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Growth versus the Quality of Life

Our widespread acceptance of unlimited growth is not suited to survival on a finite planet.

J. Alan Wagar

In economics, as in most other matters, past experience provides a major basis for current decisions, even though changing circumstances may have diminished the appropriateness of such experience. Such use of "conventional wisdom" may explain our continuing emphasis on economic and other types of growth despite the many problems created by such growth.

When the United States was sparsely populated, emphasis on growth made good sense. Growth of many kinds permitted exploitation of the rich environment at an accelerating rate and provided a phenomenal increase in wealth.

Growth still increases material wealth but has a growing number of unfortunate side effects, as each of us tries to increase his own benefits within an increasingly crowded environment. These spillover effects, which were of minor importance when settlement was sparse and neighbors farther apart, are now of major consequence. For example, a firm may make the most money from a downtown tract of land by erecting a tall office building there. Construction of the building will add to the gross national product, and the builders will be hailed for their contribution to "progress." However, the building will add to traffic congestion, exhaust fumes, competition for parking, the need for new freeways, and social disorder. These problems, which must be handled by someone else, become part of the "environmental mess" or "urban crisis."

When this article was written, the author was leader of the Cooperative Recreation Research Unit maintained by the Intermountain Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture, in cooperation with Utah State University, Logan. Since then, he has become leader of a similar unit maintained by the Pacific Northwest Forest and Range Experiment Station in cooperation with the University of Washington, Seattle.

Too few people have recognized the connection between uncontrolled growth and our environmental ills. Growth has become so widely accepted that, in *The Costs of Economic Growth*, Mishan (*1*) found it necessary to emphasize at some length that his criticism of economic growth was to be taken seriously. Yet, because rising levels of congestion, pollution, and social and biological disorder accompany our growing material wealth, an increasing portion of what passes for progress is illusory. We face the choice either of using more of each gain to offset the problems of growth or of accepting such threats to the quality of life as smog, rising crime rates, dead fish, and vanishing species. Rather than getting full measure for our resources and toil, we seem to be on a treadmill that makes us run faster and faster just to inch forward.

Growth is not an unmixed blessing, and the purpose of this article is to argue that growth is no longer the factor we should be trying to increase.

Unfortunately, growth is as deeply entrenched in our economic thinking as rain dancing has been for some other societies. In each case there is faith that results will come indirectly if a capricious and little-understood power is propitiated. Thus, instead of concentrating directly on the goods and values we want, we emphasize growth, exploit the environment faster, and assume that good things will follow by some indirect mechanism.

From time to time, the correlation between rainfall and rain dancing must have been good enough to perpetuate the tradition. Similarly, the correlations between exploitation of the environment, growth, and progress were usually excellent in our recent past. So great have been the successes of our economic habits that they have become almost sacrosanct and are not to be challenged.

However, here in the United States as in most of the world, the relationships between people and environment have changed drastically, and past experience is no longer a reliable guide. While we rush headlong through the present with frontier-day attitudes, our runaway growth generates noxious physical and sociological by-products that threaten the very quality of our lives. Although we still seem confident that technology will solve all problems as they arise, the problems are already far ahead of us, and many are growing faster than their solutions (*2*).

We cannot return to some golden and fictionally perfect era of the past, and we certainly should extend the knowledge on which not only our comfort but our very existence depends. However, to cope with the future, we may need a fundamental reanalysis of the economic strategy that directs our application of knowledge. Instead of producing more and more to be cast sooner and sooner on our growing piles of junk, we need to concentrate on improving our total quality of life.

If environmental resources were infinite, as our behavior seems to assume, then the rate at which we created wealth would depend mainly on our rate of exploitation, which is certainly accelerated by growth. However, the idea of an unlimited environment is increasingly untenable, in spite of our growing technological capacity to develop new resources.

