Towards a Liberatory Technology

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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 fetishism of the word "industrialization"excused the most abusive of economic plans and programs.

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 techno-logical innovation could be described as schizoid, divided into a gnawing fear of nuclear extinction on the one hand,and 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 both as a foe and a friend of humanity, and even traditionally human-oriented sciences, such as medicine, occupy an ambivalent position—as witness the promise of advances in chemotherapy and the threat created by research in biological warfare.

It is not surprising to find that the tension between promise and threat is increasingly being resolved in favor of threat by a blanket rejection of technology. To an ever-growing extent, 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 produces is often as simplistic as the optimism that prevailed in earlier decades. There is a very real danger that we will lose our perspective toward technology, that we will neglect its liberatory tendencies, and, worse, submit fatalistically 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, human-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 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. On the contrary, I shall try to show that an organic mode of life deprived of its technological component would be as nonfunctional as a man deprived of his skeleton. Technology must be viewed as the basic structural support of a society; it is literally the framework of an economy and of many social institutions.

TECHNOLOGY AND FREEDOM

The year 1848 stands out as a turning point in the history of modern revolutions. This was 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 a half earlier.

What strikes us about the convergence of these ideological, political and technological milestones is the extent to which the Communist Manifesto and the June barricades were in advance of their time. In the 1840s, the Industrial Revolution centered around 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 finally brought the factory system to the textile industry; meanwhile, a number of striking innovations in iron-making technology assured the supply of high-quality, inexpensive metals needed to sustain factory and railway expansion. But these innovations, important as they were, were not accompanied by commensurate changes in other areas of industrial technology. For one thing, few steam engines were rated at more than fifteen horsepower, and the best blast furnaces provided little more than a hundred tons of iron a week—a fraction of the thousands of tons produced daily by modern furnaces. More important, the remaining areas of the economy were not yet significantly affected by technological innovation. Mining techniques, for example, had changed little since the days of the Renaissance. The miner still worked the ore face with a hand pick and a 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 emerging from its centuries-old sleep. Although a great deal of land had been cleared for food cultivation, soil studies were still a novelty. So heavy, in fact, 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 occupied the mechanical center of the construction site. Steel was a relatively rare metal: as late as 1850 it was priced at $250a 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 that Charles Babbage's efforts to build a sophisticated mechanical computer were thwarted by the inadequate machining techniques of the time.

I have reviewed these technological developments be-cause both their promise and their limitations exercised a profound influence on nineteenth century revolutionary thought. The innovations in textile and iron-making technology provided a new sense of promise, indeed a new stimulus, to socialist and Utopian thought. It seemed to the revolutionary theorist 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 lei-sure for the mass of humanity. Socialism, the theorists argued, could be based on self-interest rather than on man's dubious nobility of mind and spirit. Technological innovation had transmuted the socialist ideal from a vague humanitarian hope into a practical program.

The newly acquired practicality compelled many socialist theorists, particularly Marx and Engels, to grapple with the technological limitations of their time. They were faced with a strategic issue: in all previous revolutions,technology had not yet developed to a level where men could be freed from material want, toil and 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 leave the stage of history after the revolution, 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 feature of society as a whole, there-by recreating all the conditions for a new struggle over the material things of life, for new forms of property, and eventually for a new system of class domination. A development of the productive forces is the "absolutely necessary practical premise [of communism]," wrote Marx and Engels in 1846, "because without it want is generalized, and with want the struggle for necessities and all the old filthy business would necessarily be reproduced."

Virtually all the Utopias, theories and revolutionary programs of the early nineteenth century were faced with problems of necessity—of how to allocate labor and material goods at a relatively low level of technological development. These problems permeated revolutionary thought in a way comparable only to the impact of original sin on 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—authoritarian and libertarian, Utopian and scientific, Marxist and anarchist. Implicit in the Marxist notion of a planned economy was 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, to restrict—the distribution of goods and would have to rationalize—in effect, to intensify—the use of labor. Toil, under socialism, would be a duty, a responsibility which every able-bodied individual would have to undertake. Even Proudhon advanced this dour 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 could 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 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, in which necessity and freedom were mediated by the state, differed very little politically from the common run of bourgeois-democratic radical opinion in the last century. The anarchist hope for the abolition of the state, on the other hand, rested largely on a belief in the viability of man's social instincts. Bakunin, for example, thought custom would compel any individuals with antisocial proclivities to abide by collectivist values and needs without obliging society to use coercion.

