by Hazel Henderson

The Limits of Traditional Economics:

New Models for Managing A 'Steady State Economy'

Today's application of economics as the basic tool in managing national resources is being challenged by environmentalists, by scientists from other disciplines and even by an increasingly skeptical public. Nowhere is this debate hotter than in the United States where the environmental movement began. In the past year, the advocates of zero population growth were joined by a vanguard of environmentalists calling for a re-examination of the nature and direction of economic growth as defined by the Gross National Product, and development of more sensitive indicators of human welfare which might subtract some of the disamenities, dis-economies and dis-services associated with growth, such as costs of pollution related illnesses, crowding, traffic jams, decaying cities and the depletion of energy supplies and other natural resources.

These new realities pose serious challenges to prevailing economic policies which, in the next few years, may result in vast changes in the formulation of our national economic accounts and, in turn, our methods of assessing corporate performance.

Indeed, at the United Nations Conference on the Human Environment in June 1972, many Third World delegates questioned the advisability of trying to imitate the capital-intensive developmental models provided by the West. Rather, they hope to leapfrog many wasteful processes, bypassing, for example, the "automobilization" stage in favor of a more diverse mix of public transportation for intermediate and long hauls, and arranging for the growth of human settlements so that walking and bicycling can serve most individual needs. Many less-developed nations are now looking to China as a more viable model to emulate, because its labor-intensive system uses the human resources that are abundant in all countries, and does not require the surrender of national autonomy which often becomes the hidden cost of importing foreign capital. Obviously, this kind of economy that substitutes exhortation for incentive and utilizes human rather than mechanical energy is a pragmatic response to lack of capital to seed economic development any other way; however, it might also result in a resource-conserving and therefore more environmentally-benign economy than a capital-intensive one.

Much of the new questioning of the goals of economic development is slipping into a sterile re-hashing of the communism versus capitalism dialectics of the last century. The Chinese, for example, have denounced capitalism as the root of environmental problems, and yet China is one of the first nations to order the environmentally-disruptive supersonic Concorde plane. The U.S.S.R., after initially taking a similar position, has now acknowledged its own pollution problems and will collaborate with the U.S.A. on a new bi-lateral committee of scientific experts to search for solutions to these mutual problems. Many economists reject such arguments against capitalism and point to government-directed investments in many centrally-controlled economies, such as power generation, steel and auto production and many extractive industries, which produce environmental results as horrendous as similar operations in market economies. And recently, many less developed nations without noticeably capitalistic leanings have proclaimed their willingness to capitalize

Hazel Henderson frequently writes and speaks on the subject of corporate responsibility in society.

their relatively clean environments and actually become "pollution havens" in their understandable drive for development.

On the other hand, the Norwegian coalition which recently engineered the defeat of their country's bid for membership in the European Economic Community, cited new fears of giving up national autonomy to a "Kafkaesque" technocratic bureaucracy in Brussels, and of the Common Market's promotion of "materialism and unbridled economic growth that depresses human values to achieve the greatest profit for multi-national corporations and the privileged few." In the same vein, the now-famous Founex Report prepared for the U.N. Conference on the Environment, by experts from less developed countries, stated, "In the past, there has been a tendency to equate the development goal with the more narrowly-conceived objective of economic growth, as measured by the rise in Gross National Product. It is usually recognized today that high rates of economic growth do not guarantee the easing of urgent social and human problems. Indeed, in many countries high growth rates have been accompanied by increasing unemployment, rising disparities in income—both between groups and between regions, and the deterioration of social and cultural conditions. A new emphasis is thus being placed on the attainment of social and cultural goals as part of the developmental process."

The problems cited at the beginning of this article challenge the prevailing economic policies in most industrial nations, because—in both market-oriented and centrally-planned economies—economics is the chief tool by which resource-allocations are made. A return to a broader, more philosophical approach to economics may permit integration of the new variables.

In the industrialized nations, where environmental costs are now most visible, we see various mixes of centralized and decentralized resource-allocation systems. Many of these industrial nations, notably in Western Europe and including the U.S.A. and Japan, have opted for a greater degree of reliance on market mechanisms of allocation, on the assumption that they optimize individual autonomy while approximating shared social goals. Other industrial nations have followed the lead of the U.S.S.R. and prefer centralized political mechanisms for resource allocation, on the assumption that overall social goals are pursued which simultaneously approximate individual needs. Of course, the two systems' assumptions and results are constantly and reciprocally challenged. However, the two largest, most advanced models for these two differing value-systems, the U.S.A. and the U.S.S.R., are beginning to appear very similar in certain of their major contours. In particular, they share the same dedication to ecologically-unassessed industrial growth, technological determinism, and increasing dominance by bureaucracies, whether officially designated as public or private.

