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The Dangerous Illusion of Human Efficiency

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People are becoming increasingly concerned about polution, population, poverty and protest, but they still believe that science and technology will save them from the pestilence, famine, war and death which these four problems fore-shadow. More efficient combustion will reduce polution, more efficient agriculture will feed the growing population, more efficient machines will eliminate poverty, and more efficient organizations will eliminate protest. It is not surprising that people hold to these beliefs; they have done so throughout history. Throughout this history, also, combustion, agriculture, machinery and organization have, fairly steadily, increased in efficiency, and while pestilence, famine, war and death have, in consequence, occasionally fallen a little bit behind, they have always come back, after a brief hiatus, bigger and better than ever. It would seem to be time to question the value of efficiency itself, a concept as much misunderstood as are its consequences. Efficiency is often thought to be a way of getting something for nothing, or at least of getting more for less. In one sense, the latter idea is correct, but in one sense only. When a more efficient way of doing something is discovered this does not mean that more of something can be obtained at a lower unit cost than before. It does not mean, however, that even by the new method more can be obtained than is invested.

All notions of efficiency that pretend to get more out of a process than goes into it are delusions, based on a restricted or biased view of the process.

Until about a century ago, physics was concerned with this ~~delusion~~ idea under the guise of perpetual motion. Then, with the discovery and proof of the second law of thermodynamics this ~~idea~~ delusion was laid to rest, only to be dug up, revived, and re-furbished by economics under the label of surplus value. Physics had proved that every process, if a strict accounting is made, uses up more energy than it yields. Economics said, in effect, that human production represents an exception to this rule. Marx did, it is true, point out that the surplus value, called profit, was sweated out of the bodies of exploited workers but even he did not question the assumption that production yields a net benefit, if only the workers are allowed to share it. ~~Since~~ All this was prior to Einstein's demonstration that matter and energy are convertible into each other, there was an excuse for not extending the laws of thermodynamics from processes involving energy to processes involving matter. Now there is no such excuse.

If a process appears to produce more value than it absorbs this is only because certain inputs are ignored or because they are appraised at less than their value in terms of some common denominator of costs and benefits. Here, of course, is where much of the misunderstanding occurs. The man who values the process, even if he is aware of the laws of physics, will not accept its common denominator nor any other. "What if the beef I eat does take enough grain to keep

eight others alive," he says. "My life and work are worth a hundred of theirs, even to them. Without the knowledge, or machinery, I produce none of them would be alive at all." The man is even, in one sense, correct. This globe could not support the amount of human life it currently does were it not for human inventions. Whether this justifies the man's position, assuming that he makes a significant contribution to the production of these inventions, is another question. It may well be the central question on which the continuation and continued value of human life depends.

The element of truth in the man's reply is that all forms of life live on lower forms of life or on ~~inorganic~~ processes which use up limited supplies of energy in support of life. Coal, oil and uranium deposits run out; even the sun will eventually burn up its supply of hydrogen leaving man, if he still exists, with only the option of escape to another star. While it lasts, human life must exploit other energy consuming processes including lower forms of life. Man's inventions clearly increase the ability of such processes to sustain human life but only at the expense of some other part of the universe. Vegetarians aside, this has not bothered most of us very much—except where human exploitation was involved—until quite recently. But now many people are becoming aware that we are all involved in the "delusion of efficiency." There are new critical problems at the level of the non-living environment, the level of plant and animal life, the level of traditional human exploitation, and finally, what may perhaps best be characterized, briefly, as the level of self-

exploitation by the privileged classes of mankind. All these levels of energy exchange have, almost simultaneously, developed major new dimensions of which only a few people have, until recently, been much aware.

At the level of the non-living environment, the new dimension is illustrated by the ability of the atmosphere to absorb the products of combustion and nuclear reaction. At the level of plant and animal life the new dimension is the increasing dependence of life-sustaining acreage upon human inputs of seed, fertilizer and water. At the level of human exploitation the new dimension is the growing conviction of the underprivileged that modern technology makes human exploitation unnecessary. At the level of self-exploitation the new dimension is the increasing institutional enslavement of larger and larger proportions of the so-called privileged populations.