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 derived from his study of animal and social evolution).

The fact remains, however, that in both cases—the Marxist and the anarchist—the answer to the problem of want and work was 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 necessity by means of a state, and the anarchists, to deal with it through free communities, but given the limited technological development of the last century, in the last analysis both schools depended on an act of faith to cope with the problem of want and work. Anarchists could argue against the Marxists that any transitional state, however revolutionary its rhetoric and democratic its structure, would be self-perpetuating; it would tend to become an end in itself and to preserve the very material and social conditions it had been created to remove. For such a state to "wither away" (that is, promote its own dissolution) would require its leaders and bureaucracy to be people of superhuman moral qualities. The Marxists, in turn, could invoke history to show that custom and mutualistic propensities were never effective barriers to the pressures of material need, or to the onslaught of property, or to the development of exploitation and class domination. Accordingly, they dismissed anarchism as an ethical doctrine which revived the mystique of the natural man and his inborn social virtues.

The problem of want and work—of 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 ideal remained only a vision of man's future, of the time when technology would 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 the ideologies of modern state capitalism.

In retrospect, it is astonishing to consider how long the problem of want and work cast its shadow over 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 paleotechnic age of coal and steel, and the neotechnic age of 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 proportion to other social classes, labor–more precisely, toilt—acquired an increasingly high status in revolutionary thought. During this period, the propaganda of the socialists often sounded like a paean to toil; not only was toil "ennobling," but the workers were ex-tolled as the only useful individuals in the social fabric. They were endowed with a supposedly superior instinctive ability that made them the arbiters of philosophy, art, and social organization. This puritanical work ethic of the left did not diminish with the passage of time and in fact acquired a certain urgency in the 1930s. Mass unemployment made the job and the social organization of labor the central themes of socialist propaganda in the 1930s. 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 pointed to Russia as a land where every able-bodied individual was employed and where labor was continually in demand. Surprising as it may seem today, 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 had subtly invaded and corrupted the ideal of freedom.

That the socialist notions of the last generation now seem to be anachronisms is not due to any superior in-sights that prevail today. The last three decades, particularly the years of the late 1950s, 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 countries) are confronted by the possibility of a materially abundant, almost workless era in which most of the means of life can be provided by machines. As we shall see,a new technology has developed that could largely 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 lifestyles among today's young people, a generation that is rapidly divesting itself of the values and the age-old work-oriented traditions of its elders. Even recent demands for a guaranteed annual income sound like faint echoes of the new reality that currently permeates the thinking of the young. Owing to the development of a cybernetic technology, the notion of a toil-less mode of life has become an article of faith to an ever-increasing number of young people.

In fact, the real issue we face today is not whether this new technology can provide us with the means of life in a toilless society, but whether it can help to humanize society, whether it can contribute to the creation of entirely new relationships between man and man. The demand for a guaranteed annual income is still anchored in the quantitative promise of technology—in the possibility of satisfying material needs without toil. This quantitative approach is already lagging behind technological developments that carry a new qualitative promise—the promise of decentralized, communitarian lifestyles, or what I prefer to call ecological forms of human association.

I am asking a question that is quite different 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 not only liberate man from want and work, but also lead him to a free, harmonious, balanced human community—an ecocommunity that would promote the unrestricted development of his potentialities? Finally, can it carry man beyond the realm of freedom into the realm of life and desire?

THE POTENTIALITIES OF MODERN TECHNOLOGY

Let me try to answer these questions by pointing to a new feature of modern technology. For the first time in history, technology has reached an open end. The potential for technological development, for providing machines as substitutes for labor is virtually unlimited. Technology has finally passed from the realm of invention to that of design—in other words, from fortuitous discoveries to systematic innovations.

The meaning of this qualitative advance has been stated in a rather freewheeling way by 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.

Bush focuses here on the two most important features of the new, so-called "second," industrial revolution, namely the enormous potentialities of modern technology and the cost-oriented, nonhuman limitations that are imposed upon it. I shall not belabor the fact that the cost factor—the profit motive, to state it bluntly—inhibits the use of technological innovations. It is fairly well established that in many areas of the economy it is cheaper to use labor 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 labor 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 order of relationships is relatively new. Traditionally, speculation, generalization and rational activity were sharply divorced from technology. This chasm reflected the sharp split between the leisured and working classes in ancient and medieval society. If one leaves aside the inspired works of a few rare men, applied science did not come into its own until the Renaissance,and it only began to flourish in the eighteenth and nineteenth centuries.

