The Limits to Growth

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- April 2, 1972
- New York Times, Section BR, Page 1

"If this doesn't blow everybody's mind who can read without moving his lips," writes "Up the Organization"-man Robert C. Townsend, "then the earth is kaput?' Anthony Lewis of The New York Times deems it "likely to be one of the most important documents of our age" and learns from it "the complete irrelevance of most of today's political concerns" to the world's long-run travail. The author's press agents describe the book as a "rediscovery of the laws of nature" through the medium of the computer.

The book is "The Limits to Growth," and its message is simple: Either civilization or growth must end, and soon. Continued population and industrial growth will exhaust the world's minerals and bathe the biosphere in fatal levels of pollution. As the authors summarize, "if the present growth trends.. continue unchanged, the limits of growth on this planet will be reached sometime within the next hundred years."

"The Limits to Growth" is a product of an interdisciplinary M.I.T. team led by Dennis Meadows. It is financed and publicized as part of the "Project on the Predicament of Mankind," an activity of the Club of Rome. The Club of Rome is a four-year-old international organization of 75 technocrats and businessmen self described as an "invisible college" dedicated to probing "the complex of problems troubling men of all nations," including poverty, degradation of the environment, alienation of youth, rejection of traditional values, and monetary disruptions. These "seemingly divergent" problems are, says the Club, in reality part of a single "world problematique," which can now be analyzed with the help of computers. Using techniques developed by M.I.T. systems-engineer Jay Forrester, the Meadows team claims to have limned the underlying fallacy of industrial expansion.

"The Limits to Growth," in our view, is an empty and misleading work. Its imposing apparatus of computer technology and systems jargon conceals a kind of intellectual Rube Goldberg device—one which takes arbitrary assumptions, shakes them up and comes out with arbitrary conclusions that have the ring of science. "Limits" pretends to a degree of certainty so exaggerated as to obscure the few modest (and unoriginal) insights that it genuinely contains. Less than pseudoscience and little more than polemical fiction, "The Limits to Growth" is best summarized not as a rediscovery of the

laws of nature but as a rediscovery of the oldest maxim of computer science: Garbage In, Garbage Out.

“Limits” approaches the problem of predicting the future straightforwardly enough, employing the time honored technique of mathematical simulation. Simulation has proved invaluable as a device for testing engineering designs at little cost and no risk to lives. For instance, instead of simply building a prototype aircraft and seeing if it flies, the airplane's characteristics are condensed to a series of computer equations which simulate the airplane in flight. The Apollo moon rocket made thousands of trips in an I.B.M. 360 before it was even built. Economists also use simulation, though their successes have been modest. Simulation models have a rather spotty record in using current data to predict national income, unemployment and inflation even two in advance.

But “Limits” is cast from a more heroic mold than any engineering or economic study to date. The Meadows team focuses its attention on the whole world and extends its time horizon to centuries. Factors the researchers believe influence population and income are boiled down to a few dozen equations, The crucial variables—population, industrial output, raw materials reserves, food production and pollution—all interact in ways that are at least superficially reasonable: Population growth is limited by food output, health services and pollution; industrial growth and agricultural growth are limited by resource availability and pollution. “Limits” is thus able to create a hypothetical future based on knowledge of the past.

As a first approximation of the future, the authors assume that the world is utterly incapable of adjusting to problems of scarcity. Technology stagnates and pollution is ignored, even as it chokes millions to death. A shortage of raw materials prevents industry and agriculture from keeping up with population growth. World reserves of vital materials (silver, tungsten, mercury, etc.) are exhausted within 40 years. Around 2020 the pinch becomes tight enough to cause a fall in per capita income. A few decades later, malnutrition and lagging health services abruptly reverse the climbing population trend. By the year 2100 the resource base has shrunk so badly that the world economy is unable to sustain even 19th-century living standards.

Scientists should have few objections to this grim scenario, even though it is based on what the Meadows team admits are crude assumptions. The scenario does plausibly illustrate the need for continued scientific progress to sustain current levels of prosperity. The quality of life in the future surely depends on the progress of technology and, to a lesser extent, on our willingness to limit population growth. But that should come as no surprise to a world that is already enormously dependent on modem techniques: If the telephone company were restricted to turn-of-the-century technology 20 million operators would be needed to handle today's volume of calls. Or, as British editor Norman Macrae has observed, an extrapolation of the trends of the 1880's would show today's cities buried under horse manure.

By the same measure, the simulation provides some small insight into the probable, hazards of continued indifference to pollution and population growth. Current

industrial and agricultural practices dump vast quantities of debris into the biosphere which would ultimately leave the air unfit for humans and water unfit for fish. Unchecked, the world's population is likely to double by the year 2000, with most of the burden on less developed countries. The future would be grim indeed if Con Ed were indefinitely allowed to ignore what out of its stacks or if Colombia permitted 20 Million people to jam the barrios of Bogota. Had the “Limits” team concluded on this note, they would have had an acceptable point—but one quite independent of their elaborate computer simulation. It doesn't take a $10-million machine to figure out that only science—and the will to use it intelligently — could keep us ahead of population growth.

