THE NEW ECONOMICS

Nicholas Georgescu-Roegen

Biology and economics[1]

The concern recently generated, first, by some alarming cases of pollution and, later, by shortages of water, gas, and crude oil has led a large part of the economic and even other professions to a position which boils down to the creed that even though the human individual is mortal, at least the human species is immortal. "Come what may, we will find a way" is the slogan, to which economists have added their own: "Every thing will be all right if the price is right."

But, as the perceptive and also detached pundit J.B.S. Haldane argued, we are just a biological species and as such our most certain fate is extinction. How and when this will come about nobody knows; biologists cannot explain *why* any species-say, the dinosaur, after an existence of some 120 million years, became extinct. The only thing of which we may be fairly certain is that the human species is far from being ready for its paleontological grave, although an ecological crisis may build itself up any time. But aging and crisis do not necessarily mean imminent death. Think of the momentous historical event of the Great Migration, a crisis triggered by the exhaustion of the soil nutrients after millennia of overgrazing in Central Asia. Mankind survived it.

But we should also add with sufficient speed that the human species is nonetheless a unique biological species. This biological uniqueness rests on the particular mode of our evolution. And it is this particular mode that we must examine and understand in order to come to grips with the present issues.

All species, including ours, have progressed by the occurrence of advantageous mutations, mutations which endowed the individuals with more powerful muscles, sharper claws, finer hearing, etc. But this method of improving one's existence is fantastically slow. For example, it took not less than 45 million years to the Eocene eohippus-an

[1] I titoli dei paragrafi sono stati aggiunti dal curatore.

animal not bigger than a beagle to turn into the animal that nowadays can run the British Derby or pull a heavy plow. The human species a lone found a quicker way of improving its mode of life, by simply transcending the biological evolution. The turning point may be placed millions of years back when some Pithecanthropus, as he picked up a club from the woods, felt that his arm became longer and stronger. The club then became an exosomatic mutation, i.e., one which did not affect the endosoma, the body. Ever since, mankind has kept forging one such exosomatic organ after another. Nowadays, we can run faster than the cheetah although we do not have its powerful and flexible muscles; we can fly higher than any bird although we have no endosomatic wings, and so on. This is what technological activity means.

With time, the production of some exosomatic organs came to require the collaboration of more people than in one family or one clan the new organs also could be used by many other people. This new turning point caused the human species to become a social species, but of a type completely different from all other social species.

These other species came to live in society through biological evolution, with the paramount, albeit little noticed feature that every member of an ant hill, for example, is born with a particular structure fit, to perform one and only one role in that society. By its endosomatic nature the doorkeeper in an ant hill can only guard the door and, moreover, has no other propensity than to do exactly that. For this reason, in insect societies distribution raises no problem. Those societies only produce and consume they produce according to everyone's innate abilities and consume according to everyone's biological needs, just as in the Utopian Marxist dream. Insect societies do not produce for the market; they are not involved in an economic process.

In sharp contrast, there is no biological reason for one and the same person to fit only the role of a rickshaw man. The consequence is that evolved human society does not only produce and consume-as the ultra familiar circular representation of the economic process by almost every introductory manual of economics would make us think, but it also distributes both the chores and the benefits according to some rules of non biological nature.

From the "old" (standard) economics to bioeconomics

Distribution the process by which it is decided who should work in side a coal mine and who should feast on caviar and champagne is the most crucial problem of economics, if economics is to be viewed as a social science instead of a huge mathematico-imaginative exercise vacuous of empirical content. Yet the issue of distribution has been one of the great omissions of standard economics, of all contemporary economics for that matter. To be sure, there is distribution in the Walras-Pareto optimal equilibrium, the first article of standard faith. But that analytical construction assumes a given initial distribution. It thus ignores the real issue of what may be, even within a broad range, the optimal distribution. Perhaps, there is no objective optimal distribution. But if so, we should at least know how distribution works and how it evolves.

Still another grave omission of standard economics-we may in fact call it now "*the old economics*" is the consequence of the same mechanistic conception of the economic process as a circular merry-go round of which I spoke a little while ago. For the "old economics" the economic process is a closed and self sustaining mechanism, not a process anchored into the material environment and in a relation of mutual influence with it. Such a mutual relation exists even between an amoebae and the environment. But in the case of mankind, it has acquired formidable proportions.