The men who personify the application of science to technological innovation are not the inventive tinkerers like Edison, but the systematic investigators with catholic interests like Faraday, who add simultaneously to man's knowledge of scientific principles and to engineering. In our own day this synthesis, once embodied by the work of a single, inspired genius, is the work of anonymous teams. Although these teams have obvious advantages, they often have all the traits of bureaucratic agencies—which leads to a mediocre, unimaginative treatment of problems.

Less obvious is the impact produced by industrial growth. This impact is not always technological; it is more than the substitution of machines for human labor. One of the most effective means of increasing output, in fact, has been the continual reorganization of the labor process, extending and sophisticating the division of labor. Ironically, the steady breakdown of tasks to ever more inhuman dimensions—to an intolerably minute, fragmented series of operations and 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 labor, without tracing the development of the work process from craftsmanship, where an independent, highly skilled worker engages in many diverse operations, through the purgatory of the factory, where these diverse tasks are parceled out among a multitude of unskilled or semiskilled employees, to the highly mechanized mill, where the tasks of many are largely taken over by machines manipulated by a few operatives, and finally to the automated and cybernated plant, where operatives are replaced by supervisory technicians and highly skilled maintenance men.

Looking further into the matter, we find still another new development: the machine has evolved 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 muscles but rather enlarged 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 strict terms of labor productivity: one man, using a given machine, produced as many commodities as five, ten, fifty, or a hundred before the machine was employed. Nasmyth's steam hammer, exhibited in 1851, could shape iron beams with only a few blows, an effort that would have required many man hours of labor without the machine. But the hammer required the muscles and judgment of half a 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 labor and judgment involved in operating the machines formed an indispensable part of the productive process.

The development of fully automatic machines for complex mass-manufacturing operations requires the successful application of at least three technological principles: such machines must have a built-in ability to correct their own errors; they must have sensory devices for replacing the visual, auditory and tactile senses of the worker; and,finally, they must have devices that substitute for the worker's judgment, skill and memory. The effective use of these three principles presupposes that we have also developed the technological means (the effectors, if you will) for applying the sensory, control and mind-like devices in everyday industrial operation; further, effective use pre-supposes 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. The governor, which is attached by metal arms to the engine valve, consists of two freely mounted metal balls sup-ported by a thin, rotating rod. 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 inward, 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 the temperature 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 the norm is actually used to adjust a machine is called a closed system. This may be contrasted with an open system—a manually operated wall switch or the arms that automatically rotate an electrical 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 whether it is night or day; similarly the electric fan will rotate at the same speed whether a room is warm or cool. The fan maybe automatic in the popular sense of the term, but it is not self-regulating like the flyball governor and the thermostat.

An important step toward developing self-regulating control mechanisms was the discovery of sensory devices.Today these include thermocouples, photoelectric cells, X-ray machines, television cameras and radar transmitters. Used together or singly they provide machines with an amazing degree of autonomy. Even without computers, these sensory devices make it possible for workers to engage in extremely hazardous operations by remote control. 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 photoelectric cell that turns it off when daylight approaches, the light responds to daily variations in sunrise and sunset. Its operation is now meshed with its function.

With the advent of the computer we enter 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 factor: the enormous rapidity of computer operations—a quantitative superiority of computer over human calculations—has profound qualitative significance. By virtue of its speed, the computer can perform highly sophisticated mathematical and logical operations. Supported by memory units that store millions of bits of 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 bring sweeping changes in computer technology), 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 and transportation. Modern man, in effect, has produced an electronic"mind" for coordinating, building 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.

