

["Limits to Growth"]

FOREIGN AFFAIRS

AN AMERICAN QUARTERLY REVIEW



JULY 1972

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THE COMPUTER THAT PRINTED OUT W*O*L*F*

By Carl Kaysen

“THE Limits to Growth” is a brief, forceful, easily read polemic which has already generated many times its own weight in enthusiastic encomia and equally strong condemnations.¹ It advances a familiar, indeed fashionable, thesis. The goals and institutions of our present world society stimulate population growth and production increase at a rate that cannot be sustained. Further, and perhaps less familiarly, we are now about a generation from the point of no return, after which the world must suffer a catastrophic drop in numbers and wealth, no matter what is then done to restrain further growth. The argument is presented with a sufficient panoply of graphs, flow diagrams, references to the World Model and the new discipline of System Dynamics, and invocations of the computer to produce an aura of scientific authority for the conclusions. They have the additional weight of the endorsement of a prestigious private international group of respected businessmen, officials and academics, The Club of Rome, in a commentary appended to the study and signed by its executive committee. It is my contention that the authors’ analysis is gravely deficient and many of their strongest and most striking conclusions unwarranted. None the less, it draws attention to a number of difficult and important problems which must be faced, including the question of whether its whole approach is helpful or harmful in dealing with these real problems.

The backbone of the argument of “Limits” is simple, and requires little elaborate intellectual machinery to develop. Many significant variables that characterize our global society, in particular population and industrial production, have been growing exponentially over the last century, that is, at a constant percentage rate, and thus showing a greater and greater absolute increment each year. The processes that determine this persistent growth at constant (roughly) percentage rates lie deep in the structure of our social order, and unless we deliberately make drastic changes in it, they may be expected to persist and continue

¹ “The Limits to Growth,” by D. H. Meadows, D. L. Meadows, J. Randers and W. W. Behrens III. New York: Universe Books (A Potomac Associates Book), 1972.

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to generate exponential growth in the future. Many important physical aspects of the world, however, are finite, and their finiteness implies that exponential growth cannot go on indefinitely, without, so to speak, bumping into the limits. In particular, supplies of cultivable land, reserves of mineral resources and the capacity of the earth to "absorb" pollution are finite, and one or another of these (or some combination of them) sets a ceiling level for population and industrial output.

What is more important, when one of the exponentially growing variables reaches the ceiling, it does not simply remain at the limit value, but rather moves sharply down to a much lower level in a process of catastrophic decline. Thus when industrial production, for example, reaches a ceiling level set by limits on mineral resources, it does not simply remain there but plunges from a wealth- to a poverty-level in a short space of time. It is this proposition, together with some of the characteristic time dimensions of the process that both constitute the core of novelty in the book and justify its urgent call for rapid and drastic action.

This characteristic sharp shift from growth to decline in turn reflects two features of the formal model which underly the computations and arguments presented in the book.² The first is that the several variables and limits are all interrelated in a system in which growth in each of the main variables is reinforced by growth in the others. The second is that changes in some elements of the system have their effects on others only after a long lag. Thus, for example, a fall in the birth rate affects the demand for food fully only after a lag determined by the average length of life.

The question of how the system behaves when it reaches or approaches a limit is the central question of interest, and it is worth repeating that the kind of behavior which the authors find characteristic of their system is what gives their argument both its interest and its compelling quality. The fact that some limits exist, that the earth is in principle finite, is hard to deny, but does not in itself lead to any very interesting conclusions. Examples of growth systems are known that display quite different behavior as they approach their natural limits than the sharp reversals portrayed in "Limits." For instance, a system in which

²The details of the model are not given in the present volume, but are developed in a series of technical papers listed in its appendix, and in the book, "World Dynamics," by Jay Forrester (Cambridge, Mass.: Wright-Allen Press, 1971). Forrester is the intellectual father of System Dynamics.

the rate of growth of the major variables was proportional to their distance from their limits would show a smooth, gradual, stable adaptation to its growth ceiling.

Further, the response times of the system the authors present to changes in some of the key variables are such that we must anticipate the possibility of catastrophe by half a generation or more, in order to have time to act and avert it. By the time we see the whites of their eyes, our guns will no longer fire. Thus the book's chief conclusion, endorsed by its sponsors in The Club of Rome, is that we must planfully, radically reorganize the fundamental institutions of our social world soon or face an unmanageable crisis not so late. To do so, we must now recognize the need, and begin to devise the means.

The analysis supporting these conclusions is unconvincing. It contains at least three kinds of flaws, each of which alone would justify a skeptical view of the result. Further, the first two are deficiencies of principle, which operate at the same level of simplification, approximation and qualitative generality that the authors attribute to their analysis. The most important question concerns the nature of the limits that enforce the growth ceiling in the model. Basically, there are two: arable land and the supply of exhaustible minerals. The first operates primarily on population, the second on industrial production. In order to demonstrate the ineluctability of the limits, and unimportance of the precise magnitudes assigned to them, the authors show that doubling the productivity of agricultural land, or doubling the reserves of natural resources, leads to no qualitative change in the behavior of the system, and only a relatively brief postponement of the moment of catastrophe. Pollution operates as a limit too, but somewhat more indirectly, through its effect on length of life and thus on population. Making pollution control more effective is seen as possible only with sharply increasing costs; thus an economic limit is built into the model in respect to pollution control that functions in the same way as the physical limits on agricultural land and mineral resources. The various alternative assumptions the authors work into the model always rely on one or more of these limits to bring about the characteristic crisis of the system. Even the variant of the model described as "utilizing a technological policy in every sector of the world model to circumvent in some way the various limits to growth" (p. 141) in fact incorporates all three limits—though they oper-

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ate in a more distant future than in other variants, and the onset of catastrophic decline in population occurs only at the end of the twenty-first century.³

The notion that such limits must exist gains plausibility from the use of physical terms to indicate the relevant quantities—acres of arable land, tons of chrome ore reserves—implicitly invoking the physical finiteness of the earth as the ultimate bound. But this is fundamentally misleading. Resources are properly measured in economic, not physical, terms. New land can be created by new investment, as when arid lands are irrigated, swamps drained, forests cleared. Similarly, new mineral resources can be created by investment in exploration and discovery. These processes of adding to the supplies of “fixed” resources have been going on steadily throughout human history. Indeed, the authors themselves in effect recognize this when they describe the pollution limit not in physical terms, but in terms of the increasing costs of achieving higher and higher degrees of pollution control.

* However, once the problem is recognized as one of cost limits, not physical limits, it appears in a different light. The force of rising costs as mines go deeper or exploit thinner veins, or as drier and more distant lands need more water brought from farther sources and the like, meets the force of advancing technology, which brings down the costs of using existing resources and literally creates new resources by bringing within the bounds of cost feasibility materials or methods which formerly lay outside it. Thus, for example, the Hall process for reducing aluminum oxide by bringing the costs of the metal down to a level that made it an industrially usable material rather than a jeweller's curiosity, literally added hundreds of millions of tons to our reserves of metal ores. New ways of locating oil pools and new ways of exploiting them have combined to keep oil reserves—measured in terms of annual consumption—about constant over the past generation, though the actual rate of consumption has been growing exponentially. In general, the relative prices of mineral raw materials and agricultural products have not been rising, and the share of minerals (even allowing for imports) and agricultural output in total production have been falling fairly steadily over a long period in the United States. This is

³ The plot of this model (fig. 42, p. 140) shows an inexplicable and incredible rise in food consumption per capita, although its timing does not suggest that the population has overreached to the point of extinction.