There are increasing convictions among resource economists that environmental degradation is an index of an economy's inefficiency in utilizing resources; many social critics now contend that overall efficiency, as well as general welfare, can be improved by shifting resources from the private to the public sectors of an economy. Because of its market-oriented, technologically-complex economy the U.S.A., which is the world's largest user of resources, is of particular interest. J. Kenneth Galbraith in his 1958 book, *The Affluent Society,* focussed widespread attention on the public-amenity problems developing in the U.S.A. through over-reliance on market mechanisms to allocate resources. He described the resulting public and environmental squalor and neglect of general services, while private production and consumption of frivolous and obsolescent goods soared. Galbraith pinpointed the role of advertising in overheating private consumption in order to keep the private sector of the U. S. economy, on which such major reliance for employment had come to rest, expanding.

At the same time, many of the most pressing needs in market-dominated economies such as the U.S.A., tend to be in the public sector, because they are the hardest for the market to meet: They require that the potential consumers aggregate themselves politically, and develop sufficient power to shift public funds into underpinning these new "markets" for mass transit, education, health care, parks and water-treatment plants; all of which create jobs as well. Other long-term areas like solar, hydrogen and thermonuclear fusion energy and water desalination also require government funds. Similarly, most advanced market economies routinely make transfer payments to their less fortunate citizens as well as grants to education.

As much as a century ago, John Stuart Mill had predicted an end to the continual increase in production of material goods, with economies eventually reaching what he called the "stationary state", where distribution strategies would become all-

important. Even the father of modern "growthmanship", John Maynard Keynes, challenged the assumption that human wants are infinite. In 1913 he predicted that "a point may be reached when (human) needs are satisfied in the sense that we prefer to devote our energies to non-economic purposes." And Simon Kuznets, the inventor of Gross National Product as an indicator of the level of economic activity, saw the need for including in measures of the general welfare some way of expressing the obvious value of leisure time. More recently, Ezra J. Mishan has drawn our attention to the price we pay for economic growth in the inadvertent destruction of amenities and depletion of resources. In the same vein, Kenneth Boulding has suggested that we ought to regard economic welfare as the consequence of the *use,* not the *using up,* of resources; the enjoyment of the stock of wealth rather than of a one-way process of production, consumption and waste. Market economies, with their rights of private property, seem to encourage such accelerated throughput because they assume that ownership confers the right to *use up,* rather than merely *use,* resources.

In some areas, shifting resources from the private to the public sector may produce reductions in pollution and resource depletion (e.g., taxing production of ecologically-destructive overpowered cars so as to increase the use of mass transit). Pricing can also be effective, but only if all the hidden social and environmental costs can be quantified and placed squarely on the producer. One of the advantages of market economies is that, because their capital markets are flexible and available to finance new invention and industry, they can shift into new production patterns rapidly. For example, the still growing pollution control sector of the U. S. economy has in the past ten years added some 850,000 new jobs, and this figure will reach some one million by 1975. However, grafting on such new activities while phasing out old industries does require a rolling readjustment, since so many incomes depend on existing arrangements, and the problem of cushioning the inevitable disruptions and individual hardships remains.

But such shifts between private and public means of allocating resources are by no means a panacea, since centrally-directed investments and Five Year Plans can cause just as much pollution, in some cases due to bureaucratic ignorance and in others to deliberate decisions to sacrifice the environment to economic goals. But socialist economies have problems uniquely their own, particularly in finding incentives more thrilling than "plan fulfillment" to substitute for the profit motive and reduce the need for costly, unpopular bureaucratic regulation. Indeed, in Eastern Europe and the U.S.S.R. we see the profit motive slipping back in again through the back door. We may safely conclude that there is no clear evidence of greater environmental merit in either centrally-directed or market economies, because both are operating on faulty economic data that does not accurately quantify externalities.

New Ways to Grow?

All this suggests the extent to which the economic theories which program both these major types of economic systems have fallen behind the changes wrought by technological innovation. All these new issues lead to a re-examination of human cultural notions of "value". In particular, we and other Western countries tend to over-value material wealth, while dismissing psychic wealth. As Walter Weisskopf points out in his new book, *Alienation and Economics,* the real dimensions of scarcity are not economic, but existential: Time, life and energy are the ultimately scarce resources for man because of human aging and mortality. The goals of love, self-actualization, peace of mind, companionship and time for contemplation and leisure, identified by the psychologists Fromm and Maslow, can never be satisfied by purely economic means, although economic activity satisfies lower-order survival needs that permit emergence of these non-economic goals. In short, we human beings tend to assign values arbitrarily, and then pay our measurers to collect only that data which conforms to our assumptions of "value", completing the hypnotic circle.