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 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 three hundred 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 engine took many man hours to perform. With the development of what we commonly call an "automated" machine system, the time required to transform the casting into an engine was reduced to less than fifteen minutes. Aside from a few monitors to watch the automatic control panels, the original three-hundred-man labor force was 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 sixteen 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 auto-mobile engines cannot be applied to virtually 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, tool-and-die making,electronic equipment manufacture and industrial chemical production are now partly or largely automated. What tends to delay the advance of complete automation to every phase of modern industry is the enormous cost involved in replacing existing industrial facilities by new,more sophisticated ones and also the innate conservatism of many major corporations. Finally, as I mentioned be-fore, it is still cheaper to use labor instead of machines in many industries. To be sure, every industry has its own particular problems, and the application of a toil-less technology to a specific plant would doubtless reveal a multitude of kinks that would require painstaking solutions. In many industries it would be necessary to alter the shape of the product and the layout of the plants so that the manufacturing process would lend 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 eighty 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 practically no industry that cannot be fully auto-mated 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: as soon as one describes a partially automated industry, technological advances make the 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 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, particularly 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; it is a deadening, dismal, inorganic world 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… 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 symbolize, in its own way, the triumph 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 was the continuous miner, a giant cutting machine with nine-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 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 automate large areas of industrial agriculture, ranging from cotton picking to rice harvesting. We could operate almost any machine, from a giant shovel in an open-strip mine to a grain harvester in the Great Plains,either by cybernated sensing devices or by remote control with television cameras. The effort needed to operate these devices and machines at a safe distance, in comfortable quarters, would be minimal, assuming that a human opera-tor 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 labor;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. Machines would make and repair most of the machines required to maintain such a highly industrialized economy. Such a technology, oriented entirely to-ward human needs and freed from all consideration of profit and loss, would eliminate the pain of want and toil—the penalty, inflicted in the form of denial, suffering and inhumanity, exacted by a society based on scarcity and labor.

The possibilities created by a cybernated technology would no longer be limited merely to the satisfaction of man's material needs. We would be free to ask how the machine, the factory and the mine could be used to foster human solidarity and to create a balanced relationship with nature and a truly organic ecocommunity. Would our new technology be based on the same national division of labor that exists today? The current type of industrial organization—an extension, in effect, of the industrial forms created by the Industrial Revolution—fosters industrial centralization (although a system of workers' management based on the individual factory and local community would go far toward eliminating this feature).

Or does the new technology lend itself to a system of small-scale production, based on a regional economy and structured physically on a human scale? This type of industrial organization places all economic decisions in the hands of the local community. To the degree that material production is decentralized and localized, the primacy of the community is asserted over national institutions-assuming that any such national institutions develop to a significant extent. In these circumstances, the popular assembly of the local community, convened in a face-to-face democracy, takes over the full management of social life. The question is whether a future society will be organized around technology or whether technology is now sufficiently malleable so that it can be organized around society. To answer this question, we must further examine certain features of the new technology.

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 weighed more than thirty tons, contained 18,800 vacuum tubes with half a million 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. It often broke down or behaved erratically, requiring time-consuming repairs and maintenance. Yet by all previous standards of computer development, ENIAC was an electronic marvel. It could perform five thousand computations a second, generating electrical pulse signals that cycled at 100,000 a second. None of the mechanical or electro-mechanical computers in use at the time could approach this rate of computational speed.

Some twenty 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-radio receiver. The entire ensemble, together with a typewriter and memory unit, occupies a typical office desk. The DDP-124 performs over 285,000 computations a second. It has a true stored-program memory that can be expanded to retain nearly 33,000 words (the ”memory” of ENIAC, based on preset plug wires, lacked anything like 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 DDP-124 is one of degree rather than kind. Leaving aside their memory units, both digital computers operate according to the same 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 micro-circuits. These microcircuits are very small electronic units that pack the equivalent of ENIAC’s key electronic components into squares a mere fraction of an inch in size. Paralleling the miniaturization of computer components is the remarkable sophistication of traditional forms of technology. Ever-smaller machines are beginning to replace large ones. For example, a fascinating breakthrough has been achieved in reducing the size of continuous hot-strip steel rolling mills. This kind of mill 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 fifty inches wide to a thin strip of sheet metal a tenth or a twelfth of an inch thick. This installation alone,including heating furnaces, coilers, long roller tables, scale-breaker stands and buildings, may cost tens of millions of dollars and occupy fifty acres or more. It produces three hundred tons of steel sheet an hour. To be used efficiently,such 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.Such a steel complex is geared to a national division of labor, to highly concentrated sources of raw materials(generally located at a great distance from the complex),and to large national and international markets. Even if it is totally automated, its operating and management needs far transcend the capabilities of a small, decentralized community. The type of administration it requires tends to foster centralized social forms.

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

One of the most important steps towards scaling a 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, two and a quarter 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 backup rolls. By operating the cages and backup rolls at different rotational speeds, the work rolls are made to turn in two directions. This gives the steel slabs a terrific mauling and reduces it to a thickness of only one-tenth of an inch. Sendzimir's planetary mill is a stroke of engineering genius; the small work rolls, turning on the two circular cages,replace the need for the four huge roughing stands and six finishing stands in a continuous hot-strip mill.