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also true in other developed countries for which we have good evidence. While comparably good quantitative evidence for the whole world is not available, and such evidence as there is has not been assembled and analyzed, the best guess is that for the world as a whole, the share of extractive industries in output has been falling over the long period.⁴

In sum, the advance of technology, like the growth of population and industry, has also been proceeding exponentially. In the United States—again the society for which the best data are available over a long period of time—the average annual rate of technological growth over the last half-century for the private economy as a whole has been in the neighborhood of two percent. Broadly speaking, this means that a representative bundle of inputs—labor, capital, raw materials, land—of constant value (in constant prices) will each year yield two percent more output than the year before. As "Limits" points out in urging the force of exponential growth, a two percent annual growth rate corresponds to a 35-year doubling time. Thus, technical progress over the life of a generation has made it possible for our children to get twice as much output from the same bundle of inputs as their parents. There is even some evidence that the rate of technological advance in the United States has speeded up in recent years, but it is not conclusive. Other industrial countries also show exponential growth in technology; some, such as Germany and Japan in recent years, at higher rates than the United States but the data pertaining to them cover only a short recent period.

Once an exponentially improving technology is admitted into the model, along with exponentially growing population and production, the nature of its outcomes changes sharply. The inevitability of crisis when a limit is reached disappears, since the "limits" themselves are no longer fixed, but grow exponentially too. The qualitative character of the results then depends on the fine details of the model, and, in particular, on the differences between the growth rates of the most important variables. Catastrophes need no longer be the rule, and more stable outcomes, in

⁴ At this point, the reader probably feels uneasily that there must be some flaw in the argument. Surely the earth is finite, and even the wonders of technology must have some limit. The earth is finite, to be sure, and without broaching the larger question of whether the universe is or is not, it can be shown that the finiteness of the earth does not in itself set limits to what technology might accomplish that are relevant to the time horizons of the kind of argument with which we are concerned. I owe to Professor Robert Socolow of Princeton University a calculation that shows that in terms of physical limits alone, *i.e.* available matter and energy, the earth could support a population at least 1,000 times the present one at the current U.S. per capita income level.

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The second major flaw in the authors' analysis lies in the total absence of adjustment mechanisms of any kind in the model. Certain behavioral relations among the major variables are laid down, the magnitudes of their parameters determined by average behavior over the past, and then the relations projected unchangingly into the future. That is not how real social mechanisms work. Especially in the workings of the economy, adjustment mechanisms play a crucial role. The most important of these is price: as a resource becomes scarce, the consequent rise in price leads to savings in use, to efforts to increase supply, and to technical innovation to offset the scarcity. All economists know that these adjustment mechanisms are far from perfect and smoothly functioning. Yet they are and have historically been sufficiently powerful to mediate very large shifts in use of resources location, of population and patterns of consumption. Prices play no significant role in the basic logical structure that supports the argument of "Limits," although it is precisely their function to make smooth transitions possible as scarcities and demands change. Their absence is not unrelated to the characteristically unstable responses the model system of "Limits" displays. Only the effort of constructing another and much more complex model could show in detail what kind of stabilizing influence the incorporation of price changes and responses to them would exert. It is, however, well known that dynamic models structurally similar to those employed in "Limits," that characteristically display various forms of unstable behavior in the absence of prices as variables, are stabilized by the incorporation of prices and normal responses to price changes.

The third defect of the analysis is of a quite different order, one of detail rather than of principle. It is simply the failure of the authors to use available knowledge fully, effectively, or in some cases, at all. No one detail is of great importance, but together, they weaken seriously the claim of the work to respect. The most important single example is the authors' treatment of the determinants of population growth. Nowhere in their discussion do they acknowledge the great fact of demographic history in the Western world: the adjustment of birth rates to death rates. Our understanding of this "demographic transition" is far from complete; even if the underdeveloped countries repeated the same pattern over the same (relative) time period, they and the world

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 Not collapse!
 but need to change - no incentive without
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a [would not be free of appropriate concern over the magnitude of population growth. But what should we think of a model of a process in which population growth plays a crucial role that simply ignores this central, elementary and familiar fact? Or to take another example of much less significance to the central argument, the discussion of equality and economic growth (p. 42-44) closes with an italicized warning that "the process of economic growth, as it is occurring today, is inexorably widening the absolute gap between the rich and the poor nations of the world." The "absolute gap," *i.e.* the difference in dollars between average per capita income in the United States and, say, Peru, is growing and, given their present levels, will probably continue to do so for a very long time. But is that interesting or important? The *relative* gap between average income in many of the poorer countries and the industrial West is narrowing, and that is what is relevant to the question of equality. Economic history shows that, after the early stages of urbanization and the development of commerce, economic growth has tended to greater equality of incomes, both within nations and between them. A complete syllabus of errors would be tediously long; perhaps the length of the list is the natural result of the process of reinventing economics, demography and much else as System Dynamics.

b [So much for the analysis. Can the major conclusion stand alone on its intuitive (or counter-intuitive?) merits without the analytic underpinnings? Is there merit in the proposition that we must seek now to move as rapidly as possible to the state of "global equilibrium" defined by stability of both population and capital, and that failure to do so invites catastrophe? After all, this proposition is now frequently advanced on the basis of much simpler arguments than those we have examined. Briefly, and simply, the answer is "No." There are no credible reasons for believing that the world as a whole cannot maintain a fairly high rate of economic growth (though not necessarily the present one) over a long period of time into the future. Further, if it becomes necessary, for whatever reason, to slow down the growth rate, a relatively smooth transition from higher to lower rates will be perfectly possible, and not achievable only through the mechanism of catastrophe. Moreover, whatever is done to slow down the rate of population growth, population will continue to grow, especially in the poorer countries, for a long time. Only

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an increased rate of economic growth in those countries will make it at all possible for them to deal with their unavoidable population increases without catastrophe. The large poor countries contain in aggregate a substantial share of the world's people, and thus increased growth for them will have some reflection in world totals. Further, it is difficult or even impossible to conceive of continued substantial economic growth in the poor countries in general taking place in a context of economic stagnation in the industrialized world. Thus, seen both in terms of need and of feasibility, the prospect for the foreseeable future is continued long-term economic growth, perhaps at rates lower than those currently observed, and with quite a different distribution of rates as among countries.

In the legend, there were in the end, real wolves. In the world today, there are real and difficult problems attendant on economic growth as we now experience it. The social-economic system is not self-correcting or self-managing; sustained, self-conscious efforts are necessary to deal with the problems, and they often must be maintained against strong resistance. Two of the authors' three central concerns, population growth and pollution, do indeed present genuinely urgent and difficult problems. A third equally important and difficult one, mentioned in "Limits," but only in passing, is the assessment of the indirect consequences of technical change, the unanticipated "side effects" that can sometimes outweigh the benefits. Present social mechanisms are not adequate for coping with any of the three, and the kinds of changes required to do so more effectively meet strong opposition at every level, from that of the individual family to organized interest groups and governments. From one point of view, all three problems can be seen as examples of "external effects," where costs and benefits of particular actions are not borne by the primary actors and thus fall outside the reach of the price system as it usually functions and the control of the incentives and adjustment mechanisms it provides.

In each case, the problem is to find a set of supplementary adjustment mechanisms and incentive systems which can guide the relevant actors to socially more desirable choices, a proposition easy to state in the abstract and difficult to realize in the concrete. In many situations we lack knowledge of the likely consequences of specific actions; in many, those who benefit from present arrangements or think they do resist change, while those

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who might benefit from change may lack both knowledge and power. In many situations we lack reliable indicators of what is desirable in an overall sense, and the machinery for resolving conflicting judgments is inadequate. Determined effort to deal with these problems is important. Failure to pay proper attention to them might well result in serious troubles, though they are unlikely to be of a kind which can properly be termed catastrophic. And, though there is widespread discussion of many of these problems and considerable social effort at dealing with some of them, it can be plausibly asserted that it falls far short of what is required.