The dilemma is that all currently recognized solutions to any of these problems involve further increases in the scale, or efficiency, of supporting processes. But efficiency increases may be illusory, since an increase in efficiency, at one level, implies an increase in scale at another. To exploit a declining food-producing acreage more efficiently we must increase the scale of combustion, or nuclear reaction, as well as the input of labor per acre. To reduce human exploitation we must increase the demand on every acre, not only to feed a growing population but also to feed the existing population better. To increase the standard of life of the underprivileged we must institutionalize the lives of more people in a greater variety of ways.

The popular escape from these dilemmas is to decrease, or at least limit, the size of the human population. While this is a necessary part, and may even be the core of any long-term solution, it is, obviously, not a practical answer. Population control, in its present form, is merely something that privileged people urge poor people to practice. Not that the privileged are unwilling to practice it themselves. Some of them are, but there are not enough of them to make much difference. Furthermore, birth control is quite a different matter for privileged people to whom a large family may be a burden than for poor people to whom each added child may be a blessing, not only psychological but economic. In many kinds of poverty children provide more support than they demand.

This is not the main reason, however, why birth control is not the answer. Recent calculations show that two-hundred million Americans are a greater burden on the earth than two-billion Asians. Standard of living puts a much greater demand on land and energy supplies than mere numbers of people. Ten Asians would have to give way to accomodate one more American, while only one American could make room for ten Asians. Clearly, the problem will not be resolved along these lines. Either an increase in conflict or in identification of interests will have to occur and either one, in terms of current approaches, would require an enormous increase in the exploitation of the world's energy, land and human resources.

A re-statement of the problem may be a necessary prelude to the search for an adequate solution. So long as man burned only wood and

dung, the atmosphere could dissipate the heat while the earth's plant life could use the carbon dioxide created and replace the oxygen consumed. If all men, even today, turned from these fuels to the use of coal and oil, in the average amounts currently used in Europe and America, the atmospheric balance could not be maintained. It may not even be ~~maintained~~ in balance today, with only a tenth of mankind consuming fossil fuels.

So long as there were less than a billion men on earth, agricultural land could recreate itself as fast as it became exhausted. Today this requires major inputs of fertilizer made from inorganic sources, of water artificially channeled at great expense, and of labor invested directly and indirectly in the land.

So long as privileged societies and privileged classes were small they could support a rich cultural life upon a human base of slavery, serfdom or market exploitation of the masses. Today, these means, although still widely practiced, are becoming increasingly difficult to maintain. Most areas of the world have had to return to openly despotic forms of government in order to contain the popular revolts which appear almost everywhere more imanent.

So long as large institutions could choose their members and their clients from among large numbers who were not included in either category, institutional life could not corrupt the values of entire societies. Today, some people have become so totally incarcerated in large scale institutions that they have lost all ~~vestige~~ marginal vestige of identity or independence, their lives all but ~~vestigal~~ marginal scraps of meaning.

The total institutional involvement of modern man is not

avoidable, so long as he puts no limits on his demands. According to the law which governs energy exchanges at the level of physics, man's total energies must become institutionally channeled long before his appetites are satisfied, unless he lives on the energy of others. Nor is this merely a psychological matter of appetites being insatiable. It follows more economically from the law of physics which says that the energy input of a process is always greater than its output. A small elite can consume the energy of its masses; a large elite must consume itself.

These statements are, obviously, not deductions from the laws of physics. They result, rather, from applying the logic of physics to human affairs. Since this is not always appropriate, and since human efficiency is a complex concept, it may be useful briefly to review its history and to note some of the complications.

The concept of efficiency is a child of the marriage of measurement and the older qualitative concept of effectiveness. Effectiveness originally meant merely that a given means produced a desired end. Just how effective various means were and at what costs their effects were produced could not be systematically thought about until measurement was invented. The union of the two ideas gave man a great new power. He could now select those means which not only gave the best results but gave them at the least cost. He could not then, and still cannot, measure everything or even be aware of all the conditions and consequences of his acts. For a long time many of them did not matter, at least to the person deciding on the action. Even now, only those conditions and consequences with discernible effects on human beings

are of much concern, except to a few scientists, philosophers and theologians.