The rolling of hot steel slabs by the Sendzimir process requires a much smaller operational area than a continuous shot-strip mill. With continuous casting, moreover, we can produce steel slabs without the need for large, costly slabbing mills. A future steel complex based on electric furnaces, continuous casting, a planetary mill and a small continuous cold-reducing mill would require a fraction of the acreage occupied by a conventional installation. It would be fully capable of meeting the steel needs of several moderate-sized communities with low quantities of fuel.

The complex I have described is not designed to meet the needs of a national market. On the contrary, it is suited only for meeting the steel requirements of small or moderate-sized communities and industrially undeveloped countries. Most electric furnaces for pig-iron production produce about a hundred to two hundred and fifty tons a day, while large blast furnaces produce three thousand 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 scale of our hypothetical steel complex constitutes one of its most attractive features. Also, the steel produced by our complex is more durable, so the community's rate of replenishing its steel products would be appreciably reduced. Since the smaller complex requires ore, fuel and reducing agents in relatively small quantities, many communities could rely on local resources for their raw materials, thereby 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 would at first glance seem to be a costly, inefficient duplication of effort that could be avoided by building a few centralized steel complexes 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 smaller production facilities 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, underpinning the intensive division of labor required by the new factory system. Industrial operations were subordinated entirely to the product. In time,this narrow pragmatic approach has "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 drilling machine of the kind envisioned by Leaver and Brown 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-1950s,however, a number of such machines were actually de-signed 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 at Dearborn, Michigan. This boring mill would qualify beautifully as a Leaver and Brown machine. Equipped with five optical microscope-type illuminated control gauges, the mill drills holes smaller than a needle's eye 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 large variety of products in a single plant. A small or moderate-sized community using multi-purpose machines could satisfy many of its limited industrial needs without being burdened with underused industrial facilities. There would be less loss in scrapping tools and less need for single-purpose plants. The community's economy would be more compact and versatile, more rounded and self-contained, than anything we find in the communities of industrially advanced countries. The effort that goes into retooling machines for new products would be enormously reduced. Retooling would generally consist of changes in dimensioning rather than in design. 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 be in circuitry and programming rather than in machine form and structure.

Single purpose machines, of course, would continue to exist, and they would still be used for the mass manufacture of a large variety of goods. At present many highly automatic, single-purpose machines could 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. A major shift from conventional automobiles, buses and trucks to electric vehicles would undoubtedly lead to industrial facilities much smaller in size than existing automobile plants. Many of the remaining centralized facilities could be effectively decentralized simply by making them as small as possible and sharing their use among several communities.

I do not claim that all of man's economic activities can be completely decentralized, but the majority can surely be scaled to human and communitarian dimensions. This much is certain: we can shift the center of economic power from national to local scale and from centralized bureaucratic forms to local, popular assemblies. This shift would be a revolutionary change of vast proportions, for it would create powerful economic foundations for the sovereignty and autonomy of the local community.

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 preindustrial cultures, man's 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; 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 places in grave jeopardy. Here, I shall try to show

how the new technology can be used ecologically to crystallize man's sense of dependence upon the natural world into the human experience, we can contribute to the achievement of human wholeness.

The classical utopians fully realized that the first sept in this direction must be to remove the contradiction between town and country. "It is impossible," wrote Fourier nearly a century and a half 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 lab our; 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 dependance 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 practiced 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 the 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; the light and extremely manageable, they can follow the count our 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 addiction 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 with apply seed, fertilizer, and pesticides (of course!) simultaneously, a technique that telescopes several different operations in a single one and reduces the soil compaction often produced by the recurrent use of heavy machines.

The variety of mechanical harvesters has 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 infintium.* 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 preformed by one or two excavating machines. Terrain with poor drainage or subsoil can be improved by earth-moving equipment and by tillage devices that can 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 three 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 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 of 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 food, 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 and 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.

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 a man a deep, abiding respect for the needs of the natural world-a respect identified with 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 forsee that the community will 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; its 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 common rock exists that does not contain traces of gold, large quantities of uranium, and progressively more amounts of industrially useful elements, such as magnesium, zinc, copper, and sulfur. 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 direct 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; sulfur from calcium sulphate and industrial wastes. Large amounts of industrially useful hydrogen could be collected as a large 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, centers 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 photosynthesizing 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 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 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 minuscule 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 norther 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 life-time of the house. In addition, the system works automatically without smoke, soot, and fume production, and saves all trouble in stoking, refuel-ling, 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 favorable conditions were equipped with solar heating systems, fuel saving worth mil-lions 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.