The authors, however, have much more in mind. They are out to show that pollution and malnutrition cannot be attacked directly, but only by stopping economic growth. They argue that any reasonable modification of their equations to account for new technology, pollution and population control might postpone collapse but it would not avoid it. Under the most sanguine conditions imaginable, they say, growth must end within 100 years. Even if technology doubled known resources and crop yields, pollution were cut by three fourths, and birth control eliminated all unwanted pregnancies, growth would turn out to be self-limiting. In no more than a century, the collective weight of food shortages, raw material depletion and pollution would reverse expansion. Hence the only way to avoid collapse and its attendant miseries is to halt growth now. “Limits” preaches that we must learn to make do with what we already have.

It is no coincidence that all the simulations based on the Meadows world model invariably end in collapse. As in any simulation, the results depend on the information initially fed to the computer. And the “Limits” team fixes the wheel; no matter how ‘many times you play there is only one possible outcome. Critical to their model is the notion that growth produces stresses (pollution, resource demands, food require meats) which multiply geometrically. Like compound interest on a savings account, these stresses accumulate at a pace that constantly accelerates: Every child born is not only another mouth to feed but another potential parent. Every new factory not only drains away exhaustible resources but increases our capacity to build more factories. Geometric (or as mathematicians prefer to call it, exponential) growth must eventually produce spectacular results. If the Indians who sold Manhattan 300 years ago for $24 could have left their money untouched in a bank paying 7 per cent (a number chosen no more arbitrarily than many in “Limits”) they would have more than $25-billion today.

While the team's world model hypothesizes exponential growth for industrial and agricultural needs, it places arbitrary, non-exponential, limits on the technical progress that might accommodate these needs. New methods of locating and mining ores, or recycling used materials, are assigned the ability to do no more than double reserve capacity; agricultural research can do no more than double land yields; pollution can cut emissions from each source by no more than three-fourths. Hence the end is inevitable. Economic demands must outstrip economic capacities simply because of the assumption of exponential growth in the former.

It is also disconcerting to note that one earlier variant of the world model, which does manage to avoid collapse, is not even discussed in “Limits.” In “World Dynamics,” the

Forrester book which sets forth the basic simulation one scenario has crowding reduce the population growth rate (to zero before pollution, food shortages and depletion overtake the planet. But the “Limits” researchers jigger the assumptions just enough to eliminate this non catastrophic possibility. In the “Limits” version pollution is less controllable and crowding actually increases birth rates. The world economy overshoots its sustainable limits and, obligingly, collapses. Where even Forrester's model provides hope, the “Limits” team prudently fudges the result.

“The Limits to Growth” is not the first research effort to explore the dangers of exponential growth. Nor, once again, was it necessary to use fancy computer techniques to justify what so obviously follows from the assumptions. The Rev. Thomas Malthus made a similar point two centuries ago without benefit of computer printouts or blinking lights. Malthus argued that people tend to multiply exponentially, while the food supply at best increases at a constant rate. He expected that starvation and war would periodically redress the balance.

Still, “The Limits to Growth” might be excused in spite of its lack of originality and scent of technical chicanery if those dismal assumptions behind the calculations were accurate. It is true that exponential growth cannot go on forever if technology does not keep up—and if that is the case we might save ourselves much misery by stopping before we reach the limits. But there is no particular criterion beyond myopia on which to base that speculation. Malthus was wrong; food capacity has kept up with population. While no one knows for certain, technical progress shows no sign of slowing down. The best econometric estimates suggest that it is indeed growing exponentially. The Forrester-Meadows team could have performed a service by citing hard evidence to discredit these estimates, if they have any. Instead they simply assume a bleak future for technology, announce that their own estimates are generous, and conclude that under any hypothesis about scientific progress growth must end, Heads you lose; tails you lose.

Natural resource reserves and needs in the model are calculated on the most conservative assumptions about the ability of the world economy to adjust to shortages. This is largely due to the absence of prices as a variable-in the “Limits” projection of how resources will be used. In the real world, rising prices act as an economic signal to conserve scarce resources, providing incentives to use cheaper materials in their place, stimulating research efforts on new ways to save on resource inputs, and making renewed exploration attempts more profitable.

In fact, natural resource prices have remained low, giving little evidence of coming shortages. And the reasons are not hard to find. Technical change has dramatically reduced exploration and extraction costs, while simultaneously permitting the substitution of plentiful materials for scarce ones—plastics for metal, synthetic fibers for natural, etc. Moreover specialists usually agree that cheap energy is the critical long-run constraint on output of raw materials. Given enough energy, minerals might be reclaimed from under the sea, or from seawater itself. A virtually infinite source of energy, the controlled nuclear fusion of hydrogen, will probably be tapped within 50 years.