It is natural for human beings to distinguish human effieiency from the more general concept which takes biological and physical events into account. In the pre-scientific era, man was not even aware of the energy transfers in which his own work was not involved. It is still second nature for man to treat the world as if it were made for men. The second law of thermodynamics is not, for most men, as important as are the facts and principles which place limits on human efficiency, on man's ability to exploit the rest of the world.

Until the recent advent of modern ecology it was heresy to suggest that there were such limits. There have been heretics, to be sure, Bertrand de Juvenal and Jacques Ellul among others, but they have been countered, even among the humanists, by such as Teillard de Chardin and Jane Jacobs. The latter's distinction between the development and the large-scale use of increased efficiency serves to aclarify an important point. Mrs. Jacobs points out that the discovery and invention of more efficient ways of doing things is itself an inefficient process, depending on trial and error and upon an environment which permits and encourages experimentation and innovation by all kinds of people in all walks of life. What is important to note here, however, is that successful discoveries, inventions, and other unique creative processes are the only ones which can claim to defy the law of entropy. They do not really defy it because they do not fall under its jurisdiction. The laws of thermodynamics refer to repetitive processes. Nevertheless, until Mrs. Jacobs did so, no one had sucoeeded in making the public aware of

the difference between the creation and the use of efficiency. An invention, such as the steam engine, clearly yields a net energy output greater than James Watt personally and perhaps all of its other developers invested in it. Nevertheless, each individual steam engine absorbs more energy than it delivers. Creation, whether by God, nature or man is the only truly dis-entropic process, but creation refers only to unique and not to repetitive processes. Creation does, locally, increase structure rather than randomness; although it always does so at the expense of a quantitatively larger amount of more primitive structure. The point is crucial since it permits Mrs. Jacobs and others to argue that man's only real limits are the ultimate boundaries of the universe and the limitations of his own creativity. The boundaries of the universe may for practical purposes be ignored. The limits of this earth and its bio-sphere are admittedly arbitrary but may be of practical importance. The main point of this essay, however, is that man's own creativity is limited, precisely by the efficiency he himself creates. As Mrs. Jacobs describes, better than anyone else, large-scale efficient production enterprize radically suppresses creativity. Individual man has limited time and creative energy. He has, on the other hand, unlimited wants. As he multiplies large-scale production enterprizes, in order more efficiently to cater to his wants, he will exhaust his supply of creative time and energy long before his wants are satisfied. This is man's fate unless he reverses his direction or unless he first destroys himself in attempting to breach his immediate environmental barriers.

The minor thesis of this essay is that, despite further increases in scientific knowledge, man will be increasingly constrained, in the

foreseeable future, by environmental thresholds. Its major thesis is that any further increases in human efficiency will have to break sharply with trends which have characterized all of man's history.

The major trends of human history, especially those of the last thousand years, themselves provide the principal basis for man's future constraint by environmental thresholds. Man has run heedlessly into these thresholds in the course of his most recent millenium of progress. He has done so by increasing his numbers, increasing his knowledge, and increasing his ability to shape his life and his environment. What guarantees his future constraint is not only his present state and momentum but his pride in, and universal advertisement of, his accomplishments.

Short of catastrophic reduction in the human population of the earth, man's only conceivable escape from the constraints of his newly discovered environmental barriers depends upon new scientific discoveries and technological inventions. But, even the most fantastic of these that can be imagined would merely guarantee a tighter bind in the almost immediate future--at higher levels of population and per capita consumption. The already generated and currently frustrated potentials for future increases in population and consumption are almost unimaginable. All that is required to double and triple present rates of population increase is to provide people already living with the "right to live" enjoyed by the privileged minority. The promise of the extra-ordinary "green revolution" now in progress, promising to double and triple crop yields if inputs of fertilizer,

water and work can also be multiplied by at least as many times, would still fall short of providing the food value of the European-American diet on a world wide basis. The average living standard of Europe and America, if extended to the rest of the world, would multiply total fuel combustion by at least a factor of fifty and the use of common metals over a hundred fold. And yet fifteen percent of Americans are regarded as living below the poverty line and the pressure for rising standards of consumption is nowhere fiercer than in the United States, where a three percent annual rise in income comes to twice the entire income of a resident of India. Discoveries and inventions in a world like this are like oil-sprays in a forest fire.

