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AUTOMATION

Learning a Living

A newspaper headline recently read, "Ittle Red Schoolhouse Dies Wehn Good Road built." One-room schools, with all subjets being taught to all the same time, simply dissolve when better transportation permits specialized spaces and specialized teaching. At the extreme of speeded up movement, however, specialism fo sapce adn subject disappears once more. With automation, it is not only jobs that siappear, and complex roles that reappear. Centuries fo specialist stress in pedagogy and inthe arrangemnt of of data now end with the instantaneous retrieval of information made possible by electricity. Automation is information and it not only ends jobs in the world of work, it ends subjects in the world of learning. It does not end the world of learning. The future of work consists of earning a living in the automation age. This is a familiar pattern in electric technology in general. It ends the old dichotomies between

culture and technology, between art and commerce, and between work and leisure. Whereas in the mechanical age of fragmentation leisure had been the absence of work, or mere idleness, the reverse is true in the electric age. As the age of information demands the simultaneous use of all our faculties, we discover that we are most at leisure when we are most intensely involved, very much as with the artists in all ages.

In terms of the industrial age, it can be pointed out that the difference between the previous mechanical age and the new electric age appears in the different kinds of inventories. Since electricity, inventories are made up not so much of goods in storage as of materials in continuous process of transformation at spatially removed sites. For electricity not only gives primacy to process, whether in making or in learning, but it makes independent the source of energy from the location of the process. In entertainment media, we speak of this fact as "mass media" because the source of the program and the process of experiencing it are independent in space, yet simultaneous in time. In industry this basic fact causes the scientific revolution that is called "automation" or "cybernation."

In education the conventional division of the curriculum into subjects is already as outdated as the medieval trivium and quadrivium after the Renaissance. Any subject taken in depth at once relates to other subjects. Arithmetic in grade three or nine, when taught in terms of number theory, symbolic logic, and cultural history, ceases to be mere practice in problems. Continued in their present patterns of fragmented unrelation, our school curricula will insure a citizenry unable to understand the cybernated world in which they live.

Most scientists are quite aware that since we have acquired some knowledge of electricity it is not possible to speak of atoms as pieces of matter. Again, as more is known about electrical "discharges" and energy, there is less and less tendency to speak of electricity as a thing that "flows" like water through a wire, or

is "contained" in a battery. Rather, the tendency is to speak of electricity as painters speak of space; namely, that it is a variable condition that involves the special positions of two or more bodies. There is no longer any tendency to speak of electricity as "contained" in anything. Painters have long known that objects are not contained in space, but that they generate their own spaces. It was the dawning awareness of this in the mathematical world a century ago that enabled Lewis Carroll, the Oxford mathematician, to contrive *Alice* in Wonderland, in which times, and spaces are neither uniform nor continuous, as they had seemed to be since the arrival *of* Renaissance perspective. As for the speed of light, that is merely the speed of total causality.

It is a principal aspect of the electric age that it establishes a global network that has much of the character of our central nervous system. Our central nervous system is not merely an electric network, but it constitutes a single unified field of experience. As biologists point out, the brain is the interacting place where all kinds of impressions and experiences can be exchanged and translated, enabling us to react to the world *as a whole.* Naturally, when electric technology comes into play, the utmost variety and extent of operations in industry and society quickly assume a unified posture. Yet this organic unity of interprocess that electromagnetism inspires in the most diverse and specialized areas and organs of action is quite the opposite of organization in a mechanized society. Mechanization of any process is achieved by fragmentation, beginning with the mechanization of writing by movable types, which has been called the "mono-fracture of manufacture."

The electric telegraph, when crossed with typography, created the strange new form of the modern newspaper. Any page of the telegraph press is a surrealistic mosaic of bits of "human interest" in vivid interaction. Such was the art form of Chaplin and the early silent movies. Here, too, an extreme speed-up of mechanization, an assembly line of still shots on celluloid, led to

a strange reversal. The movie mechanism, aided by the electric light, created the illusion of organic form and movement as much as a fixed position had created the illusion of perspective on a flat surface five hundred years before.

The same thing happens less superficially when the electric principle crosses the mechanical lines of industrial organization. Automation retains only as much of the mechanical character as the motorcar kept of the forms of the horse and the carriage. Yet people discuss automation as if we had not passed the oat barrier, and as if the horse-vote at the next poll would sweep away the automation regime.

