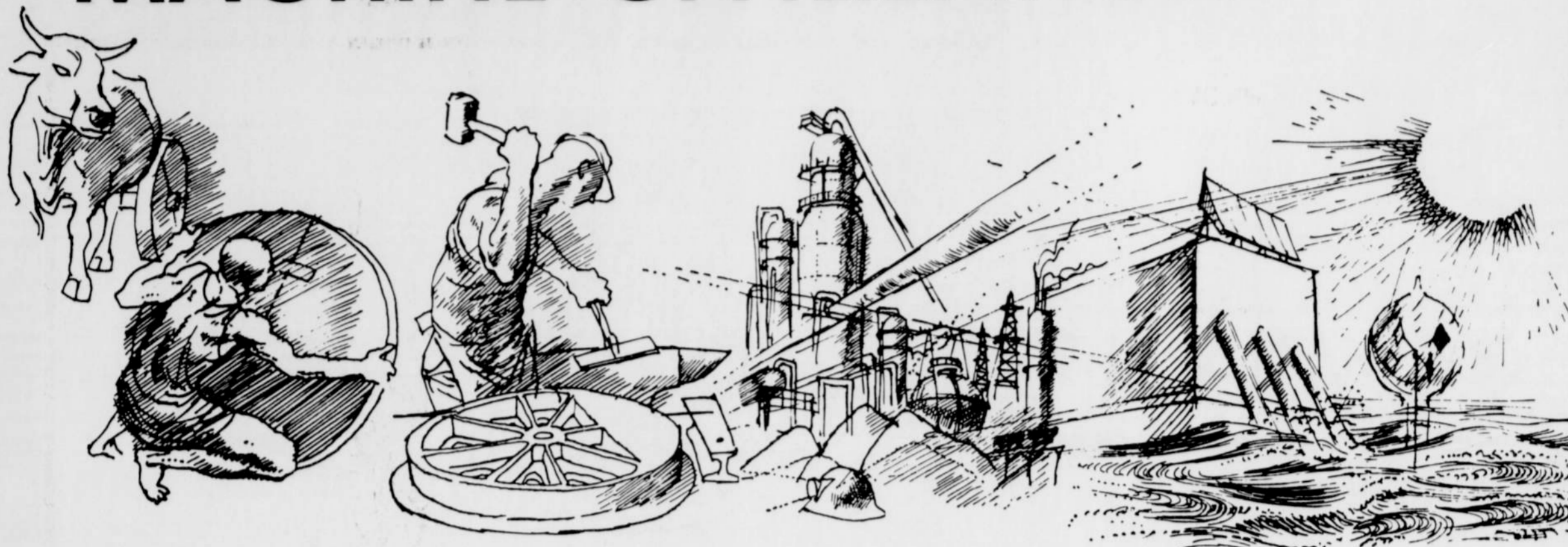


# MACHINE CIVILIZATION



NICHOLAS M. SOLOVIOFF (1959)

uranium and thorium is equivalent to the energy released by burning approximately fifty tons of coal. The actual processing of the rock can be accomplished at an energy expenditure considerably smaller than fifty tons of coal, with the result that it is possible to obtain a net energy profit from average rock and at the same time obtain a variety of metals that are essential to the operation of an industrial society.

The basic raw materials for the industries of the future thus will be seawater, air, ordinary rock, sedimentary deposits of limestone and phosphate rock, and sunlight. All the ingredients essential to a highly industrialized society are present in the combination of those substances.

A great deal of water will be distilled from the sea for agricultural and industrial purposes, and most food will be grown using artificial fertilizers. Metals such as iron, aluminum, titanium, manganese, copper, tungsten, and lead will be obtained from rock, which raw material will also provide the major source of phosphorous. The waters of the seas will provide magnesium, chlorine, bromine, iodine, and sulfur. Energy will be provided by the uranium and thorium of rocks, by the rays of the sun, and conceivably by controlled thermonuclear reactions utilizing deuterium extracted from the oceans. Liquid fuels and the whole complex of organic chemicals and plastics will be produced from the carbon of limestone, utilizing either atomic energy or controlled photosynthesis — probably both.

