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Throughout the ages, man's image of his environment has always been tempered by the existence of an inexhaustible frontier somewhere beyond the known world, an illimitable plane in which respite could be found once one's immediate surroundings deteriorated socially or environmentally. More recently, man has had to become accustomed to the notion of a finite earth and a closed sphere of human activity. However, it was not until World War II and the air age that the global nature of our lives really entered the popular imagination, and in the intervening period we have not entirely come to terms with this transition from the illimitable plane to the closed sphere. Economists in particular have failed to come to grips with the ultimate consequences of this transition.

Man is, in fact, quite unfamiliar with closed systems. Almost by definition, an entirely closed system would be unknowable unless we are participants in it. Overwhelmingly it is open systems, structures maintained in the midst of a throughput from inputs to outputs, with which we are familiar. Indeed, human life itself is an open system. We must receive inputs of air, water and food and give off outputs of effluvia and excrement. Human societies have likewise been open, drawing upon inputs from the earth, the atmosphere, and the waters, and depositing wastes into the same. If there is an infinite capacity to draw upon these inputs and dispose of the outputs in perpetuity, then such an open system can survive indefinitely.

The world economy or "econosphere" is still an open system with respect to three important classes of inputs: matter, energy and information. For example, materials pass from the non-economic into the economic sphere as they are utilized to produce goods, then pass back into the non-economic arena as they lose their usefulness and are discarded. With respect to the energy system, the econosphere utilizes inputs of available energy in the form of water power, fossil fuels, sunlight, etc. Water and solar power can be viewed as a kind of energy income, while fossil fuels represent a capital stock of stored-up sunshine. Relatively few activities can be based on the available energy income, and so in the advanced societies energy use has been heavily supplemented by the use of fossil fuels, i.e., by dipping into the capital stock. By so doing, we have been able to maintain a vastly larger energy input into the system. However, this supplementary input is, by its very nature, exhaustible. Finally, from the human perspective, information is the most important of the three systems; it is only through knowledge that matter acquires significance and enters the econosphere. Technology is knowledge that has been accumulated and embodied in capital, and this accumulation is the key to human development of all kinds.

Loosely formulated, the concept of entropy can be applied to these systems. In the material system, there are entropic processes that take concentrated materials and diffuse them over the earth's oceans and through the atmosphere. There are also anti-entropic processes, whereby diffuse matter is gathered and concentrated. Since there is no law of increasing material entropy, it is possible to go on concentrating material elements given sufficient energy inputs.

In the energy system, however, there is no escape from the grim Second Law of Thermodynamics. If there were no energy inputs into the earth, developmental processes would be impossible. Moreover, the energy inputs that we extract from the earth are strictly limited. Even the most optimistic estimates suggest that, at current levels of usage, readily available supplies of fossil fuel will be exhausted within several centuries. This rate of use will accelerate with population growth and as other nations begin to approach the levels of energy consumption seen in the United States. Nuclear technologies have not fundamentally changed this picture, as the supplies of fissionable materials remain limited. If fusion should become technically feasible, then the picture would be significantly altered and our time horizon would extend to the point that we would essentially have an open system. Failing this, however, the time when man will be forced once more to rely entirely upon the current energy from the sun is not too far distant.

The closed earth of the future requires economic principles that are entirely different from the open "cowboy" economy of the past, principles best embodied in the imagery of a "spaceman" economy, in which the earth has become a spaceship. In the spaceship we are profoundly aware of both the limited resources available and the limited reservoirs for waste disposal. We must develop a cyclical ecological system that is capable of continuous reproduction of material, in which success is not quantitatively measured in terms of throughput and consumption, but rather is a measure of the nature, extent, quality, and complexity of the total capital stock. "In the spaceman economy, what we are primarily concerned with is stock maintenance, and any technological change which results in the maintenance of a given total stock with a lessened throughput (that is, less production and consumption) is clearly a gain."(259)

This notion that production and consumption are, in fact, bad things is a difficult one for economists who have been obsessed with income-flow concepts to the virtual exclusion of capital-stock concepts. There are indeed tricky and unsolved problems in this issue of whether human welfare is best captured in stock or flow measurements. Is it, for example, eating that is most important, or being well fed? The stock concept is actually the more fundamental one. If it is true that we eat primarily to maintain a condition of being well fed, then the less we can eat to maintain that condition, the better off we shall be. Of course, we can not exclude the possibility that there is also a value in the eating (or producing) in and of itself.

Perhaps we ought not concern ourselves with these questions. The spaceman economy might well be a long way off. We could spend, pollute and extract, go on increasing GNP, and leave these future problems to the future. When problems arise in the future, with respect to scarcity of resources or pollutable reservoirs, the needs of the then present will determine the solutions of the then present. This approach, which leaves to posterity the onus for resolving these issues,

can be a difficult one to refute. After all, what can one say to the man who says "what has posterity ever done for me?"

Conservationists must fall back upon vague ethical arguments and principles that rely upon an identification with a larger community, one that extends not only back in time but also into the future. With this in mind, it is important to stress that the welfare of the individual depends in large part upon the extent to which he can identify himself with others in a community, both spatially and over time. Once that identification is secure, then posterity does have a voice in the present. Moreover, it must be stressed that the shadow of the future falls heavily upon us today. This fact is most evident with respect to pollution. Thus it is not only for posterity's sake that we must change our approach.

All of these problems are large scale and may not seem immediate, but our success in dealing with the big problems is not unrelated to our ability to confront the more immediate, less difficult ones. One can only hope that the succession of smaller, immediate crises will, in mobilizing support for solutions to those problems, lead to an appreciation, of and perhaps solutions to, the larger, more intractable problems.