Finally, therefore, how much does "crying Wolf" help to direct social energies toward improving our responses to these problems? In principle, it is not only useful, but indispensable. The social mechanism is made up of human beings moved by passion far more than by reason. The mobilization of feeling that is the necessary prelude to all but the most routine social action requires some stimulus stronger than a sound argument. But to be effective, the cry must be well directed: the wolves must be imminent and they must indeed be wolves. On this score we can give only a moderate grade to "Limits," or more properly, to its sponsors in The Club of Rome. The problems they call us to attend are real and pressing. But none are of the degree of immediacy that can rightly command the urgency they feel. Indeed, at least two problems of worldwide consequence outside the scope of this work seem to be more urgent than any it deals with: the creation of an international order stable enough to remove the threat of nuclear war, and the diminution of the staggering inequalities in the international distribution of wealth. A good sentry does not cry up tomorrow's wolves and ignore today's tigers.

I ask, is that an academic speaking?

wait till things get bad.

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World Dynamics
Limits to Growth
and
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To Prof. Forrester

EXPRESS (E)
PORTLAND, MAINE
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Here — And Also There

On The Future Of Maine

One of the things that sets men apart from the animals, anthropologists say, is man's ability to laugh. I would say that another is man's ability to speculate about his future.

The vertebrates, even those that are most imitative of the society of man, can do no more than to procreate, survive as long as good fortune serves them, and then die.

A very long time ago our earliest ancestors were able to do some rudimentary planning in the way of mutual security, food supplies, and protections against the hazards of climate. Milleniums later they observed the heavens, guided their behavior by changes of the seasons, built strong habitations to guard their progeny, organized ruling dynasties and ultimately pondered the question of life after death.

This primitive planning involved some thinking about the future, and modern society does a great deal of future planning, together with conjecture about what will happen decades or centuries hence.

Some of it is frivolous, like the faith some people have in astrology, though perhaps it is no farther off the mark than chartists who predict the course of the stock market.

All of which introduces a highly serious two-day session held at the University of Maine at Portland-Gorham last week, charged by a recent law with drawing some perimeters about the future of Maine.

In reading the excellent news coverage of this event, I was struck by the difficulty some members of the commission had in separating factual data from conclusions.

A Boston banker, assuming that the

people of this state want economic growth — which is by no means certain — felt that less severe environmental rules would be good for us all.

Dexter's town manager, George Campbell, whom I applaud for his



By
Ed
Penley

thoughtful approach to the broad purpose of the commission, warned small towns that they must develop stronger and more intelligent leadership or they will be gobbled up by regional units capable of providing services that small communities cannot furnish.

But after the conferees had finished, meanwhile fending off an attempt by a university senior researcher to "synthesize" the panel's conclusions, I was happy to see that the commission felt it had hardly scratched the surface of the task given it.

So the commission, I guess, will begin casting about for whatever economic and demographic and other data it can find before it draws any conclusions, let alone synthesizing them.

When the law was passed last year creating the commission I applauded it, and I think it can perform a number of useful functions. It should

be able to map out for Maine people a number of directions in which the state can move, assuming it does certain things by way of official policy.

I would hope that the commission will let its imagination run unchecked in postulating some very innovative possibilities.

Here is one, for a starter — what will this state do, 30 years from now, when it is likely that this country will have used up all of its crude oil and natural gas, and the Middle East is probably down to its last 150 billion barrels? A part of the answer will lie in what Maine will do with its vast forest reserve, over 17 million acres of growing trees.

I did not see in the news stories any mention of the report made by MIT for the Club of Rome, and entitled "The Limits To Growth."

Chances are that most commission members have read it, but if I were Chairman Halsey Smith I would provide copies for each one and insist that they read or re-read it. What the MIT research team did was to take existing supplies of farm land, minerals, fuel, and other necessities and by computerizing show how long they can be expected to last. The report has its critics, but it is basic in today's civilization that the world's 3.5 billion people, increasing at the rate of 82 million every year, are consuming these finite resources at an accelerating rate.

That may not scare the commission, but it scares me, simply because when the scarcities really begin to bite the world's nations will begin fighting for them. And that will be of more than casual interest to Maine and its people.

Stricken Man Chooses To 'Lifts World From His S

SAN BERNARDINO, Calif. (AP) — Chuck McCracken unplugged himself from his kidney dialysis machine last week because he says the life-saving treatment was "sheer agony for me."

Now he is waiting to die. His wife is resigned to his decision. His children are confused. He figures he has less than two weeks to live.

He says that each day he grows weaker. He sits at home, passing the time talking to friends and family.

"Uremic poisoning causes a loss of strength," he said candidly in a telephone interview Tuesday. "I look forward to a pleasant death, not painful, not traumatic. I'll go peacefully and quietly."

He adds, "I don't believe a

person should commit suicide, but to be kept alive by doctors is not quite humane. A person has a right to choose between life and death."

McCracken, 36, went off dialysis July 22. He had been taking the treatments — in which a machine filters the wastes from his blood — for three months after he suffered kidney failure.

He had to leave his job as a television repairman eight years ago when he lost his vision. He also has diabetes and a diseased thyroid gland. He suffered leg paralysis last March.

"During the (dialysis) treatment my blood pressure would suddenly drop, and I wouldn't be able to breathe," McCracken said. "They would raise my legs above my head to help me recover and that was sheer agony for me. It was more than I wanted to bear."

McCracken says that once he had made the decision to die the "world lifted from my shoulders. I have felt extreme

inner peace."

Barbara McCracken says she is resigned to her husband's decision. But she says the McCracken's four young children — his by an earlier marriage — "don't quite understand the full impact of it yet." McCracken has already made his funeral arrangements: "It's one less thing my wife will have to worry about when I'm gone," he says.

Mrs. McCracken — who works at the General Telephone Co. — has supported the family since her husband's paralysis.

McCracken's physician, Dr.

someone, but he was very depressed. He was unable to do more than go back and forth from the treatments here and his home. So, the life he faced was a very limited one."

Teichman said McCracken had "less than a 30 per cent chance of living for one year" if he had stayed with dialysis.

The doctor said McCracken has signed a release which testifies that he was of sound mind when he made his decision to die.

Harris Begins Picknicking For '76 Presidential Race

WASHINGTON (AP) — Democratic presidential hopeful Fred R. Harris is starting from in front of the White House on a 13-state, 5,300-mile cross-country camper trip to boost his presidential candidacy.

The rally today in Lafayette Square across from the White House starts what is being billed as the most extensive cross-country travel by a presidential candidate since Harry S. Truman's whistlestop train trips in the 1948 campaign.

Accompanied by his 14-year-old daughter Laura and, for portions of the trip, by his wife LaDonna, Harris plans to work his way across the northern

camper and Harris' appearances at coffees and "brown bag" picnics is designed to contrast the former Oklahoma senator's campaign from those of other presidential hopefuls.

Harris has called for a "fairer distribution of economic and political power in America."

Harris, who served for a year as Democratic national chairman and ran briefly for the 1972 Democratic presidential nomination, is running the lowest-cost campaign of the several Democratic candidates listed in the most recent reports to the Federal Election Commission.

In the last 18 months, he has raised \$77,897 and spent \$74,294. That's about 50

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5/15/73

May 10, 1973

Aurello Peccei, Club of Rome
Dennis L. Meadows, M.I.T.
Jay Forrester, M.I.T.
William Watts, Potomac Associates

Having just finished reading THE LIMITS OF GROWTH with great excitement and general approval, I cannot refrain from commenting, both positively and negatively.

