at the core of human behaviour. Even in this lousy bourgeois society, we do not find it unusual that adults will rescue children from danger although the act will imperil their lives; we do not find it strange that miners, for example, will risk death to save their fellow-workers in cave-ins or that soldiers will crawl under heavy fire to carry a wounded comrade to safety. What tends to shock us are those occasions when aid is refused —when the cries of a girl who has been stabbed and is being murdered are ignored in a middle-class neighbourhood.

Yet there is nothing in this society that would seem to warrant a molecule of solidarity. What solidarity we do find exists despite the society, against all its realities, as an unending struggle between the innate decency of man and the innate indecency of the society. Can we imagine how men would behave if this decency could find full release, if society earned the respect, even the love of the individual? We are still the offspring of a violent, blood-soaked, ignoble history—the end products of man's domination of man. We may never end this condition of domination. The future may bring us and our shoddy civilization down in a Wagnerian Gotterdammerung. How idiotic it would all be! But we may also end the domination of man by man. We may finally succeed in breaking the chain to the past and gain a humanistic, anarchist society. Would it not be the height of absurdity, indeed of impudence, to gauge the behaviour of future generations by the very criteria we despise in our own time? An end to the sophomoric questions! Free men will not be greedy, one liberated community will not try to dominate another because it has a potential monopoly of copper, computer "experts" will not try to enslave grease monkeys, and sentimental novels about pining, tubercular virgins will not be written. We can ask only one thing of the free men of the future: to forgive us that it took so long and that it was such a hard pull. Like Brecht, we can ask that they try not to think of us too harshly, that they give us their sympathy and understand that we lived in the depths of a social hell.

But then they will surely know what to think without our telling them.

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an idea on the wing

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