Boulding has beautifully contrasted the open or "cowboy" economy, where resources are considered infinite, with the closed "spaceman" economy of the future (*3*). He has pointed out that, as the earth becomes recognized as a closed space capsule with finite quantities of resources, the problem becomes one of maintaining adequate capital stocks with the least possible production and consumption (or "throughput"). However, this idea of keeping the economic plumbing full, with the least possible pressure and flow, is still almost unthinkable. Experience to the contrary is still too fresh.

Cult of Growth

The economic boom of World War II, in contrast with the stagnation of the Great Depression, seemed to verify the Keynesian theory that abundance will follow if we keep the economy moving. As a result, continuing growth has been embraced as a cornerstone of our economy and the answer to many of our economic problems. At least for the short run, growth seems to be the answer to distribution of wealth, debt, the population explosion, unemployment, and international competition. Let us start with the distribution of wealth.

Probably no other factor has contributed as much to human strife as has discontentment or competition concerning wealth. Among individuals and nations, differences in wealth separate the "haves" from the "have-nots." The "have-nots" plot to redress the imbalance, and the "haves" fight to protect their interests and usually have the power to win. However, the precariousness of their position, if recognized, demands a more just balance. But, rather than decrease their own wealth, they find it much more comfortable to enrich the poor, both within a nation and among the nations. Only growth offers the possibility of bringing the poor up without bringing the rich down.

In our market society, the distribution of wealth has come to depend on jobholding, consumption, and, to an increasing extent, on creating dissatisfaction with last year's models. Unless this year's line of larger models can be sold, receipts will not be sufficient to pay the jobholders and assure further consumption. Inadequate demand would mean recession. We have therefore been urged: Throw something away. Stir up the economy. Buy now. And if there are two of us buying where there had been only one, wonderful! Rapid consumption and a growing economy help to distribute income and goods and have been accepted as part of "progress."

Problems of debt also seem to be answered by growth. To keep up with production, consumption may need to be on credit, or personal debt. But debt is uncomfortable. However, if we are assured that our income will grow, then we can pay off today's debt from tomorrow's expanded income. Growth (perhaps with just a little inflation) is accepted as an answer.

The same reasoning applies to corporate debt, the national debt, and the expansion of government services. As long as debt is not increasing in proportion to income, why worry? Debt is something we expect to outgrow, especially if we can keep the interest paid.

The population explosion is growth that is finally causing widespread concern. Yet many businessmen can think of nothing worse than the day our population stops growing. New citizens are the customers on which our economic growth depends. Conversely, economic growth can meet the needs of added people—if we are careful not to look beyond our borders.

Growth might also handle unemployment problems, and Myrdal (*4*) has indicated that only an expanding economy and massive retraining can incorporate our increasingly structural "underclass" into the mainstream of American life.

Finally, there is the problem of international competition. In an era when our sphere of influence and overseas

sources of economic health are threatened, strength is imperative. Yet our main adversary has grown from a backward nation to a substantial industrial and military power. To counter the threat, we expect to outgrow the competition.

The evidence suggests that growth is good and that we have always grown. Isn't it reasonable to believe that we always will? This question takes us from the short run to the middle and long run.

Dynamics of Growth

Viewed in the most general terms, growth will continue as long as there is something capable of growing and the conditions are suitable for its growth. The typical growth pattern starts slowly because growth cannot be rapid without an adequate base, be it capital, number of cells or organisms, or surfaces for crystallization. However, if other conditions are suitable, growth can proceed at a compound rate, accelerating as the base increases. But growth is eventually slowed or stopped by "limiting factors." These factors can include exhaustion of the materials needed for growth. They can also include lack of further space; the predation, disease, or parasitism encouraged by crowding; social or psychological disorganization; and concentrations of wastes or other products of growth. For example, the concentration of alcohol eventually limits the growth of yeast in wine.

Perhaps it is worth examining the U.S. economy within this frame of reference. Although its vigor has been attributed solely to free enterprise, or to democracy, or to divine grace, it fits the general growth model of a few well-adapted entities with growth potential (settlers) landing on an extremely rich and little exploited growth medium (North America).