The industries of the future will be far more complex and highly integrated than those of today. As time goes on it is likely that the single-purpose plant will diminish in importance, eventually to disappear from the scene. Increased automation will produce far-reaching effects. Unskilled and semiskilled labor will disappear. The highly trained engineer will become the "laboring man." Human supervisors will be replaced by automatic computers. The man-hour requirements per unit of production might decrease to as little as one-tenth those of the present.

To many, these changes may seem fantastic — perhaps even impossible. But when we view the future in the perspective of both the present and the past, it seems clear the die has been cast. We are already well along the road and it is too late to turn back. There is no way, except by the development of machine civilization, that the rapidly increasing population of the world can be supported.

World population jumped from about 500 million persons in 1650 to about 2,700 million persons in 1958. Human numbers are still increasing rapidly, but even more significant is the fact that the rate of increase of population is climbing rapidly as well. In the absence of a major catastrophe there does not appear to be the slightest possibility the world population will level off much below 7 billion persons.\* As industrialization spreads throughout the world and if our ability to produce food is indeed the population-determining factor, the number of human beings might eventually exceed even that high figure. Ten billion persons could, if necessary, be supported, but only within the framework of a culture that most of us would be reluctant to consider.

As our resources diminish in abundance and in grade, as machine civilization spreads over the world, and as human numbers continue to increase, industrial society will be confronted by a variety of problems of great complexity. Perhaps the most difficult of these problems involves the perpetuation of that society.

The vast network of mines, factories, and communication systems upon which we have become dependent is extremely sensitive to disruption. So interdependent are the components of the network that the sudden failure of but a relatively small section of it could result in a breakdown of the entire system. It is for this reason that machine civilization is probably far more vulnerable to disruption from nuclear attack than most persons suspect. For example, not many well-placed hydrogen bombs would be required to destroy the productive capacity of a large country such as the United States. Indeed it is quite possible that far more persons would die in the chaotic aftermath of a nuclear war as a result of the breakdown of the industrial network than would be killed directly by nuclear explosions.

Once a machine civilization has been in operation for some time, the lives of the people within the society become dependent upon the machines. The vast interlocking industrial network provides them with food, vaccines, antibiotics, and hospitals. If such a population should suddenly be deprived of a substantial fraction of its machines and forced to revert to an agrarian society the resultant havoc would be enormous. Indeed, it is quite possible that a society within which there has been little natural selection based upon disease resistance for several generations, a society in which the people have come to depend increasingly upon surgery for repairs during early life and where there is little natural selection operating among women relative to the ability to bear children — such a society could easily become extinct in a relatively short time following the disruption of the machine network.

Indeed, a society such as the United States is far more vulnerable to disruption than is an agrarian society such as that of India. Most of the people of India live in small villages, each an independent economic unit producing most of the necessities of life. Cloth is woven, simple tools are manufactured, and food is produced in the surrounding countryside. Were the major cities of India to be destroyed a large number of the villages would not be seriously affected. For this reason, should a great catastrophe strike mankind, the agrarian societies that exist at the time will clearly stand the greatest chance of inheriting the earth.\*\*

However, the underdeveloped areas of the world are themselves rapidly becoming vulnerable to disruption, for the reason that they are becoming increasingly dependent upon certain Western products for continued low mortality. Were a country such as Ceylon suddenly find that (it) could no longer obtain DDT, for example, the resultant epidemic of disease would cause a burst in death rate which would almost certainly be disastrous. And as the new inexpensive techniques for control of disease spread still further, to countries such as India and China, the vulnerabilities of these areas to disruption will in turn grow.

It is quite possible that, so long as high-grade resources remain available in some quantity, the West itself would recover from a major war, although recovery would be a much slower process than it was after World War II. But once industrial civili-

zation has used up those high-grade resources and has become worldwide, it will be far more vulnerable.