Positively, I agree that our predicament is one of

1. increasing interdependence. "Man..does not understand the...inter-relationships of its (our predicament) components..., because we continue to examine single items in the problematique without understanding that the whole is more than the sum of its parts, that change in one element means change in the others." (11)

2. increasing incompetence to adapt by merely traditional methods. The problems "are of such complexity and so interrelated that traditional institutions and policies are no longer able to cope with them." (10)

3. increasingly urgent. "Taking no action to solve these problems is equivalent to taking strong action. ...A decision to do nothing is a decision to increase risk of collapse." (183)

and that we need

1. "Entirely new approaches...to redirect society toward goals of equilibrium rather than growth." (193)

2. Such approaches "must ultimately be founded on a basic change of values and goals at individual, national, and world levels. This change is already in the air." (195) "The final, most elusive, and most important information we need deals with human values." (181)

Negatively, omission [even though omission was needed to achieve the powerful effect of this book] of philosophical trends, of a growing chaos of ideals, of rising crime rates, and of increasing distrust, leaves a serious gap. Doubtless one could diagram feedback loops exemplifying the demoralizing influence of teaching Sartrean aesthetic existentialism in required "English literature" classes in colleges and high schools.

Is it not time to raise questions about the limits of growth of pluralistic ideals, of individualisms which now advocate "personal anarchy," of ideals of personal freedom which now include "freedom from responsibility"? Should we not prepare feedback loops regarding each of the new types of "permissiveness," such as electing students to boards of directors, thereby signifying growing inability of elders to guide youth in meaningful directions through our present chaos?

I propose a modification of your analysis of what is lacking, when you rise to a hopeful note: Man "has all that is physically necessary to create a totally new form of human society...." (184) I think that man also has enough of what is intellectually necessary to achieve a new philosophy needed to clearly express the assumptions inherent in such a new form of society.

"The two missing ingredients are a realistic, long-term goal that can guide man to the kind of equilibrium society and the human will to achieve that goal." (184) Ought we not say that there are at least three missing ingredients, and that one of them is the absence of an adequate philosophy of interdependence? Granted that the book asserts that "The final, most elusive, and most important information we need deals with human values." But there is no hint that anything is being done anywhere to achieve such information.

I do have some proposals to make. (E.g., "Organicism: The Philosophy of Interdependence," INTERNATIONAL PHILOSOPHICAL QUARTERLY, VII, June, 1967, pp. 251-284.) And they may be thought of in terms of a dynamic equilibrium between excessive individualism and excessive socialism, for example, and between the poles of many other polarities.

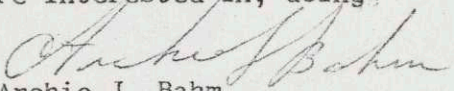
But more important just now is publication of the urgency for need of awareness of this lack as one of our most serious.

Are you planning to press attention to this need?

Are you doing anything about it?

Can you refer me to others who are, or who are interested in, doing something about it?

Appreciatively yours,


Archie J. Bahm
Professor of Philosophy
University of New Mexico
Albuquerque, N.M. 87106 U.S.A.

P.s. I forgot two specific criticisms, doubtless picaunish because pertaining to hasty language rather than intent:

1. "Since ours is a mathematical model it has two important advantages.... After all assumptions have been scrutinized, discussed, and revised to agree with our best current knowledge, their implications for the future behavior of the world system can be traced without error by a computer, no matter how complicated them become." (22) (a) There are computer errors, i.e., errors due to mechanical and electronic malfunctioning of computers. So to assert boldly "without any error by a computer" is to allow enthusiasm to hide some truths about such errors. (b) Computers programmed via dyadic logic developed in PRINCIPIA MATHEMATICA presuppose atomic propositions, atomic facts, and an excluded middle between I and \bar{O} . Systems entail unity; dyadic logic postulates no such unity. Contradiction in assumptions is an achilles heel of computer logic which seems to be perpetually overlooked. (See "Systems Theory: Hocus Pocus or Holistic Science?" GENERAL SYSTEMS, XIV, 1969, pp. 175-7.) Generalized and idealized claims about "without computer error" seem premature, and are not needed to substantiate the thesis of the book.

2. "It is through knowledge of wholes that we gain understanding of components, and not vice versa." (188) Surely what is meant is "as well as vice versa." Wholes and parts interdepend, and knowledge of each is a source of knowledge of the other.

These are trivial criticisms, but they may be worth considering if the book is ever reedited.

Not Man Apart

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In the Shadow of Malthus



Calvary Cemetery, Queens, New York. Photo by Arthur Tress.

In the Shadow of Malthus

DONELLA H. AND DENNIS L. MEADOWS

Editor's Note: Starting in 1971, The Club of Rome published a series of books on its Project on the Predicament of Mankind. The Club has been described as a self-selected, non-governmental, international brain trust; the human predicament is to make the transition from social and economic systems based on growth to a society based on equilibrium.

Writing about the first book in the series, World Dynamics, by MIT Professor Jay Forrester, NMA Senior Editor Hugh Nash said, "Have you ever thought what an inestimable privilege it would be to be an early reader of a book that turns the world around and heads it in a new direction? A book like The Wealth of Nations, The Federalist Papers, or The Origin of Species? This may be your chance. . . . World Dynamics may prove to be such a book" (NMA, February 1972). Professor Forrester had constructed a series of computer models of the relationships between natural resources, population, capital investment, pollution, and that elusive factor, the quality of life. His models showed how interactions between these elements can be expected to affect human life over the next dozen decades and how dealing with key problems could bring us to a society in equilibrium and help us "escape conditions of unspeakable horror," in Mr. Nash's phrase.

The second of the series was The Limits to Growth, by Donella and Dennis Meadows, Jorgen Randers, and William Behrens. Reviewing it, Hugh Nash wrote, "Limits and World Dynamics, taken together, constitute a landmark in the intellectual history of mankind. Largely because of their publication, the desirability and possibility of continued growth is being questioned on a scale that would have seemed decades away, at least, only two years ago" (NMA, April 1972). Limits was followed by two technical works on the computer models, Toward Global Equilibrium

and The Dynamics of Growth in a Finite World (both published in 1973 by Wright-Allen Press of Cambridge, Massachusetts).

The Meadowses' work—like all work in The Club of Rome's project—has been based on the belief that if society maintains its current reliance on growth to solve short-term problems, population and material production

With the publication of World Dynamics (Wright-Allen Press; Cambridge, Massachusetts; 1971), Professor Jay W. Forrester challenged the world's scientists and decision-makers to take the long view and examine the long-term causes and consequences of growth in the world's population and material output. To contribute to the

of the world system such as exponential growth, finite limits, and the delays that always occur between the development of a problem, the social perception of it, and its solution. These properties are the real basis of our concern about physical growth.

THE MAIN POINTS OF LIMITS TO GROWTH

We shall summarize here the five main points from *Limits* and discuss critical responses to them.

1. *Exponential growth is an inherent property of population and industrial capital but not of technology.* Population and material capital grow exponentially by the very nature of the reproductive and investment processes. This statement is derived both from empirical evidence and from knowledge of underlying causes. New people can only be produced by other people, and machines and factories are needed to generate other machines and factories. Whenever the change in a quantity depends on the quantity itself, the change tends to be exponential in form. The rate of growth varies, both in the real world and in the world models we constructed. The growth process is, nevertheless, inherently exponential.

Although human knowledge may be inherently exponential, it does not follow that any given technological application of that knowledge is inherently exponential. To bring a new technical discovery into widespread use requires social recognition of the existence of a problem. It may also require that new institutions be established, often at the expense of the old, and that investment be diverted from some other possible use. . . . Social perception and consensus,

The no-growth argument is an appeal for readjusting the composition and distribution of economic output.