Our settlers had, or soon acquired, the technological skills of Europe. They also had the good fortune to inherit and elaborate a political philosophy of equality, diffused power, and the right to benefit from one's own efforts. So armed, they faced a rich and nearly untouched continent. The growth we are still witnessing today is probably nothing more than the inevitable.

But the end of growth is also inevitable. In a finite environment no pattern of growth can continue forever. Sooner or later both our population growth and our economic growth must stop. The crucial questions are When? and How will it come about?

Malthus once saw food shortages as the factor that would limit population growth. At least half of the world lives with Malthusian realities, but the technological nations have so far escaped his predictions. To what extent can technology continue to remove the limiting factors? Will we use foresight and intelligence? Or will we wait until congestion, disease, social and psychological disorganization, and perhaps even hunger finally limit our growth?

Perhaps there is little time to spare (*5*). Many factors already in operation could stop or greatly curtail the economic growth of the United States within the next 10 to 30 years. Furthermore, the multiplier effect of many economic factors could transform an apparently low-risk decline into an accelerating downward spiral. If devastating results are to be avoided, the adjustment from a rapidly growing to a much slowed economy will take time, and we should examine the problems and possibilities far enough in advance to be prepared.

The Case for Pessimism

Some of the very problems we hope to outgrow result in part from growth. Certainly the rapid changes brought by a growing economy contribute strongly to unemployment, migration to the cities, and the uneven distribution of wealth. A great deal of our debt can also be attributed to growth, as people try to keep up with what is new. Even the population explosion may result in part from confidence that the future offers increasing abundance. By trying to inundate the problems with more growth, we may actually be intensifying the causes.

If there were no other powers in the world, technology might be sufficient to sustain our growth, replace our shortages, and keep us ahead of the problems. Boulding (*6*) has suggested that we may have a chance, and probably only one, to convert our environmental capital into enough knowledge so that we can henceforth live without a rich natural environment.

But we are not alone. The Communists have vowed to bury us, one way or another, and can be expected to do whatever they can to upset our apple-cart. We can expect competition in many places in a struggle for spheres of influence and the roots of power. The nation or bloc that can extend its influence can gain raw materials and markets and can deny them to its competitors.

It is doubtful that we can retain the hegemony enjoyed in the late 1940's, and technology cannot fully fill the breach. Our competitors have access to the same technology that we do, and, if they gain control of rich resources and markets while ours are declining, they can increase their power relative to ours.

Closely related to competition for spheres of influence are the rising nationalism and aspirations of the underdeveloped countries. Extractive economies have seldom made them wealthy, and they aspire increasingly toward industrialization. As elements in the global struggle for power, they can demand technological assistance by threatening to go elsewhere for it if refused. From their point of view, it would be rational to put their resources on the world market, to try to get enough for them to support aspirations toward technology, and to let us bid without privileged status.

The problem is compounded by rapid communication and increasing awareness by the aspiring nations that wealth and consumption are disproportionate. The United States, for example, has about 6 percent of the world's population and consumes about 40 percent of the world's annual production. Until such differences in wealth are substantially reduced, they will create constant tension and antagonism. While enduring the many frustrations and setbacks of incipient economic growth, the aspiring nations may be happy to do whatever they can to reduce our wealth. The possible effect is suggested by England's economic woes since she lost her empire and her control over vast resources and markets.

If the aspiring nations and the Communists are not enough to slow us down, perhaps our friends will add the finishing touch. Western Europe is becoming increasingly powerful as an economic bloc and will compete for many of the resources and markets we would like to have. From another quarter, we can expect increasing competition from the Japanese.

In addition to these external forces, there are processes within our own nation that could slow our rate of growth. One of them is the increasing recognition that the products of runaway growth can damage the quality of living, especially for adults who remem-

ber a different past. When our rivers are choked with sewage, our cities are choked with automobiles and smog, and our countryside is choked with suburbs, some people begin to wonder if "the good life" will be achieved through more growth and goods. When goods are so abundant and the environment so threatened, will people continue to want even more goods at the expense of environmental quality?