One thing is certain: if destroyed on a worldwide basis, civilization could never be started up again by the same steps our ancestors took. Originally the spread of industrialization was facilitated by the fact that man was easily able to find vast beds of iron ore and coal, rich crystals of copper, huge deposits of petroleum, sulfur, and a variety of useful substances. But these deposits one day will be gone.

It is of course possible that, starting from a base of knowledge accumulated by a previous society and the abilities to utilize water power and to extract magnesium from seawater, man might once again learn to process rock, harness solar power, and extract energy from uranium. In such an eventuality a worldwide industrial civilization would rise once again and cover the earth. But the probabilities of a second emergence would be remote. The advantages gained by the existence of a previously accumulated knowledge would probably be offset by the scarcity of the raw materials.

The situation is a little like that of a child who has been given a set of simple blocks — all the blocks of one type which exist — with which to learn to build and to make the foundation for a structure, the upper reaches of which must consist of more intricate, more difficult-to-handle forms, themselves quite unsuited for the base. If, when the foundation is built, he conserved it, he could on building. But if he wasted and destroyed the foundation blocks he would have "had it," as the British Royal Air Force would say. His one chance would have been squandered. His structure of the future would be a vanished dream because there would be nothing left with which to rebuild the foundation.

Our present industrialization, itself the result of a combination of no longer existent circumstances, is the only foundation on which it seems possible that a future civilization capable of utilizing the vast resources of energy now hidden in rocks and seawater and unutilized in the sun, can be built. If this foundation is destroyed, in all probability the human race has "had it."

With the consumption of each additional barrel of oil and ton of coal, with the addition of each new mouth to be fed, with the loss of each additional foot of topsoil, the situation becomes more inflexible and difficult to resolve. If we continue to think only of the present and ignore the future, it is quite likely that we shall paint ourselves into a corner from which it will be impossible to extricate ourselves.

Yet the unpleasant outcomes that are indicated by the existing trends are by no means inevitable. If we make full use of the powers of conceptual thought with which we are endowed, we should be able to avoid catastrophe. We have seen that in spite of the fact that our high-grade resources are disappearing, given adequate energy resources we can live comfortably on low-grade resources. Further, it seems clear that man has available potential sources of energy which are sufficient to satisfy his needs for a very long time in the future. We have also seen that although a large fraction of the world's population is starving there appear to be no technological barriers to the feeding of a stable world population several times the present size. We know that, although world populations are increasing rapidly, population growth can in principle be stopped. Indeed, it is amply clear that man can, if he wills it, create a world in which human beings can live comfortably and in peace with each other.

If we fail this challenge there is every likelihood that our civilization will perish — never to reappear.



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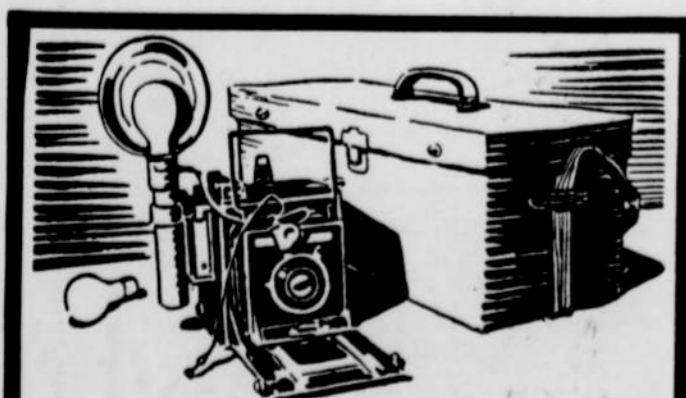
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\*World human population reached the 6 billion mark on October 12 (Columbus Day) 1999.

\*\*However, India and its agrarian neighbor and foremost adversary Pakistan both exploded nuclear devices in 1998.