Firstly, the new convergence in advanced economies of problems of pollution and resource depletion is forcing fundamental reassessments on the human inputs to value. Of course, all economic activity is human, and it is to be expected that economic policy discussions in democratic societies stress human inputs to the production process relative to the role of land, resources and capital in determining value. Although, as technology advances, economists have assigned increased weight to land and capital, their orientation toward human inputs is illustrated by the persistent use of such concepts as "man-hours" and "labor productivity", even though this latter term measures primarily the consequences of placing additional *capital* at the

disposal of the worker. This emphasis on human inputs short-changes nature's contribution to production at a time when natural resources are becoming scarcer in relation to growing human populations. For example, until quite recently, two vital resources needed by both people and production processes, water and air, were abundant enough in relation to population levels that they were routinely treated as free goods.

In advanced economies the human input to production increasingly consists of knowledge, rather than muscle power. As the lag time between the production of new scientific knowledge and its application as technological innovation continues to shorten, efforts to quantify this knowledge input to value will increase. Already the concept of "human capital" is used to rationalize educational investments, which often end up enriching the society. Kenneth Boulding suggests that since knowledge is a commodity, economists might take more interest in it; perhaps one day even discovering a unit of knowledge equivalent to the "bit" in information theory — a unit which he has christened in advance: the "wit". Boulding holds that knowledge is neglected by economists in three areas: market theory, development theory and the theory of decision-making. (Some of the new knowledge issues were described in "Coping with The Knowledge Revolution" by Joseph Spigelman and Julian Gumperz in *The Financial Analysts Journal* (July-August and Sept.-Oct. 1972). Another excellent compilation on the growing role of knowledge is *The Economics of Information and Knowledge* edited by Donald Lamberton, which includes papers by Boulding, Kenneth Arrow, Gordon Tullock and others working in this field.)

Knowledge is a key factor in the efficiency of resource utilization and energy conversion. For example, it is human knowledge that makes possible the added value inherent in a fuel cell's potential 60 per cent energy-conversion efficiency, compared to 12 per cent for the internal combustion engine. Greater efficiency in physical resource utilization is now recognized as an ecological imperative, because it conserves and augments the availability of these factors of production at the same time that it reduces the side effects of inefficient use, which always causes pollution. R. Buckminster Fuller calls this process of doing more with less "ephemeralization", and economist Carl Madden calls it "negentropic industrial activity". Such conservation technology is vital to the developing countries if they are to detour earlier less-efficient Western production technologies and move directly to less wasteful ones.

The Club of Rome Studies

Since the planet's resources are finite, the basic requirements for economies operating as sub-systems within it eventually must be those of "steady state societies" with constantly-maintained stocks of people and physical resources. If economic growth of material wealth must be constrained at some point in time, however distant, then human development must find another dimension. Luckily, knowledge development is unfettered by these physical constraints, and can also help achieve reductions in resource depletion rates. At the same time, a "steady state economy" must recognize in its theories of value both the social nature of information and knowledge and the limits of natural resources bound by the physical size of the planet and the daily energy "income" provided by the sun. From these newly-perceived limits it must devise appropriate value-systems, perfect its methods of resource-allocation while maintaining constant levels of population. As the title of a new course offered by Prof. Carroll Wilson at M.I.T. suggests, it must devise "Strategies for Sustainable Growth".

Economics, as the discipline concerned with scarcity, choice and complex equilibrium systems, has great potential for devising these strategies for societies. Ever since Adam Smith, economics has been forced to expand its analyses to account for new variables, whether the activities of governments, the power of the labor movement, the growing complexity of technological societies, the role of information and organization or the rise of consumerism. The new issues concerning the ecological and psychological limits to growth and the implications of "steady-state societies" will require major restructuring of economic models, and will trigger debates on value assumptions underlying such concepts as "profit", "productivity", "profit and utility maximization" and "capital". However one assesses their methodologies (and their authors admit the need for further validation) the Club of Rome studies (Jay Forrester's *World Dynamics* (1971) and Dennis Meadows' more recent *Limits to Growth*) have entered the realm of political debate and therefore must be addressed by economists. These first attempts to model global interactions of physical and social systems have raised an issue that economists often sweep under the rug: that of distribution of wealth. A generation of increasing acceptance by econo-