Automation is not an extension of the mechanical principles of fragmentation and separation of operations. It is rather the invasion of the mechanical world by the instantaneous character of electricity. That is why those involved in automation insist that it is a way of thinking, as much as it is a way of doing. Instant synchronization of numerous operations has ended the old mechanical pattern of setting up operations in lineal sequence. The assembly line has gone the way of the stag line. Nor is it just the lineal and sequential aspect of mechanical analysis that has been erased by the electric speed-up and exact synchronizing of information that is automation. Automation or cybernation deals with all the units and components of the industrial and marketing process exactly as radio or TV combine the individuals in the audience into new interprocess. The new kind of interrelation in both industry and entertainment is the result of the electric instant speed. Our new electric technology now extends the instant processing of knowledge by interrelation that has long occurred within our central nervous system. It is that same speed that constitutes "organic unity" and ends the mechanical age that had gone into high gear with Gutenberg. Automation brings in real "mass production," not in terms of size, but of an instant inclusive embrace. Such is

also the character of "mass media." They are an indication, not of the size of their audiences, but of the fact that everybody becomes involved in them at the same time. Thus commodity industries under automation share the same structural character of the entertainment industries in the degree that both approximate the condition of instant information. Automation affects not just production, but every phase of consumption and marketing; for the consumer becomes producer in the automation circuit, quite as much as the reader of the mosaic telegraph press makes his own news, or just is his own news.

But there is a component in the automation story that is as basic as tactility to the TV image. It is the fact that, in any automatic machine, or galaxy of machines and functions, the generation and transmission of power is quite separate from the work operation that uses the power. The same is true in all servo-mechanist structures that involve feedback. The source of energy is separate from the process of translation of information, or the applying of knowledge. This is obvious in the telegraph, where the energy and channel are quite independent of whether the written code is French or German. The same separation of power and process obtains in automated industry, or in "cybernation." The electric energy can be applied indifferently and quickly to many kinds of tasks.

Such was never the case in the mechanical systems. The power and the work done were always in direct relation, whether it was hand and hammer, water and wheel, horse and cart, or steam and piston. Electricity brought a strange elasticity in this matter, much as light itself illuminates a total field and does not dictate what shall be done. The same light can make possible a multiplicity of tasks, just as with electric power. Light is a nonspecial-ist kind of energy or power that is identical with information and knowledge. Such is also the relation of electricity to automation, since both energy and information can be applied in a great variety of ways.

Grasp of this fact is indispensable to the understanding of the electronic age, and of automation in particular. Energy and production now tend to fuse with information and learning. Marketing and consumption tend to become one with learning, enlightenment, and the intake of information. This is all part of the electric implosion that now follows or succeeds the centuries of explosion and increasing specialism. The electronic age is literally one of illumination. Just as light is at once energy and information, so electric automation unites production, consumption, and learning in an inextricable process. For this reason, teachers are already the largest employee group in the U.S. economy, and may well become the only group.

The very same process of automation that causes a withdrawal of the present work force from industry causes learning itself to become the principal kind of production and consumption. Hence the folly of alarm about unemployment. Paid learning is already becoming both the dominant employment and the source of new wealth in our society. This is the new role for men in society, whereas the older mechanistic idea of "jobs," or fragmented tasks and specialist slots for "workers," becomes meaningless under automation.

It has often been said by engineers that, as information levels rise, almost any sort of material can be adapted to any sort of use. This principle is the key to the understanding of electric automation, in the case of electricity, as energy for production becomes independent of the work operation, there is not only the speed that makes for total and organic interplay, but there is, also, the fact that electricity is sheer information that, in actual practice, illuminates all it touches. Any process that approaches instant interrelation of a total field tends to raise itself to the level of conscious awareness, so that computers seem to "think. In fact, they are highly specialized at present, and quite lacking in the full process of interrelation that makes for consciousness. Obviously, they can be made to simulate the process of

consciousness, just as our electric global networks now begin to simulate the condition of our central nervous system. But a conscious computer would still be one that was an extension of our consciousness, as a telescope is an extension of our eyes, or as a ventriloquist's dummy is an extension of the ventriloquist.