The pro-growth argument is an attempt to postpone this readjustment, to confer it on future generations while ensuring that those generations will have fewer resources and thus fewer real choices to make.

will grow past sustainable limits; living space, reserves of resources, and the ability of the earth's systems to use or dilute our wastes will be outstripped; and there will be an uncontrolled decline in the population and economic activity of humanity. But society can—indeed, must—make an orderly accommodation with the finite constraints of the earth. Computer modelling, the Meadowses believe, can be a valuable tool for finding the earth's limits. FOE and the editors of NMA agree with the Meadowses and with the Club, and our policies are based on the same assumptions.

Needless to say, the Meadowses, Professor Forrester, and The Club of Rome have been criticized. The following essay is a history and discussion of the Meadowses' thesis, and a response to the criticisms most commonly levelled at Limits. It was originally presented at Yale University in September, 1972, and an extended version of it appeared in Futures, February 1973.

analysis and understanding of global problems, Professor Forrester proposed a formal model of the interactions among populations, capital, and several factors that influence their growth: food, resources, and pollution. Recognizing that his own model was not perfect or complete, Professor Forrester emphasized that no perfect or complete model of world-wide processes exists, and that the models on which decisions are now based are not even explicit enough to be discussed and improved.

In *Limits to Growth* (Universe Books; New York City; 1972), we described several attributes of growth in population and material output, attributes that give the world system a tendency toward unstable behavior. We proposed material equilibrium as a sustainable alternative to the goal of perpetual growth that is the implicit basis of most contemporary policies.

Limits deals with fundamental proper es

Continued on page 8

IN THIS ISSUE

The Limits To Growth

World Dynamics and *The Limits to Growth*, the pioneering works done under the auspices of The Club of Rome, have come in for sharp criticism. Some critics have questioned the assumptions made by the authors of *Limits*; others have charged that the whole idea of defining limits is a plot on the part of the rich to keep the poor down.

Donella and Dennis Meadows, authors of *The Limits to Growth*, summarize The Club of Rome's findings to date, and provide compelling answers to their critics, pointing out, among other things, that at least their assumptions are out on the table whereas the critics' assumptions are unknown, and that it is growth that has perpetuated inequities between rich and poor (page 1).

Progress Against Strip Mining

The Montana Legislature has moved to protect its state from companies that would strip mine its coal. FOE's Ed Dobson, who has been very active in the grass-roots movement that has brought about the nation's toughest strip mine reclamation law, writes that the law is the first hurdle; upcoming are legal actions to determine who owns what coal, and the need for Montanans to stay vigilant and not let industry evade the law. The biggest hurdle, still ahead, is a federal strip mine law, and Montanans are leading in the movement to formulate tough legislation on this all-out assault against the earth (page 11).

The AEC: How Not To Protect The Public

Last year, the Atomic Energy Commission held hearings on the emergency core-cooling systems that must be built into all large light-water nuclear power plants. Consolidated National Intervenors, in the persons of Henry Kendall and Daniel Ford, entered the hearings to make the case that the systems, as now designed, will not work. The AEC's initial reaction was to make some window-dressing concessions without reexamining its basic ECCS program. Now, under pressure from a suit by FOE and Ralph Nader, the AEC has reopened the hearings. An excerpt from Kendall and Ford's book on the hearings makes it clear why the CNI's intervention was necessary; not only did the AEC rely upon fundamentally unreliable sources of information in making up its ECCS criteria; the people making up the criteria simply did not have the expertise to do an adequate job (page 14).

Energy Economics

We pay for things with money in this society, and this has made us very prone to make most of our decisions on the basis of how much of our incomes various activities would consume. But, of course, most of our decisions, particularly about what goods to buy, or which services to avail ourselves of, affect the earth by using energy or resources. Malcolm Slesser suggests a system of currency that would directly reflect what goods and services cost the earth (page 10).

Cover photograph: West 164th Street, Bronx, New York, by Arthur Tress.

LETTERS

A Hymn for FOE

Dear Mr. Brower:

I was astonished to discover at church the other Sunday that Friends of the Earth seems to have inspired a Christian hymn. The tune has a delightful "folkish" feeling, and the words are these:

FRIENDS OF THE EARTH

1. Friends of the earth now let us join together
In respect for all that gives us life.
Too long have we been trampling our resources.
Now the time has come for us to act.
CHORUS:
Thank you—thank you God
Thank you for the world that you give us.
Help us, O Lord,
Care for the earth on which we live.
2. Friends of the earth now let us join together.
Bend your knee and grasp a bit of soil.
Look on it gladly; in your hands are riches
Far more precious than the gift of gold.
CHORUS:
3. Friends of the earth now let us join together.
Drink a cup of water and find joy.
We must preserve the rivers, lakes, and oceans.
In them, through them flow the streams of life.
CHORUS:
4. Friends of the earth now let us join together.
Breathe the air and look into the sky.
Can we continue endlessly polluting
This resource that holds the key to life?
CHORUS:
5. Friends of the earth now let us join together

To preserve the only world we have.
Let us encourage all men to be brothers
While we care for every form of life.
CHORUS:

—Words and music by Roger A. Dahlin,
Rogate Sunday 1973 for the
Illinois Synod, Lutheran Church
in America

If you have further questions on it, you may wish to contact the minister who introduced it to our congregation, The Reverend Ronald Sell of St. Stephen's Evangelical Lutheran Church, 5700 Pheasant Hill Road, Monona, Wisconsin, 53716.

George Koski
Madison, Wisconsin

Marshmallow Whip On Cole Slaw

Fellow FOE Members:

Mr. Byther's letter on the glories of off-trail motor vehicles printed in the August issue of *Not Man Apart* was so fantastically disingenuous that I was surprised at the mildness of the editorial comment printed beneath it. To reply to Mr. Byther's points under his own headings:

1. Mr. Byther says, in effect, that any community that is plagued by illegal reckless or noisy motorcycle driving has only itself to blame. In other words, the individual is not responsible for breaking the law; the poor overburdened cops are responsible for forcing everyone to obey it. Oh goody. Does this apply to rural areas too? Is every woodland path supposed to have sheriff's deputies stationed on it? Is every path in a national or state forest to be constantly patrolled by rangers? If so, what becomes of wilderness and solitude?
2. It is certainly true, as Mr. Byther says, that in a great many auto-motorcycle accidents, the automobile runs into the motorcycle. But this is not entirely the automobile

driver's fault. Many riders of both bicycles and motorcycles flatly refuse to acknowledge the fact that they are difficult to see. A man in dull-colored clothes on a black or mud-smeared cycle is simply not a very conspicuous object, especially in thick traffic. The wearing of bright clothing by cyclists would do an enormous amount to cut down such accidents.

3. It is true that a motorcycle on the street or highway is a fuel-saving substitute for an automobile. A motorcycle or any other off-trail vehicle off the streets and highways is a fuel-wasting, ear-splitting, destructive substitute for walking—or for not being there at all.

4. "I think that the motorcyclist is more ecologically aware than the average person simply because he bought a bike instead of a car." Rather than get into the dubious area of what the average person's motives for buying a motorcycle might be — I think Mr. Byther is dead wrong but I can't prove it — I think his statement might be a little closer to the truth if the word "deaf" were inserted before "motorcyclist." The editor compares the sound of a motorcycle in the woods to a sonic boom. I think it would be better compared to the sound of a 34-piece rock band at a distance of three feet. People go to wilderness areas for quiet. This is one of their main reasons for being there. Motorcyclists in wilderness areas are comparable to Klieg lights in a planetarium, marshmallow whip on cole slaw, or broken glass on an air mattress.