continued on page 79

The limits of traditional economics

continued from page 32

mists of the goal of fostering growth has even prompted conservative Milton Friedman to remark that "we are all Keynesians now". But there is now a question whether growth, which has assumed the status of a panacea, has not simply become an intellectual "cop-out". For it is only this "growth paradigm" with its assumptions that an ever-expanding pie would conveniently provide increasing portions to the poor that has made it possible to submerge the issue of distribution. The "growth paradigm" has become a rationale whereby inequalities in the distribution of income and wealth are justified as essential to the formation of new capital for investment. But if at some point the economic pie ceases growing, then the focus of public attention will inevitably turn toward the manner in which it is shared. At the same time, the value of new capital may decrease as its avenues for application narrow and its major role is confined to replacement of depreciating assets.

The extent to which the Club of Rome studies have revealed this distribution issue and the intellectual weakness of the growth paradigm can be gauged by the emotional response to the studies. Although some critics have challenged the studies on methodological grounds, many others have missed their point, and straw men and non-sequiturs abound. Economists with intellectual investments in the growth paradigm stoutly defend it on the grounds that it is the only path to improving the lot of the poor and providing the "resources" to clean up the environment. Yet according to the recent study by Thurow and Lucas of M.I.T. for the Joint Economic Committee of Congress, during the past twenty-five years, in spite of considerable growth of GNP, the pattern of income distribution has remained essentially the same. Another study just published by the U.S. Department of Labor by Henle identifies a persistent trend toward income inequality, showing increasing concentration of income among the professional groups. Although this trend seems to indicate that our economy values knowledge realistically, it also points up the problem of providing minimum incomes and purchasing power to those less skilled citizens left behind by the knowledge revolution. In any society, if the numbers of such "outcasts" becomes great enough, their alienation will produce severe social conflict, crime and disruption. And the claim that growth will provide the "resources" to clean up the environment is suspect: Only a switch to more environmentally-benign forms of growth can reduce the rates of resource-depletion and pollution, let alone "clean up" the present backlog of environmental destruction.

Another criticism of the Club of Rome reports has held that technological innovation will lead to substitution of resources as they become scarcer. Malthus' predictions some 150 years ago that food production would become a constraint on population growth are often cited: Since famine has not yet occurred on a global scale, it is argued that it is unlikely to occur in the future — a somewhat shaky extrapolation. While technological innovation, especially in the area of improving energy-conversion and recycling is vital, it would be foolhardy to count on technology as the ultimate source of salvation. It may be just as likely that we will reach a technological plateau, as have so many other civilizations before us, with diminishing returns on our research investments, extracting minerals from increasingly low-grade ores at greater cost, for example. The new debate over growth is also forcing us to question whether growth of consumption in the private sector is the only form of growth. Of course, we are obliged to admit that it is not, and that growth could be channeled into the many public service areas of our economy mentioned previously: mass-transit, health care, education and research into new energy-conversion systems and recycling, with minimal environmental impact. But such a consciously-controlled readjustment would require diverting private resources through taxation to pay for these public goods and services that cannot be purchased individually.

The Tragedy of the Commons

Biologist Garrett Hardin, in his now-famous treatise, *"The Tragedy of the Commons"*, described how, in feudal England, all the farmers in a village would graze their animals in a large communal field ("the commons") until some farmers realized that they could maximize their advantage by grazing more animals than their neighbors. It was only a matter of time before the idea caught on and over-grazing destroyed the commons for all. We are now learning that if we perceive and arbitrarily designate a jointly-shared resource, such as the medieval commons, or our air and oceans as "free goods", then no individual is responsible for their overall protection. J. M. Buchanan and Mancur Olson have contributed insights into this "free rider" problem, where public resources can be abused and public services jeopardized by the temptation of each individual to avoid contributing

his share or restraining his greed. Kenneth Arrow's "general impossibility theorem" states flatly that individual preferences cannot be logically ordered into social choice. Scholarly responses to the theorem—advanced by Arrow in 1963—and its dismal prognosis for democracy came from all sides, including Gordon Tullock's rebuttal, "The General Irrelevance of the General Impossibility Theorem"; Duncan Black's assertion that the theorem is irrelevant to understanding how social choices are actually made in committee situations, and Edwin T. Haefele's contention that Arrow's conditions for ordering individual preferences into social choice can be met by representative governments with a two-party system.