Even the growth promised by automation may be self-limiting. The machines used by "management" to replace "labor" are not going to engage in collective bargaining. However, labor outnumbers management at the ballot box and may well counter such threats by demanding government control of automation and the protection of jobs, even at the cost of slowing our economic growth.

We already have a rising number of permanently unemployed and unemployable people who probably threaten our domestic tranquillity far more than "have-not" nations threaten international stability. Our traditions of self-reliance seem increasingly inadequate now that jobholding depends largely on technological skills that are so much easier to acquire in some settings than in others.

In addition to such technological unemployment, Heilbroner (*7*) has listed three other factors that may slow our growth. The first is the extent to which we now depend on defense expenditures to maintain growth and the likelihood that these outlays will eventually stabilize. His second point is that capitalism is inherently unstable, even though the factors that caused the Great Depression are now better understood and largely under control. His third point concerns the size of government expenditures that might be needed for antirecession policy in the future. If investments in plant, equipment, and construction are all low in 1980, he has estimated that government expenditures of $50 to $75 billion per year may be required to maintain growth and that Congress may well balk at such appropriations.

Another factor that could slow growth was suggested by Brown (*8*). Growth can be slowed by the increasing amount of energy and organization required for subsequent units of output from resources of decreasing richness. So far, as we have used up the richest mineral resources, improved technology, imports, newly located deposits, and the redefinition of resources have kept us ahead of the problem. But, if the difficulty of extracting essential materials from the environment should ever happen to increase more rapidly than our technological efficiency, our economy could become static and then decline.

Perhaps of greater importance, Brown predicted that the level of organization needed for a very populous society would become so interdependent that failure at one point could trigger failures elsewhere until a chain reaction led to total collapse. In relation to his prediction, the chain reaction aspects of power failures in the Northeast, the Southwest, and elsewhere are sobering. Also sobering is the growing power of strikes to disrupt our economy.

As stated earlier, growth must inevitably stop, and the major uncertainties are When? and How? Despite these uncertainties, the factors examined above could limit our growth within the next few decades, and they merit careful thought. Because growth has become such an integral part of our economy, any sudden setback is greatly feared and could be disastrous. Nevertheless, transition from accelerating growth to some other economic pattern must eventually be made, and it is desirable that we make a smooth transition to something other than total collapse.

Perhaps there is an acceptable alternative to growth or collapse.

A Simplified Calculus for "The Good Life"

If we look only at the production side of economics, it is easy to visualize the average standard of living (SL) as the sum of material goods that have been produced divided by the total population (*9*):

$$\mathrm{SL} = \frac{\Sigma \text{ production}}{\text{population}}$$

It follows that the average standard of living can be raised only by increasing production faster than we increase population. Quite conceivably, we could have a static or even declining population and a rising standard of living. For example, the Black Death, which decimated the population of Europe in the 14th century, has been credited with providing the surplus that kicked off the Renaissance. However, other factors are involved.

Goods often have a limited useful life and are depleted by a variety of losses. Thus, for a better computation of the average standard of living, we can subtract the total of everything that has been lost from the total of everything that has been produced and divide this difference by the population:

$$\mathrm{SL} = \frac{\Sigma \text{ production} - \Sigma \text{ losses}}{\text{population}}$$

The per capita share of wealth now includes antiques, the serviceable old, and the new. From this relationship it appears that we can increase the average standard of living by reducing losses as well as by increasing production. However, in our economy, production is closely related to consumption, and we face the seemingly illogical fact that we can increase the standard of living by increasing waste! Such losses as normal wear and tear, designed obsolescence, and accidents can increase consumption enough to stimulate production.

Even if we grant that technology can create and exploit new resources as needed, we must deal with the quality of living (QL) as well as the purely material standard of living. In addition to material goods, the quantity and quality of both services and experiences available to each person will be included. The model must therefore be expanded to

$$\mathrm{QL} = \frac{\Sigma \text{ production} - \Sigma \text{ losses}}{\text{population}} + \frac{\text{services/time}}{\text{population}} + \frac{\text{experiences/time}}{\text{population}}$$

As material comforts increase, it is likely that "the good life" will be defined to a greater degree by services. And, as services become more abundant, the emphasis may shift toward experiences. Services may well increase in abundance and excellence with continued growth. The quantity of experiences may also increase. However, the quality of many experiences is likely to decline, especially if the environment deteriorates seriously.