Automation certainly assumes the servomechanism and the computer. That is to say, it assumes electricity as store and expediter of information. These traits of store, or "memory," and accelerator are the basic features of any medium of communication whatever. In the case of electricity, it is not corporeal substance that is stored or moved, but perception and information. As for technological acceleration, it now approaches the speed of light. All nonelectric media had merely hastened things a bit. The wheel, the road, the ship, the airplane, and even the space rocket are utterly lacking in the character of instant movement. Is it strange, then, that electricity should confer on all previous human organization a completely new character? The very toil of man now becomes a kind of enlightenment. As unfallen Adam in the Garden of Eden was appointed the task of the contemplation and naming of creatures, so with automation. We have now only to name and program a process or a product in order for it to be accomplished. Is it not rather like the case of Al Capp's Schmoos? One had only to look at a Schmoo and think longingly of pork chops or caviar, and the Schmoo ecstatically transformed itself into the object of desire. Automation brings us into the world of the Schmoo. The custom-built supplants the mass-produced.

Let us, as the Chinese say, move our chairs closer to the fire and see what we are saying. The electric changes associated with automation have nothing to do with ideologies or social programs. If they had, they could be delayed or controlled. Instead, the technological extension of our central nervous system that we can call the electric media began more than a century ago, subliminally. Subliminal have been the effects. Subliminal they

remain. At no period in human culture have men understood the psychic mechanisms involved in invention and technology. Today it is the instant speed of electric information that, for the first time, permits easy recognition of the patterns and the formal contours of change and development. The entire world, past and present, now reveals itself to us like a growing plant in an enormously accelerated movie. Electric speed is synonymous with light and with the understanding of causes. So, with the use of electricity in previously mechanized situations, men easily discover causal connections and patterns that were quite unobservable at the slower rates of mechanical change. If we play backward the long development of literacy and printing and their effects on social experience and organization, we can easily see how these forms brought about that high degree of social uniformity and homogeneity of society that is indispensable for mechanical industry. Play them backward, and we get just that shock of unfamiliarity in the familiar that is necessary for the understanding of the life of forms. Electricity compels us to play our mechanical development backward, for it reverses much of that development. Mechanization depends on the breaking up of processes into homogenized but unrelated bits. Electricity unifies these fragments once more because its speed of operation requires a high degree of interdependence among all phases of any operation. It is this electric speed-up and interdependence that has ended the assembly line in industry.

This same need for organic interrelation, brought in by the electric speed of synchronization, now requires us to perform, industry-by-industry, and country-by-country, exactly the same organic interrelating that was first effected in the individual automated unit. Electric speed requires organic structuring of the global economy quite as much as early mechanization by print and by road led to the acceptance of national unity. Let us not forget that nationalism was a mighty invention and revolution that, in the Renaissance, wiped out many of the local regions and

loyalties. It was a revolution achieved almost entirely by the speed-up of information by means of uniform movable types. Nationalism cut across most of the traditional power and cultural groupings that had slowly grown up in various regions. Multi-nationalism had long deprived Europe of its economic unity. The Common Market came to it only with the Second War. War is accelerated social change, as an explosion is an accelerated chemical reaction and movement of matter. With electric speeds governing industry and social life, explosion in the sense of crash development becomes normal. On the other hand, the old-fashioned kind of "war" becomes as impracticable as playing hopscotch with bulldozers. Organic interdependence means that disruption of any part of the organism can prove fatal to the whole. Every industry has had to "rethink through" (the awkwardness of this phrase betrays the painfulness of the process), function by function, its place in the economy. But automation forces not only industry and town planners, but government and even education, to come into some relation to social facts.

The various military branches have had to come into line with automation very quickly. The unwieldy mechanical forms of military organization have gone. Small teams of experts have replaced the citizen armies of yesterday even faster than they have taken over the reorganization of industry. Uniformly trained and homogenized citizenry, so long in preparation and so necessary to a mechanized society, is becoming quite a burden and problem to an automated society, for automation and electricity require depth approaches in all fields and at all times. Hence the sudden rejection of standardized goods and scenery and living and education in America since the Second War. It is a switch imposed by electric technology in general, and by the TV image in particular.