Vivian Saunders
Baton Rouge, Louisiana

Redwood Park: Whose Fault Is It?

Dear Sirs:

As requested in the June issue of *Not Man Apart*, I wrote to Representative Roy A. Taylor about doing all he could to preserve Redwood National Park.

I thought that you might be interested in his answer, which is the longest, most encouraging individual letter I have ever received from a member of Congress.

As he suggested, I have written to the President and Secretary of the Interior.
Keep up the good work!

Richard P. Kellogg
New York City

Representative Taylor's letter to Mr. Kellogg follows:

Dear Mr. Kellogg:

Thank you for your letter concerning the Redwood National Park.

As you may know, this park was created by Congress in 1968. At that time, we authorized the acquisition of 58,000 acres of land. The park now includes 27,929 acres of State-owned land and 28,277 acres of federally-owned land.

Land acquisition costs in this area were to be borne partially with appropriated funds and partially by the exchange of Federal lands. Altogether, \$92 million was authorized to be appropriated (although actual costs may exceed this amount) and lands valued at more than \$52 million were to be exchanged for private lands of equal value within the park. To date, \$72 million has been appropriated and the Federal lands have been transferred in exchange arrangements.

At the time Congress created the park, it recognized that activities outside its boundaries might adversely affect the values within it. For that reason, the legislation specifically provided some flexibility for the Secretary of the Interior to modify the park boundaries if such action would help minimize siltation of the streams and damage to the timber or would assure the preservation of the scenery within the boundaries of the National Park. While there is a 58,000 acre limitation on the amount of land which can be included within the park, it should be noted that the present size of the park is only 56,206 acres.

In addition to allowing the Secretary to modify the boundaries, the Act specifically authorizes him to look beyond the boundaries of the park in order to assure its integrity. It did this by allowing him to acquire interests in land or to enter into cooperative agreements

Dear Sir:

For some time, I've been intending to send you a copy of this verse, which I've sung around the country and it seems to be well received, and I think is worth your printing sometime, when you have a few inches you're not using for something else.

Pete Seeger
Beacon, N.Y.

G C G

Woodland and grass-land, and river shore-line

D7 G

To everything living — bugs, snakes, and microbes.

C G

Fur, and feather, we're all here together

D7 G

This land was made for you and me —

extra verse by Pete Seeger
to song "This Land is Your Land"
by Woody Guthrie
© by Ludlow Music
10 Columbus Circle
NYC

with landowners "on the periphery of the park and on watersheds tributary to streams within the park designed to assure that the consequences of forestry management, timbering, land use, and soil conservation practices conducted thereon, or the lack of such practices, will not adversely affect the timber, soil and streams within the park. . . . To my knowledge, the Secretary has not negotiated any agreements or acquired any interests in any lands along Redwood Creek pursuant to this authority even though one of the main purposes of this provision was to protect that area.

Under the Constitution, of course, no owner of land can be deprived of the lawful use of his land without his consent unless it is taken for a public purpose and unless he is given just compensation. In the case of the Redwood Creek area, in the absence of voluntary cooperative agreements between the Secretary of the Interior and the owners, any property rights taken must be purchased at their fair market value.

The Act creating the Redwood National Park authorizes the appropriation of \$92 million for land acquisition. So far, \$72 million has been requested by the President and approved by Congress. All of this has been expended; however, the land and timber values on some major tracts have not yet been determined by the Court of Claims. In the event that the authorization is inadequate, further legislation may be necessary to fund the land acquisition program within the existing park. In the meantime, however, you may wish to communicate your views directly to the Secretary or to the President urging them to utilize the funds which the Congress has authorized for this important national park area.

Roy A. Taylor, Chairman
Subcommittee on National Parks and
Recreation
House of Representatives
Washington, DC

Our article on Redwood National Park also

drew a response from the Department of the Interior:

Dear Sirs:

The Curry report [on logging in Redwood Creek] in reality was commissioned by me to determine what could be done, ought to be done, and what we can afford to do within the Redwood Park ecosystem.

Your article is extremely accurate when you reiterate that Redwood Creek is a totally incomplete ecosystem for which Congress must bear the burden of its creation and its agony. Options available to the Secretary are few and we are continually hampered by the realities of the fiscal situation. However, I have not given up and do hope that we have our day in front of an oversight committee.

Nathaniel P. Reed
Assistant Secretary for
Fish and Wildlife and Parks
Department of the Interior
Washington, DC

Assembly Line Nukes

Dear Friends:

Don't look now, but it has happened. The Atomic Energy Commission is about to begin producing nuclear power plants en masse. In an interview in *Barron's Financial Weekly*, AEC Chairman Dixy Lee Ray states, "The Westinghouse-Tenneco combine already has started a shipyard facility at Jacksonville (Fla.), which will turn out nuclear plants on an assembly-line basis. They plan to mount them on barges and take them to permanent

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off-shore locations. To be economic, they figure they will have to build at least eight such plants."

The idea is to "get around the problem of each plant being challenged on environmental and safety grounds." They hope to get standardized designs so that a few could be approved once and for all.

Further, inland plants may become standardized also, either in total design or component parts.

If successful, nuclear plants will be sprouting like mushrooms (Dr. Ray favors clusters of plants) on and off the land. If ever a time for a successful FOE court appeal, this is it.

Thomas Layman
Phoenix, Arizona

¡Brazil!

Editor:

For the first time in Latin America, says the influential newspaper *Jornal Do Brasil*, there was held a meeting against pollution.

Six hundred women, housewives with their sons, walking in the streets of the little city of Perus, near the great São Paulo, have made a protest against a cement factory that does not want to set up equipment against pollution.

The posters said, "We cannot cry. Our tears are made of cement." "Down the pollution." "People will give alms to Abdalla (the owner) so he can set up filters against pollution."

The women say, "We want healthy sons, clean curtains, and gardens with flowers," which is not possible with the cement dust.

J.E. Montenegro Bentes
Rio de Janeiro, Brazil

Watch Out For That Bottom Line

Dear Sir:

There is every probability that the major oil companies are capitalizing on the energy syndrome; and all the criticism, investigations, and diatribes being leveled at them are likely justified. Action to bust up these cartels will undoubtedly be widely supported.

To this extent the emphasis placed on the issue in the July NMA was useful and timely. Nonetheless, I am concerned that all of this is obscuring the "bottom line" of the tally sheets.

The keystone of it all is that we are consuming fossil fuels at a prodigious rate on a geometric curve, that the fuels being gobbled up are the earth's energy capital (as opposed to the interest), that they were laid down as stored sunlight one time, and that they are being depleted fast. Granted all of the opportunism and chicanery; but if we write off the problem at that level, it will be the biggest blunder in a nearly perfect record of blunders for our species.

If we are to argue that there are vast stores of untapped fossil fuels, and that the basis of our problems resides in the mahogany board rooms of the major oil interests, then we are also tacitly approving the draconian environmental disruption which will be produced in the extraction of those fuels on a scale necessary to sustain our soaring appetites. We know what this has meant to Appalachia, and to some of our coastal waters. We know what it may yet mean on Alaska's North Slope; and we can only look ahead to the corrugation of some 25,000,000 acres of lands in Utah, Colorado, Wyoming, and Montana, as we grind out the oil shales and low sulphur coals.

If it is time to nail the oil interests' hides to the wall, it is also a time to cut down. The oil companies are advising that we cut down on consumption, very likely for their own special reasons. But the advice is right anyhow, for our reasons.