Our values will undoubtedly shift toward what is available, but this shift will lag enough to leave many desires for things that are remembered and cherished but no longer available. This "memory gap" between what is remembered and wanted and what is available will mean a decrease in the quality of living unless it is at least offset by new advantages. Right now, for example, how many families no longer have a "view" from their picture window because of growth? What will be the impact of added growth on activities that let the imagination run free without an

overdose of organization, regulation, and spectatorship? As growth continues, how many of us will long for such things as a picnic by an unpolluted lake, fishing in a clear stream, room for a family dog, or even places to walk, ride, boat, or fly with a minimum of regulation and traffic?

In mastering the details of production and distribution we seem to forget the environmental base on which our productive forces and many enjoyable experiences depend. Even in our outdoor recreation, we still tend to emphasize access to new areas rather than management of existing areas for continued enjoyment. One wonders if the rise in our standard of living can be sustained or whether it is the result of a rising rate of exploitation of a limited and exhaustible environment. To what extent are we drawing on the capital as well as the interest of our global savings account? Can technology replace environmental capital? Can it do so in time?

We may grow into a "Brave New World" where pleasures come from happiness pills and electrodes in the brain. Conversely, we may grow into a "1984," where repressive measures are necessary to keep society from falling apart. As a third alternative, we may exhaust the resources or disrupt the organization needed for a dynamic technology and then collapse to a thin population of subsistence farmers. To find a better alternative, we may have to rethink our entire economic strategy. How can we do it?

Some Criteria for a Future Economy

As the product of a long and often stormy evolution, our economic system is not something that can be overhauled by a few armchair critics. Yet one need not be an expert to identify some difficulties with our present system and to suggest what it ought to be doing for us. Too often we seem to view the economy as a mysterious creature operating by its own inscrutable laws and to which we humans must be subservient. Instead, we should see it as a human institution which must serve human needs as directly as possible.

Now that we are so capable of fouling our own nest, dare we assume that an "invisible hand" will somehow guide us automatically along the correct course to survival? Although modern technology can work many wonders, it can also permit enormous mistakes to be made before we have learned the consequences of our actions. Now that we are on the threshold of such things as weather modification and massive transfers of water between regions, one wonders how sure we can be of avoiding unexpected and undesirable side effects. Yet shortages induced by rapid growth may force us to act before we understand the full implications of our actions. As examples, DDT killed many fish and threatened many species of birds before we knew that it would, and some Eskimos ingested dangerous amounts of cesium-137 from what were considered harmless tests of nuclear devices. Smog alerts, epidemics of hepatitis, unemployment, riots, and other problems already demonstrate that personal greed does not necessarily aggregate to public good in a populous and highly interrelated society.

A few criteria for an ideal economy are obvious. It must provide a decent quality of living for every citizen. For the foreseeable future, it must also maintain enough national strength to prevent another nation from overwhelming us. Beyond these criteria, perhaps our major concern with any future economic system is that it not repress individual freedom any more than is inevitable because of population density and technological complexity.

Two factors seem of particular importance in maintaining individual freedom. The first is representative government. Although many voters are apathetic and poorly informed, it would be an awful and probably irreversible step to lose the power to turn an unsatisfactory government out of office by peaceful processes. Yet, as we speculate on the future, it is not difficult to imagine political instability and chaos as the electorate votes "no confidence" in the economic policies of successive governments that deal unsuccessfully with resource and environment problems. Problems resulting from population growth, worldwide as well as domestic, seem especially likely to create a serious challenge to representative government everywhere in the years ahead.