“Limits” also assumes that abatement practices will at best reduce pollution by three-quarters. Yet that goal could be accomplished using techniques that exist today and ignores the promise of innovations still under development. Relatively pollution-free autos are within reach if we have the political will to insist; electric power could be generated with minimal pollution if we are willing to pay a reasonable price.

Forrester's attempt to predict the future of the world via computer simulation has precedent in his own earlier attempt to predict the future of the cities. The approach of his “Urban Dynamics” is substantially the same as “World Dynamics.” Rather simply motivated equations are created as proxies for the forces that mold the economic structure of urban areas. Simulation then allows the analyst to extrapolate the past and present into the future.

The urban model seeks to explain the sickness of American cities and test the efficacy of various remedies. Forrester's urban system stylizes the economy of the city as a concentration of business enterprises populated by the people who seek to work in them. His city is economically viable only if its tax base of successful businesses and employed workers is large relative to the demands placed on the city by the unemployed or endemically poor. High tax rates drive business away and further erode the revenue base by discouraging middle and upper income taxpayers from living in the central city.

Just as ‘World Dynamics” provided a rationale for an end to growth, “Urban Dynamics” provides a computerized justification for benign neglect. Expenditures on low-income housing and antipoverty programs turn out to be counter-productive. They lure more poor people and thereby aggravate the problem of holding on to prosperous taxpayers. Even if the funds for renewal come from outside sources, says Forrester, the cities are left with an increased burden on local services and few new taxpayers. By the logic of the model, the cities can be saved if outside aid is used only to demolish existing housing without replacement. Plots vacated by the poor provide building sites for new industries. Federal aid devoted to lowering tax rates would have much the same effect; businesses and wage earners are attracted by more favorable condition.

As in the world model, the urban model critically depends on the assumptions upon which it is based. Forrester derives the assumptions straight from his own intuition and in the process generates some results worthy of Lewis Carroll. By his assumption, any policy that attracts business to the city brings with it a flood of poor people looking for jobs. Since Forrester's hypothetical businessman or employed worker is loath to pay taxes, the only way to prevent his flight to the suburbs is to deny poor people a place to live in the city. The healthy city, “Urban Dynamics” style, depends for its continuing prosperity on a massive shortage of low-income housing.

Forrester also avoids some troublesome questions that arise from the restricted purview of his model. One urban area may be able to attract a tax base by damn-the-poor policies, but what if all communities follow that prescription? Most Americans already live in or around cities. Where will the would-be rich urbanites come from and where will the impoverished go? Nothing in the “Urban Dynamics” formula would raise the total level of resources available for community welfare or eliminate the fact that

shuffling the poor around won't solve the problem of poverty for the nation as a whole. It seems a pity to attempt the rehabilitation of central cities by the same methods that the suburbs used to destroy them.

If the world and urban model researchers were more modest in the reforms they recommend, and if they were dealing with a less credulous press, one might excuse their efforts. Big “Urban Dynamics” has found many sympathetic readers, and “The Limits to Growth“’ appears on its way to even greater influence. Zero-growths ideology is being generalized from population—where it makes a good deal of sense—to production, where it makes almost no sense at all. A society prepared to throw out the baby should at least clean up the bathwater. Stopping growth is a sane way to curb pollution only if society doesn't have the nerve to do the job directly. But a world too timid to require smokestack precipitators would hardly jump at the chance to shut down factories. Conversely, if we ever did have the willpower to halt growth, we could use that resolve affirmatively to enhance the quality of life. The President who could convince Congress to forbid new capital investment could find money for comfortable mass transit and could put teeth into antipollution laws.

Fifteen years ago, nuclear incineration was the fashionable apocalypse. The doomsday clock on the cover of The Bulletin of Atomic Scientists marched inexorably toward midnight. Today the vision is mass death from insecticide poisoning, climatic changes, or some other form of retribution from an angry biosphere. None of these fears is chimerical. Ecologists are surely right in shaking us from our unconcern about the side-effects of growth. A fair volume of propaganda is tolerable—indeed necessary —to counter years of smug neglect.

But there is a real danger involved in exploiting modern society's intimations of disaster. Ecologists studying pest control have taught us that the remedy is often worse than the affliction. This principle has an intellectual analogue. To insist that pollution control is pointless without a halt to growth is not simply wrong; it is noxious. Instead of inspiring a zero-growth policy, it is more likely to rationalize even further stalling over the few basic steps needed to curb pollution. Con Ed can fume away, secure in the knowledge that the fault is not theirs but mankind's.

The planet certainly has its problems—and maybe even a “problematique” or two. But public-relations stunts which imply a false inevitability of doom do not speed the day of salvation. Crying wolf is too important a function to be left to invisible colleges.