To produce bigger and better exosomatic organs in increasing quantities with decreasing personal effort, man has ended up as a geological agent, a *homo geologicus*. For the last hundred years especially, we have been tapping the deposits in the bowels of the earth at an increasing rate, to use them as sources of energy or of ordered material structures. And since nothing is created and nothing is destroyed, everything that we take from these deposits must turn up a something completely equivalent in quantity. The quality of the end product, however, is essentially different. It consists of three categories: 1) highly dissipated heat, 2) highly dissipated materials, and 3) some "garbage".

I can hardly overemphasize the point that these categories must be kept separate in any correct analysis of the ecological problem. To take them in succession, highly dissipated matter has not any usefulness for us. The same is true for dissipated heat, with the difference though that its accumulation may present the highest menace to our existence Garbage in its first form is mare often than not noxious to life, although in some instances it may still represent some economic value. In the very end, however, even garbage of all kinds ends into dissipated heat and dissipated matter.

The last points are the practical expressions of the fundamental laws of thermodynamics. These laws are based on as long and *exceptionless* evidence as that for the effect of gravitation. Consequently, they can hardly be subject to doubt any more than the gravitational effect. It is therefore a disservice to our correct appraisal of mankind's exosomatic activity to preach as the editor of a scientific periodical and even an authority such as Glenn T. Seaborg do that the above thermodynamic laws will be defeated one day just as some other laws have been in the past on this issue. Historical arguments cut far more in favor of thermodynamics than against it.

In this qualitative degradation of matter- energy which goes on with an increasing speed resides the issue of the future of the human species. For if our environment is finite, it can contain only a finite amount of useful minerals, which, moreover are not all *accessible*. In some cases it may take more than one ton of oil to get one ton of shale oil.

A finite environment also cannot offer but a finite storage for the continuously accumulated garbage which, to recall. may in addition be harmful. To be sure, some harmful garbage can be transformed into a less harmful one, but, like any transformation, only at a cost in energy and materials. Some forms, moreover, we may cite increasing heat and nuclear garbage, are irreducible at any cost in practice.

Only one form of accessible energy comes to us continuously and almost freely from the sun. True, solar radiation has the disadvantage of reaching us in a highly dissipated form, like an extremely fine mist (a fortunate feature for terrestrial life). In exchange, its total flow is mind staggering. For a comparison, the free energy contained in all resources and reserves of fossil fuel could produce only two weeks of sunlight. Also, the rate of solar energy penetrating the atmosphere is about l0.000 (ten housand!) times greater than the current consumption rate of energy in all forms by the entire world. Moreover, this flow will last for at least another 4 billion years, probably much longer than the most optimistic estimation of mankind's life span.

The upshot is that terrestrial energy is a very scarce element in comparison to solar energy, which is practically a free good.

A very important point concerns the useful forms of matter. With respect to matter, our spaceship is a closed system; meteorites clearly do not matter. One may invoke at this juncture the famous Einsteinian, equivalence between matter and energy. However, the point is idle for mankind's economic problem. For even though we do transform continually matter into energy, even when we light up a match, the safe conditions of our planet do not allow us to convert energy into matter on any relevant scale. Such a conversion can occur only inside large stars where energy is so dense that we would be burned by it light-years away from them. Consequently, we must keep matter as a separate item in our ecological account. We must also recognize that it constitutes the scarcest item in that account.

Many nowadays dismiss the last idea by claiming that matter can be recycled if we have enough energy. This position ignores not only the circular bind that recycling needs also the use of additional matter, but especially the fact that as a rule we can recycle only "garbage." The dissipated form of matter is lost for ever as far as our activity is concerned. We can recycle only worn out pennies, not the copper molecules dissipated through their use.

Since dissipation is the only material loss caused by the use of material structures, the conclusion (for which I have been struggling for years) is that *both ordered matter and energy can be used only once*. The continuous use of material ordered structures therefore gradually and irrevocably decreases the accessible stock of such structures just as the continuous use of coal gradually and irrevocably depletes the terrestrial sources of energy.

Standard economists may be absolved for ignoring completely the role of natural resources in the economic process. The unique mineralogical bonanza of the last one hundred years or so caused them to believe that natural resources *in situ* are provided gratis, as Marx said it first. It is now imperative that we should reconsider the issue.