In his forthcoming book, *Toward a Steady State Economy,* Herman Daly argues that, for a society to achieve a political economy of biophysical equilibrium and non-material, moral growth, not only radical institutional changes, but a paradigm shift in economic theory will be necessary. Daly suggests that three institutions are needed to achieve a steady state economy (as defined previously: with constant stocks of people and physical wealth maintained at some desirable chosen level by a low rate of throughput). Its objectives would be to provide macro-stability while allowing for micro-variability; to combine the macro-static with the micro-dynamic. Daly endorses Boulding's earlier plan for issuing each individual at birth a license to have as many children as corresponds to the rate of replacement fertility. The licenses could then be bought and sold on the free market. Secondly, he argues for transferable resource-depletion quotas, based on estimates of reserves and the state of technology, to be auctioned off annually by government, and thirdly, a distributive institution limiting the degree of inequality in wealth and income.

Entropy Enters Economics

Somber proposals such as Daly's may be considered impractical, or "social engineering"; yet the concepts of the "steady-state economists" are beginning to gain a hearing. Most favor theories of value based on entropy. Entropy, of course, is the process described in the Second Law of Thermodynamics, which states that energy, when it exists in a bound form, such as in a piece of coal, has potential for performing useful work (low entropy); but once it has been burned and its energy has been released, or unbound, it can never be used again. All stored energy bound in matter in our planetary system is constantly being degraded and dispersed, so that eventually the system will run down into nothing but useless, undifferentiated matter (high entropy). This cosmic Entropy Law, when applied to the micro-situations familiar to engineers, is the "heat sink problem" that arises in any utilization of energy. Kenneth Boulding, for example, states in his essay *The Economics of the Coming Spaceship Earth* that economic processes consist of segregating entropy—i.e., creating improbable structures of low entropy at the expense of higher entropy level wastes somewhere else. Nicholas Georgescu-Roegen in his new book, *The Entropy Law and the Economic Process* traces entropy theories of economics back to German physicist G. Helm, who, in 1887 argued that money constitutes the economic equivalent of low entropy. Georgescu-Roegen pierces the fallacy, widely held by economists, that these irreversible economic processes are analogous to the reversible, mechanical Newtonian processes of locomotion. Because economic processes produce these qualitative changes, usually associated with higher entropy levels, he believes that they also elude what he calls "arithmomorphic schematization", and therefore economics, with its "arithmomania" ignores them. Physicists, while agreeing that matter may be recycled, caution that it can only be done with inputs of energy, which suffers from this inevitable heat loss, and that worse, energy can never be recycled. For example, even pollution control equipment and recycling use a good deal of energy and resources in their operation and original manufacture. Georgescu-Roegen states categorically that all economic processes use up a greater amount of low entropy than is represented by the low entropy resulting in the finished product, and that in entropy terms most recycling is equally fruitless. This is why the "steady state" economists stress that the real payoffs are in *durability,* which reduces this unnecessary flow of production-consumption-waste-recycling to the lowest levels achievable. We need very careful studies of entire economic processes, from extracting to refining, manufacture, consumption, waste, recycling, aimed at assessing their relative efficiencies in resource utilization and concomitant pollution and depletion rates.

Sharper economic tools may emerge from such insights. Georgescu-Roegen argues that land, far from being inert, as in Ricardo's definition, is an agent of production, in that it catches the solar radiation, which is the only incoming source of

energy available for all planetary processes from photosynthesis (the most basic and vital) to our industrial activities. The energy "capital" stored in the earth's crust as fossil fuels is a rapidly-depleting, non-renewable, stock of fossilized solar energy collected in the past by photosynthesis. The chief difference between agriculture and industry is that agriculture must rely on utilizing the unchanging rate of flow of solar energy, while industry can mine the stocks of stored energy in the earth's crust, at least while they last, at rates of its own determining.

No Deposit; No Return?

A shift toward entropy theories of value would require that "profit" be redefined to mean only the creation of real wealth, rather than wealth won at the expense of social or environmental exploitation. Similarly, we would recognize that the concept of maximizing profit or utility is imprecise until qualified by a time dimension. A realistic definition of profit would include improvements in energy-conversion ratios and better resource management and recycling geared to using the solar energy income available in nature's processes rather than further depleting energy "capital" in the earth's crust. As more externalities are included in the price of products we may find that many consumer items' profitability will evaporate and these goods will disappear from the marketplace. For example, the throwaway aluminum can might disappear in the U.S.A. if environmental and large-user subsidies were removed from electricity prices, which still subsidize aluminum production. Alcoa, aware of the precarious nature of its energy subsidy, has now developed a new refining process which reduces energy consumption by 30 per cent. As we recognize the extent of our energy shortage, prices of all energy will increase sharply, changing the economics of aluminum and, indeed, every commodity in our economy. Although the growth of the service sector will continue, goods requiring large inputs of matter/energy will gradually be replaced by goods of lower matter/energy content.