This patent inability of science and technology, as currently used, to bail man out of his current problems does not represent a failure of science and technology, nor does it suggest that man should turn his back upon them. They did, obviously, help man get into his present pickle but they can also be helpful in making clear the extent and nature of his problem and, properly used, in solving it. The problem, to re-state the obvious, is not with science and technology but with man's blind uncritical application of their powers to the satisfaction of his short term wants, without consistent application of their principles to his long term needs and possibilities. Generalization of the second law of thermodynamics to problems of human efficiency should long ago have warned man that he was digging hiw own grave.

One of the reasons this did not occur is that the law was stated while man was in the midst of his discovery and exploitation of what appeared then to be almost inexhaustible new sources of energy, the

coal and oil deposited by nature in the early history of the planet. This energy appeared, furthermore, to be almost free of human cost, especially as mechanical means of mining were developed and as oil replaced coal. With the discovery of atomic energy, breeders of fissionable compounds and, finally, of the fission of hydrogen and other light elements, it again appeared that man's energy problems were solved. That, while the second law of thermodynamics might hold, nature had presented man with relatively cost-free energy for almost as long as the sun and the planet might last. Now we understand that, plentiful as it may potentially be, this energy is far from free, that the costs not only of obtaining it in usable form, but of dealing with the products and the consequences of its use rise rather than fall as the scale of use is increased. When a complete accounting is made, there are beyond optimum points already passed, dis-economics rather than economics of scale in man's use of energy. This is now obvious at the level of ecology. It is less obvious but equally true at the levels of sociology and psychology. The uncritical application of false notions of efficiency to his own affairs, to the shaping of his own activities and values, has blinded man to his heedless use of science and technology. This blinding began with some of the most primitive applications of technology to the conquest and enslavement of less ruthless peoples by those who were more ruthless. It has reached the point of man's voluntary if unconscious enslavement of himself.

By ignoring the cost to slaves, serfs, and exploited wage labor, man learned to delude himself about the true returns of human

efficiency, just as he did in the case of physical processes prior to the discovery of the second law of thermo-dynamics. So apparently successful were his coercive tactics with people whose value he ignored that he gradually extended their use to his own women, his own children, his own brethren and himself. Current exploitation of some by others is even justified today by the statement, only partly false, that no one works harder than the boss.

The history of institutions suggests, however, that while their founders deluded themselves about the true costs of efficiency they also suspected that these costs might exceed the gains, since the major costs were always transferred to others than themselves. It is only recently that more than the exceptional managers of institutions have been willing to partake of their discipline. Kings commanded their armies, naval officers were not subject to the lash, factory owners employed other people's children. Even now, people send their children to schools they would not attend themselves. They claim, of course, that they went to worse ones, but that was when they were helpless children.

Now that more of the managers of institutions submit themselves more often to the rigors of their institutions, this is partly because these rigors have been abated and partly because the new breed of managers are themselves products of their institutions. Having come up through the institutions, and having been shaped by them, they find their constraints less foreign and less onerous than those who are used to a non-institutional life. It is also these managers who are products of the institutions they now control, who have done most to

relieve the harshness that formerly characterized the lower ranks. They could do this, however, only by substituting other controls for the overseer's whip and the lash of hunger. The substitutes constitute a vast proliferation of institutional life, down into the lives of children through the schools, into the very bedrooms of organization wives, into the lives of workers and consumers by means of advertising and consumer credit, beyond the boundaries of birth and death themselves in pre-natal clinics, undertaking parlors and life insurance policies.

Modern man receives the full benefits of his institutions only by submitting himself to them completely. Even though he does this, however, he never has enough money nor credit to avail himself of all of the benefits they teach him to want. He is the final proof that human efficiency costs more than it produces, that institutions merely displace costs rather than create values.

What must be done? These words, spoken on the eve of the Russian revolution by Lenin, now demand a much more profound answer than he gave them. The industrial workers to whom he spoke might be the first to reject an adequate answer; for this is not, as Lenin thought, to shift the benefits of human efficiency from owners to workers but, almost, to turn our backs upon the concept of efficiency itself.