The most widespread applications of solar energy devices are in 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 within fifteen minutes in bright sunlight. Such a stove is safe, portable and clean; it requires no fuel or matches, nor does it produce any annoying smoke. A portable solar oven de-livers temperatures as high as four hundred fifty degrees and is even more compact and easier to handle than a solar stove. Solar water-heaters are used widely in private homes, apartment buildings, laundries and swimming pools. Some twenty-five thousand of these units are employed in Florida and they are gradually coming into vogue in California.

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 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 seventy-five kilowatts of electric power and is used primarily in high-temperature research. 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 techniques. A solar furnace built by the U.S.Quartermaster Corps at Nattick, Massachusetts, develops five thousand degrees Centigrade—a temperature high enough to melt steel I-beams.

Solar furnaces have many limitations, but these are not insurmountable. The efficiency of the furnaces can be appreciably reduced by haze, fog, clouds and atmospheric dust, and also 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 hand, solar furnaces are clean, they are 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 match.

Equally promising as an area of research are current attempts 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 millions of square meters of desert land are free for power production," observes Thirring, "we find that by utilizing only one percent of the available ground for solar plants a capacity could be reached far higher than the present installed capacity of all fuel-operated and hydroelectric power plants in the world." In practice,work along the lines suggested by Thirring has been inhibited by cost considerations, by market factors (there is no large demand for electricity in those underdeveloped, hot areas of the world where the project is most feasible) and by essentially the conservatism of designers in the power field. Research emphasis has been placed on the development of solar batteries—a result largely of work on the"space program."

Solar batteries are based on the thermoelectric effect. If strips of antimony and bismuth are joined in a loop, for example, a temperature differential made, say, by producing heat in one junction, yields electric power. Research on solar batteries over the past decade or so resulted in devices that have a power-converting efficiency as high as fifteen percent, and twenty to twenty-five percent 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, radios, phonographs,clocks, sewing machines and other appliances. Eventually, the cost of producing solar batteries is expected to diminish 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 some time now, engineers have been studying ways of acquiring electric power from the temperature differences produced by the sun's heat in the sea. Theoretically, a solar pond occupying a square kilometer could yield thirty million kilowatt-hours of electricity annually—enough to match the output of a sizeable power station operating more than twelve hours every day of the year. The power, as Henry Tabor observes, can be acquired without any fuel costs,"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, ten thousand square miles committed to this method of power production would provide enough electricity to satisfy the needs of four hundred million people!

The ocean's tides are still another untapped resource to which we could turn for electric power. 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 places exist where the tides are high enough to produce electric power in large quantities. The French have already built an immense tidal-power installation near the mouth of the Ranee River at St. Malo with an expected net yield of 544 million 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. A dam here could provide the electric power produced by a million tons of coal annually. A superb location for producing tide-generated electricity exists at Passamaquoddy Bay on the border between Maine and New Brunswick, and good locales exist on the Mezen Gulf, a Russian coastal area in the Arctic. 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 started work on this resource.

We could use temperature differences in the sea or in the earth to generate electric power in sizeable quantities.A temperature differential as high as seventeen degrees Centigrade is not uncommon in the surface layers of tropical waters; along coastal areas of Siberia, winter differences of thirty degrees exist between 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 for industrial purposes or 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 earth. The pumps do not require costly chimneys, they do not pollute the atmosphere, and they eliminate the nuisance of stoking 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.

Winds could also be used to provide electric power in many areas of the world. About one-fortieth of the solar energy reaching the earth's surface is converted into wind. Although much of this goes into making the jet stream, 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 five mills per kilowatt-hour, a figure that approximates the price of commercially generated electric power. Several wind generators have already been used with 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 parts shortage 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 kilowatt windmill that would provide electricity at a capital investment of $68per kilowatt. Eugene Ayres notes that if the construction costs of Thomas's windmill were double the amount estimated by its designer, "wind turbines would seem nevertheless to compare favorably with hydroelectric installations which cost around $300 per kilowatt." An enormous potential for generating electricity by means of wind power exists 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, saving from two to four million tons of coal annually.