Take the question of the desirability of capital investment itself: In the future, we will assess more accurately which capital investments are socially or environmentally destructive. This prior assessment of the impact of investments and new technology is already established in large Federal government projects, which must now submit environmental impact statements under the National Environmental Policy Act of 1969. Now, California has voted to extend these environmental impact statements to private investments as well. Ecologist Barry Commoner believes that capital investments may be less ecologically-destructive if they are more widely diffused around the planet, and that where possible highly-mechanized capital-intensive production processes should give way to natural materials and human labor inputs. For example, he states that on ecological grounds, the rubber market should be supplied by the stepped-up production of natural rubber in Malaysia, rather than being supplied by the U.S.A. and Europe with synthetic rubber at heavy environmental cost. Commoner believes that ecological sanity requires a planetary re-distribution of production and wealth from "over-developed" to under-developed countries.

We must also question the concept of "productivity". Productivity is another value-laden term which economists seek to "maximize" by raising the level of capital invested in the worker himself or the machines he uses. Raising agricultural "productivity", for example, by mechanization and application of fertilizers and pesticides can often produce social costs, such as the social problems engendered by the "green revolution", and environmental costs in breeding resistant pests, run-offs of fertilizer-polluted water, destroying more stable and resilient forms of agriculture and rapid soil depletion. There are also some limits to investments in machinery and automation beyond which workers rebel at the increasing robotization of their jobs and begin sabotaging the production process, as has occurred recently in certain automobile plants. Many useful and profitable functions cannot use much capital investment, such as private tutoring, or producing works of art or custom, handcrafted goods; and they often provide workers with psychic pleasure envied by workers in capital-intensive industries.

Human perceptions of value are based on 1) our subjective observations of the objective world around us and our increasingly accurate, but still imperfect evaluation of its component forces and material resources, and 2) our subjective evaluation of what is important to us in our own lives for the satisfaction of our heirarchies of needs, from the immediate material ones to the emotional and more transcendant spiritual ones, which as we have noted, are arbitrary and shaped by cultures. If human assessments of the value of resources and energy processes are filtered through our sub-

jective, and often erroneous perceptions of their availability, renewability, transmutability and rates of depletion; then economics, our primary tool for studying their relative exchange values must be flawed by the same subjectivity. For instance, the present sag in the prices of many raw materials on world markets may not reflect the scarcity many scientists predict, but rather still reflect the widespread, but possibly inaccurate expectations of continued abundance. Such a time lag is currently evident in the U.S.A., where energy prices have not yet caught up with growing scarcity as fossil fuels become less readily available and environmental constraints increase.

Economists to the Rescue

Fortunately, economists are making some specific efforts to improve their tools, and have evolved some new ones from the theories discussed in the first part of this article. Prices still have much useful potential for allocating resources, but only if lags in price response are reduced. Then, Gunnar Myrdal stated recently, "we can begin to fill that box marked externalities", so as to calculate as far as possible the social costs of production so that they too can be accurately reflected in prices. Myrdal also argues that organized citizens and consumers can function as a countervailing check on the power of public and private institutions, as is evidenced in the U.S.A. by the rise of the movements for consumer and environmental protection and the direct confrontation of corporations by boycotts, the use of proxy machinery, and the politicizing of company annual meetings and institutional investment policies. Improved calculations of what market economies call "profit" and state-directed economies call "economic growth", would vastly improve all resource allocation decisions. Unfortunately, economists in both capitalistic and socialistic economies tend to be influenced by the prevailing political pressures and cultural assumptions of their societies. Much economic analysis suffers from a tendency to underestimate more elusive social and environmental costs, whose impact may be borne by the society in general or a group within it, another nation, or succeeding generations.