Almost, but not quite! The price of a complete rejection is too high. The earth could not sustain a third of the present humgn population ~~x~~ if institutionalized technology were abandoned. This much cost man has succeeded in shifting to the environment and a shift back would be catastrophic--for man. More than that, almost all of the remaining third of mankind would be forced back to the level of bare

subsistence. A non-industrial world could again support only a tiny elite; the ten percent who, today, live in relative freedom from a hand to mouth existence, would shrink back to one percent or less. Man can no more afford a complete rejection of institutionalized efficiency than he can afford to let it continue on its unbridled course. Human efficiency is strong medicine; it has the power to kill but also the power, if carefully controlled, to keep alive.

By using efficient means man has far surpassed the boundaries which nature would otherwise have set him, not only in numbers but in his own nature and expectations. He is no longer a child of nature nor can he revert to his former state. He can live now only with the artificial support of the lethal powers he has himself devised. He must understand their lethal nature, however, and control them well or they will kill him. The atomic bomb is merely a symbol of this dilemma. The apparently benign instruments of man's efficiency, even those which merely save life itself, are equally deadly.

The way physics understands efficiency may provide insight not only into its nature but, possibly, also insights useful for its control. An efficient device, in physics, is one which transfers work from one point or aspect of the environment to another. It is, thus, a means of displacing costs rather than a means of creating values, since it always absorbs more energy than it transfers.

Nevertheless, displacing costs may be a very useful thing to do, even though it has to be done at a price. Such devices must necessarily have a limited use; otherwise they would use up all available energy while supplying a smaller equivalent in another form. Confined to a limited use, it then makes sense that efficient devises

be used to displace those costs which most need to be displaced, in the interests of humanity, and in an amount which uses no more energy than humanity can afford for these purposes. Efficiency is, itself, a scarce resource and must be rationed to its most profitable uses. This is also just common sense. A prudent man, free of compulsions, applies efficient means to those limited aspects of his life where they give the greatest pay-off at the least cost. He knows that to try to be efficient in all or even most things would destroy his freedom. He can follow this policy so long as he remains prudent and free. The problem of applying these principles to all mankind is that prudence and freedom cannot be assumed but have to be achieved. There are additional problems of scale, of conflict of interest and of stagnation. Great as these problems are there is no alternative but to face them.

The following sketch of a possible solution is no more than a preliminary exploration. It is not a program and nothing is said about how it might be achieved. It is appended partly to avoid a merely negative reaction to the statement of an unpleasant problem; which no one, however, can afford to ignore. It will, hopefully, offer a starting point for constructive as well as critical discussion.

To begin negatively, there are three institutions which above all others fan the flames of galloping efficiency. They are nation-states, production cartels, and schools. The first is the instrument of military competition, the second of consumer competition, the third of the personal status scramble. With these engines of efficiency in operation all prospects of its control and limitation are totally

obscured. Nations, corporations and persons competing for survival obviously cannot afford to limit the scope or level of their efficiency. A world must be imagined, therefore, in which this kind of competition is strictly controlled. Difficult as this is, it is not the greatest difficulty. The heart of the problem is to imagine a way of life which would provide people with some of the benefits of efficiency, which would enable them to maintain and increase these benefits, but would at the same time maintain their fear, respect and, perhaps necessarily, their dislike of large-scale efficiency enough to keep it, and their demands upon it, under strict control.

A society can be imagined whose members, organized in family-size non-corporate enterprises, would produce and exchange food, personal services and artisan products. These enterprises would be limited in the permitted size of their holdings and paid employment. This society would also contain a public, large-scale technical sector producing those agricultural and manufactured products and services most subject to economics of scale. The scope of this subsector would be limited to the labor input of a small fraction of the labor potential of the society, to be provided by the required service of each member for a limited period of years. In return for this service each member of the society would have a life-time right to draw upon the technical sector for a roughly equal share of its products. Within limits, and with adequate safeguards, individuals who chose to give additional years of service to the technical sector, or whose services were particularly needed, might earn additional claims upon it, or upon the services of their fellow members. The essence of the idea is that

people would live most of their lives in a non-institutionalized environment engaged in work with small-scale tools and facilities, and in exchange on a person to person or small firm basis. They would learn to know and respect and probably dislike the large-scale technical sector through their required service within it and while they would constantly be tempted to increase its output they would also be deterred by the more extended service this would require of them and by the fact that their personal increase in benefits would be small. For almost everyone, opportunities to improve any aspect of his own way of life would be much greater outside the large-scale technical sector than within it.