Automation was first felt and seen on a large scale in the chemical industries of gas, coal, oil, and metallic ores. The large changes in these operations made possible by electric energy

have now, by means of the computer, begun to invade every kind of white-collar and management area. Many people, in consequence, have begun to look on the whole of society as a single unified machine for creating wealth. Such has been the normal outlook of the stockbroker, manipulating shares and information with the cooperation of the electric media of press, radio, telephone, and teletype. But the peculiar and abstract manipulation of information as a means of creating wealth is no longer a monopoly of the stockbroker. It is now shared by every engineer and by the entire communications industries. With electricity as energizer and synchronizer, all aspects of production, consumption, and organization become incidental to communications. The very idea of communication as interplay is inherent in the electrical, which combines both energy and information in its intensive manifold. Anybody who begins to examine the pattern of automation finds that perfecting the individual machine by making it automatic involves "feedback." That means introducing an information loop or circuit, where before there had been merely a one way flow or mechanical sequence. Feedback is the end of the lineality that came into the Western world with the alphabet and the continuous forms of Euclidean space. Feedback or dialogue between the mechanism and its environment brings a further weaving of individual machines into a galaxy of such machines throughout the entire plant. There follows a still further weaving of individual plants and factories into the entire industrial matrix of materials and services of a culture. Naturally, this last stage encounters the entire world of policy, since to deal with the whole industrial complex as an organic system affects employment, security, education, and polities, demanding full understanding in advance of coming structural change. There is no room for witless assumptions and subliminal factors in such electrical and instant organizations.

As artists began a century ago to construct their works

backward, starting with the effect, so now with industry and plan-nine In general, electric speed-up requires complete knowledge of ultimate effects. Mechanical speed-ups, however radical in their reshaping of personal and social life, still were allowed to happen sequentially. Men could, for the most part, get through a normal life span on the basis of a single set of skills. That is not at all the case with electric speed-up. The acquiring of new basic knowledge and skill by senior executives in middle age is one of the most common needs and harrowing facts of electric technology. The senior executives, or "big wheels," as they are archaically and ironically designated, are among the hardest pressed and most persistently harassed groups in human history. Electricity has not only demanded ever deeper knowledge and faster interplay, but has made the harmonizing of production schedules as rigorous as that demanded of the members of a large symphony orchestra. And the satisfactions are just as few for the big executives as for the symphonists, since a player in a big orchestra can hear nothing of the music that reaches the audience. He gets only noise.

The result of electric speed-up in industry at large is the creation of intense sensitivity to the interrelation and interprocess of the whole, so as to call for ever-new types of organization and talent. Viewed from the old perspectives of the machine age, this electric network of plants and processes seems brittle and tight. In fact, it is not mechanical, and it does begin to develop the sensitivity and pliability of the human organism. But it also demands the same varied nutriment and nursing as the animal organism.

With the instant and complex interprocesses of the organic form, automated industry also acquires the power of adaptability to multiple uses. A machine set up for the automatic production of electric bulbs represents a combination of processes that were previously managed by several machines. With a single attendant, it can run as continuously as a tree in its intake and output.

But, unlike the tree, it has a built-in system of jigs and fixtures that can be shifted to cause the machine to turn out a whole range of products from radio tubes and glass tumblers to Christmas-tree ornaments. Although an automated plant is almost like a tree in respect to the continuous intake and output, it is a tree that can change from oak to maple to walnut as required. It is part of the automation or electric logic that specialism is no longer limited to just one specialty. The automatic machine may work in a specialist way, but it is not limited to one line. As with our hands and fingers that are capable of many tasks, the automatic unit incorporates a power of adaptation that was quite lacking in the pre-electric and mechanical stage of technology. As anything becomes more complex, it becomes less specialized. Man is more complex and less specialized than a dinosaur. The older mechanical operations were designed to be more efficient as they became larger and more specialized. The electric and automated unit, however, is quite otherwise. A new automatic machine for making automobile tailpipes is about the size of two or three office desks. The computer control panel is the size of a lectern. It has in it no dies, no fixtures, no settings of any kind, but rather certain general-purpose things like grippers, benders, and advancers. On this machine, starting with lengths of ordinary pipe, it is possible to make eighty different kinds of tailpipe in succession, as rapidly, as easily, and as cheaply as it is to make eighty of the same kind. And the characteristic of electric automation is all in this direction of return to the general-purpose handicraft flexibility that our own hands possess. The Programming can now include endless changes of program. It is the electric feedback, or dialogue pattern, of the automatic and computer-programmed "machine" that marks it off from the older mechanical principle of one-way movement.