In some cases the mere collection of data and its dissemination in the most effective channels can create pressure for social change. For example, New York's Council on Economic Priorities has broadened the traditional concepts of security analysis to cover the social and environmental performance of corporations. The Council's bimonthly *Economic Priorities Report* and its studies count among subscribers a growing number of brokerage houses, banks, mutual funds and other institutional investors, as well as socially concerned stockholders and citizens. It publishes comparative information on the social impact of corporations in various industrial groups in five key areas: environment, minority rights and employment practices, military contracting, foreign operations and investments, and political influence. There are now enough U. S. investors to provide a market for no less than four new mutual funds, whose stated purpose is to invest only in those companies with superior and social environmental performances. Similarly, a new series of guidelines for socially-responsible portfolio management of Yale University's investments, entitled *The Ethical Investor: Universities and Corporate Responsibility* attests to the level of interest in these issues. Investors may become more sensitive to social performance criteria, and re-allocate capital into those enterprises with least social and environmental impact.

Harvard's Raymond A. Bauer and Dan H. Fenn have completed a year-long study of the subject entitled *The Corporate Social Audit,* published by the Russell Sage Foundation. Bauer also points up the lack of incentives to quantify social costs in our market system. Political pressures have now created the necessary "incentives", and many companies are tackling the job of inventorying their social effects. Much new and useful work on model-building of externalities is in progress. Wassily Leontieff has recently constructed an input-output model that can handle pollution and its costs of control within its matrices, and Russell and Spofford have developed a model for residuals (i.e., pollution) management decisions for Resources for the Future, a Washington, D. C. think tank, which employs a quantitative framework in dealing with trade-offs in the management of airborne, waterborne and solid wastes on a regional basis.

Professor Hirofumi Uzawa of Tokyo University has advocated an annual deduction from GNP analogous to the capital consumption adjustment that now distinguishes Gross National Product from Net National Product. The new deduction allows for the depletion of natural resources: the consumption of the irreplaceable original capital of the planet. On the assumption that industrialized nations are exhausting resources more rapidly

than nature can renew them, each year Uzawa's deductions will increase.

In the U.S.A., Thomas Juster has argued for restructuring our own GNP to allow for the impact of economic activity on knowledge, skills and talents, physical environment and socio-political assets, in the 50th Annual Report of the National Bureau of Economic Research. A Measure of Economic Welfare, developed by James Tobin and William Nordhaus to supplement the GNP, includes an "urban dis-amenity index", which indicates that GNP may over-estimate advance in general welfare by as much as five per cent.

Many resource economists, including Allen V. Kneese, argue for effluent and emission taxes as a way to control pollution through the market mechanism. Effluent taxes are more likely to be decided by political power than by objective considerations, however, and therefore may be set too low to cover true costs and even turn into licenses to pollute. Similarly, the new pollution-control bonds, which are tax-exempt to encourage corporate spending on environmental improvement, are proving to be little more than another tax loophole. Their lure is that they enable corporations to borrow money at very low rates, take accelerated depreciation, investment tax credits and interest deductions, while being exempted from sales and property taxes. Such tax subsidies in no way encourage management to look at changes in the basic resource-utilization efficiency of their manufacturing processes, where the real payoff in reducing resource-depletion lies.

But if economics is to develop even more precise tools to assess the trade-offs in resource allocation, it will need to incorporate much of the new data being developed by the physical sciences concerning those actual values in the macro-biosystem of nature's chemical exchange work, which maintains global equilibrium conditions for humans. Herman Daly makes an interesting analogy between economies and ecosystems: Young ecosystems tend, like young economies, to maximize production. Mature ecosystems, like mature economies, are characterized by high maintenance efficiencies. Daly's proposal for yearly depletion quotas to be auctioned off by government came from such insights. He claims quotas are superior to effluent taxes as a basic strategy for resource utilization efficiency, which he sees as a fine-tuning tactic addressed purely to pollution control, rather than to the primary issue of depletion.

Efforts to simulate nature's closed-loop energy cycles are described by Howard T. Odum in *Environment Power and Society*. Odum's "value-system" calculated and converted from kilocalories to dollars, enables a cost/benefit analysis to credit the chemical exchange work performed by a host ecosystem of a proposed economic activity at the same rate that humans would have been paid for comparable work. This invisible and unaccounted activity performed by natural systems includes, for example, absorbing carbon dioxide from combustion and replacing oxygen that all such processes use, or converting industrial wastes and sewage back into fuel or fertilizers. Until such ecosystem activities are included as costs of production, environmental activists will be bargaining from weakness. Policy proposals growing out of such work as Odum's include such new devices as an amortization tax, as proposed by thirty-three British scientists in the now-famous "Blueprint for Survival" published in *The Ecologist* in January 1972. The amortization tax would penalize throw-away goods and obsolescent products, while encouraging with the least tax those items most durable.