Thomas E. Dustin
Executive Director, Indiana Division
Izaak Walton League of America
Huntersville, Indiana

2,700 Bottles

Dear Editor:

I was pleased to read your article concerning the required deposit or "Bottle Law," which went into effect in Oregon this past October, despite dire predictions by the beverage industry and supermarkets. This law may be the one which will help keep us from being buried in solid waste.

Personally, I have written many letters urging passage of such legislation in Pennsylvania but such legislation has not got enough support to date. To help the returnable bottle situation in another way, I decided several years ago to pick up discarded returnable soft drink and beer bottles wherever practical and return them. In the last two years I have redeemed over 2,700 bottles. With deposits on some bottles as high as 5 cents, the monetary reward has been significant, as well as the feeling that I am making a significant contribution in reducing environmental pollution. I would like to see this example followed by other FOE members.

Albert E. Wolf
Philadelphia, Pennsylvania

One Man's Protest

To the Editor:

As a citizen I believe I can do my part to help clear the air: I am delaying the purchase of a new car until it contains a nonpolluting engine. I hope that others who read this will join my boycott.

Simon Perchik
New York City

Not Man Apart

... the greatest beauty
is organic wholeness,
the wholeness
of life and things,
the divine beauty
of the universe.

Love that,
not man apart from that . . .

—ROBINSON JEFFERS

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NEWS

Appeals Court Rules Against Rainbow Bridge

By a vote of 5-2, the Federal Appeals Court in Denver, Colorado, has overturned FOE's victory in the lawsuit aiming to protect Rainbow Bridge National Monument from encroachment by Lake Powell.

The finding of the court is rather complex, but essentially it rules that the provisions of the Colorado River Storage Act of 1956 that expressly protect Rainbow Bridge and all other national monuments and parks from impairment by Lake Powell, or any other reservoir, are, at this point in time, "inoperative."

The majority ruled that since Congress has repeatedly refused to appropriate money to build protective works for the Monument, it has changed its mind about sparing the Monument from inundation. The majority ignored one major point of the plaintiffs, which was picked up in a fine dissenting opinion by Chief Judge Lewis. It is true that Congress has refused to appropriate funds for protective works; it is also true that Congress has refused on some half-dozen occasions to repeal the protective language in the CRSA. Therefore, concludes Judge Lewis, the language is still in force, and the action of the majority is, to continue the Watergate analogy, an egregious violation of the doctrine of separation of powers.

The case will be appealed to the Supreme Court.

New Legislation Would Update Wilderness Act

Conservationists Endorse Bill To Plug Mining Loophole

Senator Henry Jackson (D-Wash.) has introduced legislation that would curtail mining in areas protected under the Wilderness Act of 1964. Senator Jackson's bill, S. 1010, would bar the filing of any new mining claims in wilderness areas, and would ban prospecting in wilderness areas; private prospecting would be replaced with government mineral surveys.

Conservationists have long felt that the Wilderness Act of 1964's biggest loophole is that it allows miners to keep staking claims in wilderness areas until 1984. In January, US District Court Judge Philip Neville, ruling on a suit brought by the Izaak Walton League to protect the Boundary Waters Canoe Area of Minnesota, established a precedent for the legal protection of wilderness areas from miners (NMA, April 1973), but it was felt that his ruling would need legislative affirmation. Court rulings are too tenuous to be counted on permanently, as we have seen in the Rainbow Bridge and trans-Alaska pipeline controversies.

George Alderson, FOE's Legislative Director told the Senate Interior Committee on July 18 that the mining provision in the Wilderness Act, "... allows miners freedom to despoil the wilderness. It was enacted at the insistence of a small minority in the US Congress, consisting mainly of legislators who have since been turned out of office by their constituents. Miners no longer control the western states. It is time to enact a new law to control mining in our national wilderness areas. Mining is the greatest single threat to the integrity of wilderness areas."

Mr. Alderson also suggested a series of amendments to strengthen S. 1010. Among them would be provisions: to bar miners from cutting timber or constructing mills or tailings ponds in wilderness areas; to allow the Forest Service to use condemnation to acquire mining claims; and to repeal an 1872 law's requirement that \$100 worth of "assessment work" be done annually on each mining claim, replacing it with a yearly registration fee to be paid on each claim.

Political Reform Initiative Underway In California

Would Restrict Spending, Conflict of Interest

Spurred on by the revelations of Watergate, a coalition of organizations in California has set out to qualify a ballot initiative that would have profound effects on the electoral process in that state.

The effort is being spearheaded by the People's Lobby, the organization that sponsored the controversial "Clean Environment Act" in 1972. The Clean Environment Act was defeated by a massive \$2.6 million PR campaign waged by industry. This fact, say the leaders of People's Lobby, led the group to seek limits on campaign spending before having another go at a revised Clean Environment Act.

Specifically, the "Political Reform Initiative" would:

- limit the total amount of money that could be spent in a statewide election for any one office to \$1.2 million. That \$1.2 million would be divided between the candidates, with the incumbent restricted to 90 percent of what one of his challengers can spend;
- require all state and local decision-making officials to file annual financial statements;
- forbid lobbyists from making or arranging for political contributions and gifts to legislators whom they are lobbying;
- require complete auditing of campaign expenditures for all candidates in California;
- provide stiff civil and criminal penalties for violations.

Joining People's Lobby in the effort are Ralph Nader's California Citizen Action Group, Common Cause, the NAACP, and many other individuals and organizations.

Forest Service Winners and Sinners

No Reorganization, But Fewer Trees

There has been good news and bad news from the US Forest Service in recent weeks. In proper chronological order the good news, unfortunately, comes first.

On July 16, the Department of Agriculture announced that the Forest Service would not be closing some of its regional offices or readjusting its regional boundaries. Plans to do so had been announced by Secretary of Agriculture Earl L. Butz on April 24. Mr. Butz had announced that regional offices in Missoula (Montana), Ogden (Utah), and Albuquerque (New Mexico), and research station headquarters at Asheville (North Carolina) and Ogden would be closed and their regions absorbed into the Service's remaining regions. The Service's regions would then become the same as the administrative regions of the federal government's other agencies.

The realignment was hotly denounced by citizen conservationists, but Secretary Butz's July 16 announcement cited Senate Agriculture and Forestry Committee hearings held June 26 and 27 and the Administration's proposal for a Department of Energy and Natural Resources (DENR) as reasons for retaining the old alignment. At the hearings,

Congressional leaders voiced strong support for the old alignment. If the DENR is created, the Forest Service will be part of it; Secretary Butz implied that gerrymandering may still be in the Service's future after the DENR is set up. The present regional boundaries of the Service are more responsive to the large-scale geographical divisions of the US than they are to the bureaucratic nicety the proposed realignment would have served.

NATIONAL FORESTS UP FOR SALE (NOW MORE THAN EVER)

Once in every President's tenure, he turns silviculturist. Mr. Nixon's turn came in late July, when the White House's Office of Management and Budget issued its latest budget guidance for the Service. "Financial Planning Advice," an 85-page booklet sent to the Service's field offices, calls on the Service to concentrate on selling trees and getting them cut, even if other programs in the national forests must be postponed or cancelled. Chief of the Forest Service John McGuire said that the document represents his implementation of what the OMB wants the Service to do. He said that the budget does not include "everything we would like to do."

The document says, "In light of the current high demand for timber products for housing, etc., and the national economic importance of increased lumber and plywood production, you must make every effort to insure that these levels are met or exceeded." The levels referred to are those amounts of timber that may be cut — according to official guidelines — in the national forests during fiscal years 1973 and 1974. Many conservationists believe that the levels have been set some 11.8 billion board feet too high.