A second factor of importance to individual freedom is diffused decision-making. There is safety in a redundant system in which many suppliers estimate needs and many purchasers select among competing goods and services. Such redundancy guards against a crisis in one sector mushrooming into total collapse throughout a highly interdependent technological society. As society becomes more complex, it is unlikely that centralized decision-makers, even with the best computers, can foresee all our needs and all the effects of each decision. In addition, the centralization of decision-making is likely to decrease individual freedom.

Self-interest is also important as a strong motive force that needs to be retained in any future economy. However, in a complex society where one person's actions affect many other people, self-interest must operate within the constraints needed to guard the interests of the total society.

The market system is probably still the most effective means of maintaining the abundance, individual freedom, redundant decision-making, and self-interest we desire. However, it is less effective than it could be in achieving high levels of human benefit. For example, as we chase the rainbow of economic growth, our marketplace decisions are usually based only on the costs incurred by the individual or firm and ignore the costs borne by society in general. Thus industries have been allowed to save money by dumping their wastes, often untreated, into the atmosphere, lakes and streams, or onto the land. But the costs are borne by the public in terms of respiratory disease, dead fish, and lost amenity and recreation opportunities.

Perhaps rather subtle controls on the economy would enhance the quality of our living by forcing a consideration of *all* costs of economic activity. Included would be such social costs as air and water pollution, building surburbs on prime agricultural land, and spoiling scenic or recreation areas.

One means of bringing hidden costs into the market system would be to tax or charge the responsible party for the full costs of repairing, replacing, or cleaning up whatever was damaged by his economic activity (*10*). Water users might be required either to return water of equal quality or to pay a pollution charge. Road builders might be required to provide lands of quality and acreage equal to park lands taken for highways. Such costs would simply enter into the total allocation process. If protection of the environment were accepted as a legitimate cost of production, many abuses would simply become too expensive to perpetuate and some activities that are now profitable would become uneconomic.

A second difficulty results because marketplace decisions are usually short-run decisions that de-emphasize the future. Currently we usually discount

every future benefit by assuming that it can be equated to whatever present investment would give the same value at a selected rate of interest. For example, at an interest rate of 6 percent, each dollar in benefits 50 years from now would discount to a present worth of approximately 5 cents.

Such discounting may be perfectly appropriate for decisions that can be readily reversed. However, irreversible decisions should not be based on discounting. For example, the depletion of soils, water tables, minerals, interesting species, and space and amenity values must be curbed if future generations are to have a rich life.

I am not saying that we must go "back to nature," which is clearly impossible. A technological society can live only by greatly modifying nature on much of its land. But at some point we must admit that future people are just as important as present people and that we cannot justly discount the value of their environment. Unless we use the environment responsibly, we will greatly reduce the range of opportunities and alternatives available to our descendants.

Again, some fairly subtle controls on the economy might be effective. Tax laws are already being used to encourage or discourage specific practices, and some changes in direction might become essential. For example, to accelerate the discovery and exploitation of mineral resources, we now give generous depletion allowances. However, to encourage more efficient use of such resources, we may need to institute resource depletion taxes. We might also need a space depletion tax to encourage effective use of land and to discourage our urban sprawl.

There may be some merit in a replacement tax for durable goods. By taxing people on the frequency with which they replace things, we might encourage them to make things last as long as possible and might reestablish a belief that durability means quality. This belief might in turn improve the quality of living by greatly weakening the link we have developed between waste, production, and distribution in our economic system. For example, if each automobile lasted twice as long, we could have just as many automobiles per family by producing only half as many cars. The effect could be less industrial smoke, fewer junkyards, and fewer new scars on the landscape due to mining. It could also mean that more resources, energy, and leisure would be available for purposes other than building automobiles.

Yet, true to the assumption that man is subservient to the economic system, we hear waste defended as necessary for our prosperity. Surely we can organize our economy efficiently enough to avoid having to throw things away to have more! Are we inescapably on such a treadmill?