One recent study in the State of Illinois concerns the relative costs in total energy of refilling returnable beverage bottles versus the collection, destruction and refabrication of throwaways. Findings confirmed fears that, ecologically-speaking, recycling centers are little more than public relations tools. The study, published by Bruce Hannon in *Environment,* found that throwaway bottles consume 3.11 times the energy of returnables and that, in the State of Illinois, a complete conversion back to returnables would also save consumers some $71 million annually.

Similarly, a consulting firm in Florida now prepares total-energy cost/benefit analyses for its clients on the relative merits of different methods of heating and cooling buildings. For each system, whether using gas, electricity or oil, the firm estimates the relative quantities of sulfur oxides, nitrogen oxides and particulates discharged to the environment. After reviewing such three-dimensional cost/benefit data, the State's school system became more interested in cross-ventilation and increased tree-planting than in air-conditioning. Another consulting firm in Germany has developed a decision model for use in determining the best mix of fuels to supply an urban area, taking into account topography, meteorology and sources of energy, which incorporates similar environmental criteria.

A decision model being developed by T. Faulkner at Stanford University in California will assist in quantifying a region's life-support resources and amenities, so as to provide indications of optimum population levels. Still another very useful analysis by R. Stephen Berry, published in the *Bulletin of the Atomic Scientists* evaluates the processes in the production/scrap cycle of automobiles to pinpoint hidden energy subsidies. Berry estimates that the largest energy and thermodynamic-potential savings can be achieved in basic methods of metal recovery and fabrication which could, in principle, reduce the thermodynamic costs of autos by factors of five or ten or more. By comparison, extending the life of the vehicle could realize thermodynamic savings of 50 to 100 per cent, whereas recycling can achieve a saving of merely 10 per cent.

In fact, it is becoming increasingly clear that the close correlation between standard of living levels as measured by GNP and per capita energy consumption need to be reassessed. A. B. Makhijani and A. J. Lichtenberg contend in a recent issue of *Environment,* that although the 1964 U. S. Government study, *Energy Research and Development and National Progress* does show such correlations between GNP and commercial energy consumption, it also shows that eight industrial countries with similar standards of living (indicated by GNPs within 10 per cent of each other), The United Kingdom, Australia, Germany, Denmark, Norway, France, Belgium and New Zealand, showed large disparities in energy consumption. Consumption for industry, commerce and transportation ranged from New Zealand only consuming 45 million BTUs per capita, while the United Kingdom at the upper level, consumed 110 million BTUs per capita. Obviously, a large portion of the differential can be accounted for by exports, but the disparity was striking enough to raise questions about relative energy-conversion efficiencies. The two electrical engineers then calculated the total energy inputs for dozens of primary extraction and manufacturing processes and the energy-content of the finished consumer goods, and identified some areas where energy-consumption could be minimized and overall energy-conversion efficiencies improved. For example, they claim that utilizing waste heat from generation of electricity could realize thermal efficiencies of approximately 75 to 85 per cent, as opposed to the 40 per cent efficiencies of current fossil-fueled and nuclear fission plants. They also estimate that if the average weight of cars in the U. S. could be reduced by one-third and their fuel consumption reduced by one-third, and if some 30 per cent of auto mileage could be shifted to public transit, the nation's total energy consumption for ground transportation could be almost halved. By employing the best mix of energy conservation methods, it is claimed that an advanced economy might be able to reduce overall energy consumption without reducing its standard of living.

Is the U. S. Becoming a Pollution Haven?

Since the resources to fuel energy-wasting industrial economies generally come from less-developed countries, their stake in energy-conservation methods is doubly vital. It is interesting to note that the current energy squeeze in the U.S.A. will produce a financial bonanza in the oil-producing nations of the Mid East. These oil-rich nations are then expected to re-invest their income in the U.S.A., tending to make the U.S.A. a "pollution haven" for their foreign investments.

Thermodynamic analyses provide a useful new dimension to economics, and need to be integrated along with insights from information theory, general systems theory and advances in the physical sciences. In fact, some thermodynamicists see a new discipline of thermodynamic economics in the making, while Kenneth Boulding asserts that an entropy theory of value may cast more light on economic development processes. Obviously, thermodynamics will also have its flaws, but it may help bring economics closer to helping conserve the planet's remaining resources until better intellectual tools can supplant it in the future. In the meantime, it can raise our levels of awareness of the fragile planet we inhabit and spur us on to develop both the technology and the new systems of values we will need to steer us through the next century. ♦