There should be no illusions about the extraction of trace minerals from rocks, about solar and wind power, or about the use of heat pumps. Except perhaps for tidal power and the extraction of raw materials from the sea,these sources cannot supply man with the bulky quantities of raw materials and the large blocks of energy needed to sustain densely concentrated populations and highly centralized industries. Solar devices, wind turbines, and heat pumps will produce relatively small quantities of power.Used locally and in conjunction with each other, they could probably meet all the power needs of small communities, 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 or Paris.

Limitation of scope, however, could represent a pro-found 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 on—and respect for—the natural environment, a dependence that kept his destructive activities in check. The Industrial Revolution and the urbanized world that followed obscured nature's role inhuman experience—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 became invisible; it became theoretical and intellectual in character, the subject matter of textbooks,monographs and lectures. 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 on and all visible contact and unity with nature. In losing these, we lost a part of ourselves as feeling beings. We became alienated from nature. Our technology and environment became totally inanimate, totally synthetic—a purely inorganic physical milieu that promoted the deanimization of man and his thought.To bring the sun, the wind, the earth, indeed the world of life, back into technology, into the means of human survival, would be a revolutionary renewal of man's ties to nature. To restore this dependence in a way that evoked a sense of regional uniqueness in each 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 character. A real ecological system would emerge, a delicately interlaced pat-tern of local resources, honored by continual study and artful modification. With the growth of a true sense of regionalism every resource would find its place in a natural, stable balance, an organic unity of social, techno-logical and natural elements. Art would assimilate technology by becoming social art, the art of the community as a whole. The free community would be able to rescale the tempo of life, the work patterns of man, its own architecture and its systems of transportation and communication to human dimensions. The electric car, quiet,slow-moving and clean, would become the preferred mode of urban transportation, replacing the noisy, filthy, high-speed automobile. Monorails would link community to community, reducing the number of highways that scar the countryside. Crafts would regain their honored position as supplements to mass manufacture; they would be-come a form of domestic, day-to-day artistry. A high standard of excellence, I believe, would replace the strictly quantitative criteria of production that prevail today; a respect for the durability of goods and the conservation of raw materials would replace the shabby, huckster-oriented criteria that result in built-in obsolescence and an insensate consumer society. The community would become a beautifully molded 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 of technology will be to produce a surfeit of goods with a mini-mum of toil. The immediate purpose of this task will be to open the social arena permanently 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 work-shop. 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 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 their effort to reduce the revolutionary fervor 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 it was well aimed. 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," the Dadaists, those magnificent madmen,demanded unemployment for everybody. The decades have detracted nothing from the significance of this demand, and they have added to its content. From the moment toil is reduced to the barest possible minimum or disappears entirely, the problems of survival pass into the problems of life, and technology itself passes from being the servant of man's immediate needs to being the partner of his creativity.

Let us look at this matter closely. Much has been writ-ten 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 his tool; his labor,artistic inclinations, and personality are the sovereign factors in the productive process. Labor is not merely an expenditure of energy; it is also the personalized work of a man whose activities are sensuously directed toward preparing his product, fashioning it, and finally decorating it for human use. The craftsman guides the tool, not the tool the craftsman. Whatever alienation may exist between the craftsman and his product is immediately overcome, as Friedrich Wilhelmsen emphasized, "by an artistic judgment—a judgment bearing on a thing to be made." The tool amplifies the powers of the craftsman as a human; it amplifies his power to exercise his artistry and impart his identity as a creative being to raw materials.

The development of the machine tends to rupture the intimate relationship between man and the means of production. It assimilates the worker to preset industrial tasks,tasks over which he exercises no control. The machine now appears as an alien force—apart from and yet wedded to the production of the means of survival. Although initially 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 a bureaucracy, a social machine. With the arrival of mass production as the predominant mode of production,man became an extension of the machine, and not only of mechanical devices in the productive process but also of social devices in the social process. When he becomes an extension of a machine, man ceases to exist for his own sake. Society is ruled by the harsh maxim: ”production for the sake of production.” The decline from craftsman to worker, from an active to an 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 reduced to a machine.

Man-the-machine is the bureaucratic ideal. It is an ideal that is continually defied by the rebirth of life, by there appearance 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 with mediocrities, it errs continually. Its judgment 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 a technology for survival into a technology for life? To answer any of these questions with Olympian assurance would be idiotic. The future liberated men will choose from a large variety of mutually exclusive or combinable work styles, all of which will be based on unforeseeable technological innovations.Or these humans of the future 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 at the end of a cybernated 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 machine would not be healed. It would simply be ignored.