As we approach the "spaceman" economy suggested by Boulding, we must come into better equilibrium with the environment instead of trying to sustain the continual disequilibrium implied by our treadmill pattern of growth. We have tried to keep our economic plumbing full by increasing the pressure and flow rather than by fixing the leaks. Improved knowledge, efficiency, and durability can repair the leaks in the economic vessel that contains society's wealth, and their achievement will probably always be a desirable kind of progress. But we face enormous problems if we continue to insist that everything must grow.

First we must stop the population growth that is the major stimulus to many other kinds of growth. Thus far we have been unwilling and unable to take this step, and it seems tragic that we may reproduce ourselves back into scarcity just as we are within reach of affluence for all. Unless population growth is slowed on a worldwide basis, the "have" nations may soon face the ethical dilemma of reducing their own per capita wealth by sharing with the "have-not" nations or reverting to increasing "defense" operations to control desperate people who are trying to better their own lot.

In addition to stabilizing population levels, we need to recycle our environmental resources. For some structural purposes, we might develop reusable polymers that can be assembled, used, separated into constituents, and reassembled with minimum losses. Such materials seem well within reach of foreseeable technology and might be preferable to the problems of unscrambling and reusing alloyed metals. Human wastes should go back to agricultural lands rather than into our water supplies. Because fossil fuels will not last long if the rest of the world begins to consume them at anywhere near our own rates of consumption, much of our energy may have to come from the sun. At current levels of technology, nuclear fission and fusion may both be too dirty for widespread use. Petroleum may need to be conserved primarily for lubrication, with reprocessing after use, or perhaps for aircraft use where other energy sources might be too heavy.

My comments may amount to a redefinition of "progress." Too often, progress has been equated with mere growth, change, or exploitation rather than with a real improvement in the per capita quality of life. Thus a new smokestack has usually passed as progress, and the odors generated by new factories have been said to "smell like money." But getting rid of the stacks already in town may now be a more rational view of progress. Developing a smokeless process, a product that lasts longer, or a process that requires less expenditure of human energy, or something that makes life more meaningful—all these may better qualify as progress.

In its time the treadmill pattern of growth was progress enough and served us well. But as the relationships change between human numbers and the total environment, we must abandon unregulated growth before it strangles us.

The essential tasks ahead are to stabilize human population levels and to learn to recycle as much of our material abundance as possible. Ideally, the change to new ways would be by incremental, evolutionary, and perhaps experimental steps, although some writers believe an incremental approach may not work (*11*). But if steps of some kind are not started soon, they may well be outrun by the pace of events. Unless we can slow the treadmill on which we have been running faster and faster, we may stumble—and find ourselves flung irretrievably into disaster.

References and Notes

1. E. J. Mishan, *The Costs of Economic Growth* (Praeger, New York, 1967).
2. Although we have generally assumed our well-being to be a linear function of total size (X), it has turned out to be the curvilinear function $Y = a + bX - cX_n$, where n is greater than 1. Thus at some point we can expect added growth to decrease our wellbeing rather than add to it.
3. K. E. Boulding, in *Environmental Quality in a Growing Economy*, H. Jarrett, Ed. (Resources for the Future, Washington, D.C., 1966), pp. 9–10.
4. G. Myrdal, *Challenge to Affluence* (Pantheon, New York, 1963).
5. For a summary of threats to our survival, see J. Platt, *Science* **166**, 1115 (1969).
6. K. E. Boulding, in *Future Environments of North America*, F. F. Darling and J. P. Milton, Eds. (Natural History, Garden City, N.Y., 1966), p. 234.
7. R. L. Heilbroner, *The Future as History* (Grove Press, New York, 1959), pp. 136–140.
8. H. Brown, *The Challenge of Man's Future* (Viking, New York, 1954), pp. 222–225.
9. To be precise, we should exclude production used to replace capital goods. However, the general logic of this analysis does not depend on such refinement.
10. M. M. Gaffney, *Bull. At. Sci.* **21** (6), 20 (1965); A. V. Kneese, *Pap. Proc. Reg. Sci. Ass.* **11**, 231 (1963).
11. B. L. Crowe, *Science* **166**, 1103 (1969).