We should begin by noting that Malthus was wrong not because he formulated his famous laws in unacceptable strict forms, but because he was not Malthusian enough. Indeed, he allowed for population to grow *ad infinitum* provided it did not grow too fast. The same error is committed by the Club of Rome, which sees the ecological salvation in the steady state. This logic is obviously wrong and in all probability influenced by the practice of economists to think that every process can be only exponential or linear. It is elementary though that the negation of continuous growth, is not a zero growth, but a negative growth as well. The fact that the environment is finite and irrevocably deteriorable suffices for the conclusion that a decrease is inevitable in the long run. The Ploesti oil field (of WWII fame), put Romania until the 1930's in the third place of the world's producing countries. That oil field is now almost dried up. The same will certainly happen to any other oil field, of which there can be only a finite number. To be sure, we may turn to uranium. But even uranium used in ordinary reactors does not represent a bigger energy asset than fossil fuels.

On the other hand, the breeder, if used on a large scale, would pose both ecological and social dangers. As far as thermonuclear energy is concerned; we may note that even the announcement of the recent breakthrough at MIT was accompanied by great cautions. As I have dared to speculate, thermonuclear energy may remain usable only as a bomb, as is the case of gunpowder and dynamite. In any case, we should not build skyscrapers without elevators or staircases on the mere hope that one day we may defeat the law of gravitation. As things stand now, not only cannot the United States realize Project Independence, but the entire world cannot do so for long. In fact, the sooner the United States succeeds in relying only on its own resources, the sooner we will end up bankrupt in matter-energy.

Technological progress and the increasing differences between "rich" and "poor"

Technological progress may stretch the use of natural resources, through more efficient combustion and improved material structures. But even technology has its efficiency limits, as proved one hundred and fifty years ago by Sadi Carnot, an officer of the French engineer corps. Above all, as disagreeable as it may be for our current intellectual temper, technology has not always served either the most urgent needs of mankind or the economy of natural resources.

Not all economists are willing to admit that capital is produced not only by labor, but by capital, labor, and resources. For a clarifying analogy, nowadays horses are not produced from warm mud, from which they originally evolved; instead, they are raised from horses, oats, and man's care. So, one who has more horses can produce more horses. The same brute truth applies to capital, and hence to technology. Technology is active only where by a phenomenon analogous to biological drift, it has become a dominant human activity, namely, where technological level is the highest. As a consequence, present technology is continuously aimed at improving only this high level to add horse powers to an already powerful automobile, to improve the pattern of lets, to make a faster cutting electric knife, a remote control for color television, etc. Technologists are not interested in improving technologies of lower level such as those by which two thirds of the world population now live. No R & D, we may be sure, is concerned with devising a contraption that would burn dung, or even wood, more efficiently. Nowadays, the poor are a far more marginal concern for the beneficiaries of technology than they were before the Industrial Revolution. It is this feature of technological progress which, in my opinion, vindicates the position that the predicament of the hungry is in a large part the consequence of the affluence of the rich nations. Diffusion of technological progress, regardless of where it might originate, would rapidly bring the benefits to the entire world, if the technological level were more even all over.

Technology, as everything involving human activity, is subject to error. Naturally, the error is likely to be the more fateful, the greater is the dimension of the innovation. For example, the ultimate outcome of the modern insecticides is a greater and much less vulnerable mass of insects. The Aswan Dam now irrigates additional millions of acres in Egypt, thus assuring without fail food for the towns. But additional tens of millions of Egyptian fellahs are now suffering from fluke worm, schistosomiasis. In fact, more than 300 million people in the whole world, almost one out of ten, suffer from this disease. But as a recent Rockefeller Foundation report points out, little effort has been made in finding a cure for it, simply because it is a disease of the poor; the effective demand of the poor is practically nonexistent.

Innovations that increase the efficiency of resources or help man perform necessary and otherwise impossible tasks are certainly to be applauded. They are economical in the true sense of the word. But hosts of innovations do not belong to this category. Examples are supplied by the two garage cars, even the two car garages. But my favorite example is the golfcart, to which I want to add my own patent of an electronic club, so that one would not have even to get out of the car, and in the end even out of his home armchair.

A great number of innovations are violating the economizing imperative resulting from the hierarchy of the three categories of natural resources mentioned earlier. According to this hierarchy, what we should economize in the first place is matter. But many of our exosomatic instruments have to be discarded prematurely because of poor design. To put it in a plastic analogy, we have to throw away a pair of shoes only because one lace broke. For actual instances, we may cite, among others, broken electric clocks and use up felt-tip pens. Think also of how many trees are unnecessarily destroyed each year only because of the easy access to various types of multigraphing machines. But the most glaring example is the highly mechanized agriculture, which has replaced the best known solar cell, the beast of burden, by the tractor, which is produced and driven by terrestrial resources and which calls for an immense additional terrestrial energy and matter in the form of chemical fertilizers.