Ignoring technology, of course, is no solution. Man would be closing off a vital human experience—the stimulus of productive activity, the stimulus of the machine.Technology can play a vital role in forming the personality of man. Every art, as Lewis Mumford has argued, has its technical side, requiring the self-mobilization of spontaneity into expressed order and providing contact with the objective world during the most ecstatic moments of experience.

A liberated society, I believe, will not want to negate technology precisely because it is liberated and can strike a balance. It may well want to assimilate the machine to artistic craftsmanship. By this I mean the machine will remove the toil from the productive process, leaving its artistic completion to man. The machine, in effect, will participate in human creativity. There is no reason why automatic, cybernated machinery cannot be used 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. 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; 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 and of creative interdependence unparalleled in any period in human history. William Morris's vision of a return to craftsmanship would be freed of its nostalgic nuances. We could truly speak of a 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 would give a new interpretation to the word ”need.”Marx's ”realm of necessity,” instead of expanding indefinitely, would tend to contract; needs would be humanized and scaled by a higher valuation of life and creativity. Quality and artistry would supplant the current emphasis on quantity and standardization; durability would 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, would replace the mindless seasonal restyling of commodities; innovations would be made with a sensitivity for the natural inclinations of man as distinguished from the engineered pollution of taste by the mass media.Conservation would replace waste in all things. Freed of bureaucratic manipulation, men would rediscover the beauty of a simpler, uncluttered material life. Clothing,diet, furnishings and homes would become more artistic,more personalized and more Spartan. Man would 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 would be replaced by the sensitive acts of making and giving. Things would cease to be the crutches for an impoverished ego and the mediators be-tween aborted personalities; they would become the products of rounded, creative individuals and the gifts of integrated, developing selves.

A technology for life could play the vital role of integrating one community with another. Rescaled to a revival of crafts and a new conception of material needs, technology could also function as the sinews of confederation.A national division of labor and industrial centralization are dangerous because technology begins to transcend the human scale; it 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), 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 the regional level. On this level, however, the sharing of factories and resources could actually promote solidarity between community groups; it could serve to confederate them on the basis not only of common spiritual and cultural interests but also of common material needs. Depending upon the resources and uniqueness of regions, a rational, humanistic balance could be struck between autarky, industrial confederation, and a national division of labor.

Is society so ”complex” that an advanced industrial civilization stands in contradiction to a decentralized technology for life? My answer to this question is a categorical no. Much of the social ”complexity” of our time originates 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, stylemongers, financial manipulators, and the architects of market consent. He is totally mystified by the state—the police, courts, jails, federal offices, secretariats,the whole stinking, sick body of coercion, control and domination. Modern society is incredibly complex, complex even beyond human comprehension, if we grant its premises—property, ”production for the sake of production," competition, capital accumulation, exploitation,finance, centralization, coercion, bureaucracy and the domination of man by man. Linked to every one of these premises are the institutions that actualize it—offices, mil-lions of "personnel," forms, immense tons of paper, desks,typewriters, telephones, and, of course, rows upon rows of filing cabinets. As in Kafka's novels, these things 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 highly 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, and kitchens cluttered with an endless number of imbecile appliances. 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 the 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 the sizeable category of material that can be furnished only by a nationwide system of distribution. In what sense need there be a division of labor in the current sense of the term? There need be none at all. First, copper can be distributed, together with other goods, among free,autonomous communities, be they those that mine it or those that require it. This distribution system need not require the mediation of centralized bureaucratic institutions. Second, and perhaps more significant, a community that lives in a region with ample copper resources would not be a mere mining community. Copper mining would be one of the many economic activities in which it was engaged—a part of a larger, rounded, organic economic arena. The same would hold for communities whose climate was most suitable for growing specialized foods or whose resources were rare and uniquely valuable to society as a whole. Every community would approximate local or regional autarky. It would seek to achieve wholeness,because wholeness produces complete, rounded men who live in symbiotic relationship with their environment. Even if a substantial portion of the economy fell within the sphere of a national division of labor, the overall economic weight of society would 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 behavior. Even in this lousy bourgeois society we do not find it unusual that adults will rescue children from danger although the act may 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 neighborhood.

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 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 behavior of future generations by the very criteria we despise in our own time? Free men will not be greedy, one liberated community will not try to dominate another be-cause 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 and women 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.

Lewis Herber
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Lewis Herber is pseudonym of Murray Bookchin