This computer offers a model that has the characteristics shared by all automation. From the point of intake of materials ^{t0} the output of the finished product, the operations tend to be

independently, as well as interdependent, automatic. The synchronized concert of operations is under the control of gauges and instruments that can be varied from the control-panel boards that are themselves electronic. The material of intake is relatively uniform in shape, size, and chemical properties, as likewise the material of the output. But the processing under these conditions permits use of the highest level of capacity for any needed period. It is, as compared with the older machines, the difference between an oboe in an orchestra and the same tone on an electronic music instrument. With the electronic music instrument, any tone can be made available in any intensity and for any length of time. Note that the older symphony orchestra was, by comparison, a machine of separate instruments that gave the effect of organic unity. With the electronic instrument, one starts with organic unity as an immediate fact of perfect synchronization. This makes the attempt to create the effect of organic unity quite pointless. Electronic music must seek other goals.

Such is also the harsh logic of industrial automation. All that we had previously achieved mechanically by great exertion and coordination can now be done electrically without effort. Hence the specter of joblessness and propertylessness in the electric age. Wealth and work become information factors, and totally new structures are needed to run a business or relate it to social needs and markets. With the electric technology, the new kinds of instant interdependence and interprocess that take over production also enter the market and social organizations. For this reason, markets and education designed to cope with the products of servile toil and mechanical production are no longer adequate. Our education has long ago acquired the fragmentary and piece-meal character of mechanism. It is now under increasing pressure to acquire the depth and interrelation that are indispensable in the all-at-once world of electric organization. Paradoxically, automation makes liberal education mandatory

The electric age of servomechanisms suddenly releases men from the mechanical and specialist servitude of the preceding machine age. As the machine and the motorcar released the horse and projected it onto the plane of entertainment, so does automation with men. We are suddenly threatened with a liberation that taxes our inner resources of self-employment and imaginative participation in society. This would seem to be a fate that calls men to the role of artist in society. It has the effect of making most people realize how much they had come to depend on the fragmentalized and repetitive routines of the mechanical era. Thousands of years ago man, the nomadic food-gatherer, had taken up positional, or relatively sedentary, tasks. He began to specialize. The development of writing and printing were major stages of that process. They were supremely specialist in separating the roles of knowledge from the roles of action, even though at times it could appear that "the pen is mightier than the sword." But with electricity and automation, the technology of fragmented processes suddenly fused with the human dialogue and the need for over-all consideration of human unity. Men are suddenly nomadic gatherers of knowledge, nomadic as never before, informed as never before, free from fragmentary specialism as never before --but also involved in the total social process as never before; since with electricity we extend our central nervous system globally, instantly interrelating every human experience. Long accustomed to such a state in stock-market news or front-page sensations, we can grasp the meaning of this new dimension more readily when it is pointed out that it is possible to "fly" unbuilt airplanes on computers. The specifications of a plane can be programmed and the plane tested under a variety of extreme conditions before it has left the drafting board. So with new products and new organizations of many kinds. We can now by computer, deal with complex social needs with the same architectural certainty that we previously attempted in private housing. Industry as a whole has become

the unit of reckoning, and so with society, politics, and education as wholes.

Electric means of storing and moving information with speed and precision make the largest units quite as manageable as small ones. Thus the automation of a plant or of an entire industry offers a small model of the changes that must occur in society from the same electric technology. Total interdependence is the starting fact. Nevertheless, the range of choice in design, stress, and goal within that total field of electromagnetic interprocess is very much greater than it ever could have been under mechanization.

Since electric energy is independent of the place or kind of work-operation, it creates patterns of decentralism and diversity in the work to be done. This is a logic that appears plainly enough in the difference between firelight and electric light, for example. Persons grouped around a fire or candle for warmth or light are less able to pursue independent thoughts, or even tasks, than people supplied with electric light. In the same way, the social and educational patterns latent in automation are those of self-employment and artistic autonomy. Panic about automation as a threat of uniformity on a world scale is the projection into the future of mechanical standardization and specialism, which are now past.