The victory cry accompanying the discovery of how to get food protein from crude oil (and recently repeated by John C. Sawhill, former head of Federal Energy Administration) is the most instructing evidence of the staggering ignorance of some scholars and public experts. Good economy of natural resources means the opposite to produce fuel from vegetable sources, as happened during WWII in many countries when cars were driven by poor gas from charcoal, indirectly, by solar energy. The above censure applies to the elation over the Green Revolution. However, uneconomical the new agriculture may be. at least for some time to come we cannot do without it, if we do not wish to let the undernourished nations die of mass starvation. *For some time to come*, the slogan of the developed nations must be "factories, not food for the hungry", factories to enable the hungry to produce their own tractors and fertilizers (a policy which should *not* be confused with the standard faith that industrialization is a cure all).

Yet the long range target for the whole world is to bring the population down to the level at which it can be fed by organic agriculture This type of agriculture is the only one which relies in the greatest extent on the most abundant form of energy. The position that the world population must necessarily decrease is therefore fully supported by a deeper reason than those ordinarily advanced. It must, however, be accepted *concomitantly* with the above call for building factories in the lands of the hungry.

Market prices and the problem of value the environment

Many of my fellow economists aroused by the recent ecological accidents and shortages of resources now maintain that all the misallocation and squandering of resources have been caused by wrong prices. All will be in order provided "the prices are right". Some have even claimed that it is up to us to create an environment tailored to our own wishes. I take a very strong exception to this position. Prices are parochial elements; they depend upon the distribution of income, the distribution of resources, and above all on the prevailing scale of values. The price system at any one time may reflect also the interest of a few future generations only. With man's very short time horizon (of a few decades at most) we cannot count on the market to avoid ecological cata strophes or to weaken them. Standard economics itself teaches that the only way to find out the price of an irreproducible object, such as Leonard's Mona Lisa, is to allow absolutely anyone to bid on it otherwise, one may have it for a few dollars in his home instead of its being in a museum where numberless people could admire it. The upshot for the case of the *stock* of our terrestrial resources (the same problem does not arise for the *flow* of solar energy) is that the future generation s cannot participate in determining the present market prices. Actually, prices cannot be trusted as a sure lever even for less complicated policies. Today's call for a government measure aimed at stopping people from smoking tar containing cigarettes would be satisfied in a ridiculous way by a tax on cigarettes. Smoking would then be limited to millionaires. And if the tax is set too high even for them, the measure is a prohibition not a price disincentive.

One extremely important question now presents itself. Can we reduce the entire cost of our exosomatic instruments, nay, of our daily maintenance, to some unique value element so that we may compare quantitatively the efficiency of various procedures in the same way in which we compare money costs? Unfortunately, the answer is in the negative. Everything we mine or produce is the result of a process in which some *fund* elements, the agents of the process: machines, labor-power, and Ricardian land; convert some input *flows* into some output *flows*. This flow-fund analytical view of a process brings to light a point totally ignored by standard economists as well as by the ecologists who have dealt with the economy of resources.

To produce energy, say, from coal *in situ*, we must degrade not only some free energy into bound energy but also some ordered matter into dissipated matter and garbage. The same is true for any production. But since, as I pointed out above, we cannot convert energy into matter industrially, no every matter into energy, nor every chemical element into another, *we have no basis for reducing all the cost and output elements to one single denominator*.

To compare only the input of energy with the output of energy ignores the cost in materials. To wit, if one can get gratis a gallon of gasoline from one, place and spends less than one gallon of gasoline in driving there, it does not necessarily mean that the operation is advantageous; we must also take into account the material deterioration of the car.

In view of these last observations, the only way to deal rationally with the economy of resources is, first, to take into account the hierarchy of the three items which form mankind's dowry of energy and ordered matter and, second, to change our scale of values so that the interest of future generations be at least in part represented by the present one. The present generation would benefit from such a change, too. For bigger and better two garage cars necessarily means better and bigger pollution.

A few bioeconomic recommendations

There are a few specific bioeconomic recommendations that one may make in this direction, beginning with that of outlawing not only wars but, in complete consistency, also the production of armaments, the most absurd use of an immense amount of resources, and ending with that of renouncing fashion, which is another substantial and quite ridiculous way of squandering matter-energy and that of appreciating gadgetry less and leisure more. If we do change our scale of values in this way prices will also be "right" in a truly meaningful way for the entire human species.