The policies governing the technical sector would be made by people whose lives were lived largely outside it. They would be experienced enough to understand its requirements but would not live under its control or direct influence. Computers would undoubtedly play an even greater role in its management than they do now, but they would be programmed by people whose minds had not been formed under their spell. The technical sector of this society would be publicly owned and so, probably, would the land, but the rest of the economy could be privately operated. The competition of the technical sector and the public ownership of land would provide most of the necessary controls on the private economy but some additional restrictions on organizational size and scope of activities might be required. There would be little need for public services in this society except for the transportation and communication services provided by the technical sector. People could exchange services in the market or organize cooperatives, on a local scale, to provide the services they desired.

Compared to the industrial areas of today's world, life in this projected society would, at least for a time, be somewhat primitive. A restricted technical sector could probably not provide private autobiles nor all of today's major household durables, although it might provide the components from which they could be built. The large scale entertainment, luxury goods and service industries of today would not exist, but many reasonable small scale substitutes could be developed. Much more of all kinds of responsibility would devolve upon the household and small community than is now the case in large urban concentrations. The largest cities might even be gradually dispersed since some of the compulsions and attractions of urban life would be reduced. Much less would be done for people than is now done in the wealthier parts of the world, but people would be far more free to do things for themselves, to choose where and how they wanted to live, at what they wanted to work or play and with whom. There would be no extremes of poverty or wealth but there would be an infinitely greater variety of styles of life and activity. Both equality and superiority would decline in importance as the qualitative variety of life increased.

At least two major problems are posed by this dystopia. One is to awaken a humanity immersed in the existing utopia, backed by the cumulative historic successes of science and technology, from ~~their~~ its present cornucopian day-dream. People will be reluctant to exchange this dream, which is before their eyes and under their hands, for a much less glamerous promise in the sky.

The other problem would be to maintain the tension and the balance

of the projected society, if it were ever established. Actually the second problem must be faced before the first, since faith in this possibility is a necessary precondition of steps to bring it into being.

Three general arguments will be raised against the feasibility of the society sketched above. The first is that the technical sector could not be run by amateurs, as is envisioned. This argument is not impressive to those who have worked in the bowels of institutions. As many managers have testified, the myth of managerial efficiency is precisely that. In wars and other emergencies, when amateurs are drafted in large numbers into responsible institutional roles, many of them do better than the veterans. This is when most institutional innovations occur and the amateurs are largely responsible for them.

A second objection is much more difficult to deal with. It is that a society built on the suggested model would become stagnant, that especially the people who were previously better off would lack the motivation to develop new products, methods and styles of life. Jane Jacobs makes a convincing case that innovation has always been a product of specialization, that new work is based on old work, and that cities have been the centers of innovation. In the suggested model opportunities for innovation would, admittedly, be less concentrated; neither the pressure nor the rewards would be as great as they are now in certain locations. It is also true, of course, that innovations have come largely from those locations where the pressures and rewards for innovations were concentrated. This does not mean, however, that less innovation would occur if opportunities for innovation were more dispersed, so long as the rewards and pressures for innovation did not

fall below critical thresholds. No one knows what these thresholds are, and it is difficult to predict just what the incentives for innovation would be in the society so inadequately sketched above. The model would appear to be flexible enough to allow for adjustment if needed.

A final argument is even harder to refute; it is that despite all precautions a limited technical sector would gradually increase its scope; that an elite would grow up around or within it and that this elite would eventually capture and subvert the society. This is, of course, the great danger of any society which allows a potential concentration of power to exist within it. In the last analysis the only counter-rebuttal may be that at least the safeguards suggested would put off the evil day on which humanity destroys itself once and for all.

For this day to be seriously delayed, however, men must first become convinced that a delay is possible and desirable--and before that, even, that real danger is imanent. The probability of each of these events, taken separately, seems not too great; their joint probability is, of course, even less. No matter what the odds, however, the game of "avoid catastrophe" always remains worth playing.