The document stresses that Forest Service monies be channelled towards timber sales, road construction, and other activities that relate directly to production of forest products, rather than towards recreation or research. The document suggests channelling monies towards "the largest timber producing forests and areas where [land use planning] must be done in response to high impact developments (e.g., oil, gas or coal; transmission lines; etc.). Defer routine planning or less critical areas...."

The new document establishes by administrative fiat some of the goals of S. 1775 and S. 1996, legislation now pending that would make timber production the dominant use of the national forests, in contravention of the Multiple Use and Sustained Yield Act of 1960. The Forest Service has openly opposed S. 1775.

New Bill For Tallgrass Prairie Introduced

Representative Larry Winn, Jr., (R-Kan.) has introduced a bill to create a Tallgrass Prairie National Park in Kansas. Representative Winn's bill, H.R. 9262, would create a national park of up to 60,000 acres in Kansas' Flint Hills. Legislation introduced earlier this year by Representative Joe Skubitz (R-Kan.) would preserve some tallgrass prairie as part of a Cherokee Strip National Historical Park to be located in Kansas and Oklahoma. Representative Skubitz's bill has yet to be acted on.

Representative Winn's bill has been strongly endorsed by Kansas conservationists, including Save the Tallgrass Prairie, Inc. (STP), and the Kansas Branch of FOE. Charles Strough, President of STP, commented on July 18th that, "both a Cherokee Strip Park and a Tallgrass Prairie National Park are needed to adequately portray and protect these two different, but significant aspects of our heritage." He suggested that the two parks would make "a fine birthday present to the nation in 1976, the bicentennial of our heritage as a nation, a heritage in which the prairie has played a great role." He urged Kansas' Congressmen and Senators to unite in sponsoring the formation of both parks.

The Highways' Last Hurrah

Highway Trust Fund Busted

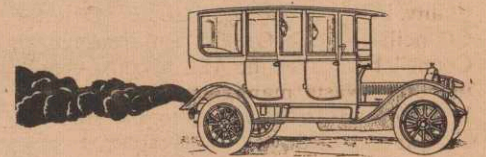
CAROL PARKER

After more than three months of intensive bargaining, the House-Senate conferees on the highway bill came to a compromise we didn't expect. Years of trying to overcome one of the most powerful special interest groups, the highway lobby, succeeded. The previously sacrosanct Highway Trust Fund was busted. Beginning in fiscal 1975, some of the \$6 billion-a-year Trust Fund can go for mass transit.

Although the need to implement the Clean Air Act and pressure caused by the "gas shortage" influenced the conferees to stop funding more highways and to divert some highway funds to mass transit, the compromise came as a surprise. During the three long months of deliberation in closed sessions, it appeared that a compromise would not be reached and that the bill would be dragged back to the floor for a third time.

THREE-YEAR WITHDRAWAL

Although the compromise is weaker than the original Senate-passed version, it marks the first time that Highway Trust Fund money has been made available for the construction of anything but highways. During the first year of the three-year compromise bill, the Highway Trust Fund monies will still go for



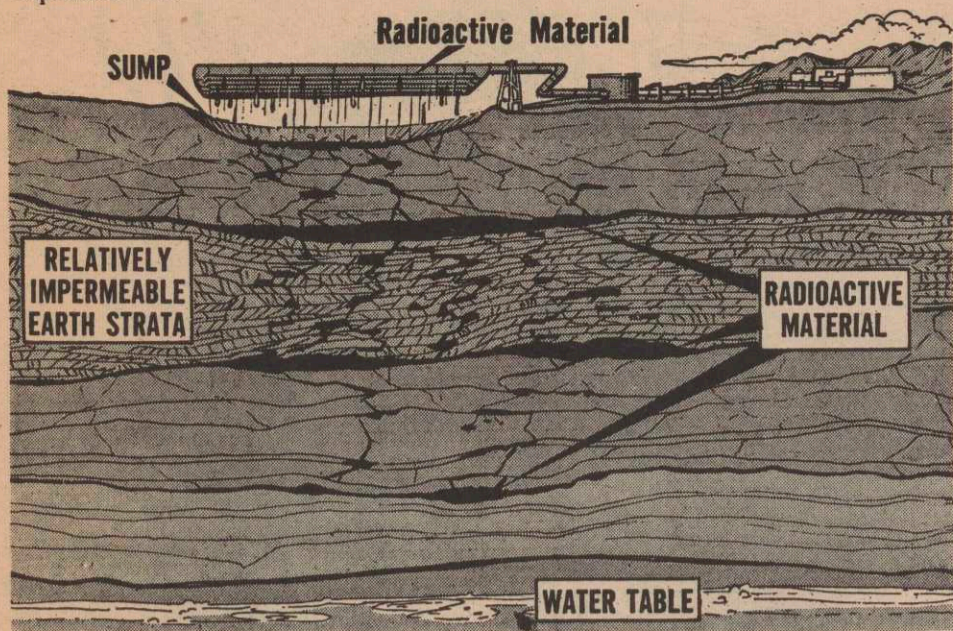
highways only, but, beginning with fiscal 1975, urban areas will have the option of using up to \$200 million of the \$800 million of urban systems money to purchase buses. In 1976, the entire \$800 million can be used for bus or rail mass transit. During the first two years, cities may return all or part of their urban systems money and request an equal amount from general revenue for bus or rail mass transit.

Another important provision of the compromise bill is one which funds mass transit through the Interstate System. A city, together with the governor of its state and the Secretary of Transportation, can decide to cancel a controversial Interstate segment which is not an essential link to the entire Interstate System. The city can then receive an equal amount of funds for bus or rail mass transit, but the money must come from general funds, not from the Highway Trust Fund.

Bicyclists and pedestrians also received a boost in the final bill, as conferees agreed to allocate as much as \$40 million a year for bikeways and walkways. The bill also includes a provision making bicycle safety a mandatory part of states' highway safety programs.

THE HABIT NOT ENTIRELY KICKED

Despite numerous gains, environmentalists were not overjoyed with the entire bill. Though the highways-only precedent of the Trust was broken, less than \$1 billion of the entire, three-year, \$20 billion bill will go for mass transit. Two environmentally destructive highways, the San Antonio Expressway and the Chicago Crosstown Expressway, will be completed without having to comply with the National Environmental Policy Act. In order to avoid a Presidential veto, an important Senate provision was deleted that would have authorized \$800 million over two years for urgently needed operating subsidies for mass transit. The bill also contains money for a new "junior interstate" system. This "Priority Primary System" could add 10,000 miles of new highways funded at the present Interstate 90-10 (federal-state) ratio and built to Interstate standards.



Radioactive wastes, disposed of by dumping into sump, approach the water table. Drawing from the Los Angeles Times, used by permission.

Glow On, Columbia Nuclear Wastes At Hanford May Irradiate Washington And Oregon

CATHERINE JOHNSON

The Atomic Energy Commission (AEC) maintains a Radioactive Waste Management Program on its 585-square-mile Hanford Reservation in south-central Washington. Bordered on two sides by the Columbia River, the reservation is the storage and disposal site for approximately 75 percent of the accumulated radioactive wastes in the United States. The Committee for Nuclear Responsibility, FOE, the Natural Resources Defense Council, and the Oregon Environmental Council, have taken the AEC to court, charging that "waste management practices at Hanford unlawfully fail to provide an adequate margin of safety against contamination of the environment and pose unacceptable risks."

Plutonium — which in addition to being the world's most carcinogenic substance and requiring 500,000 years of isolation before it can be safely allowed into the biosphere — has been dumped *directly* into open-bottom trenches at Hanford. The AEC spokesmen have admitted that "due to the quantity of plutonium contained in the soil of [trench] Z-9, it is possible to conceive conditions which could result in a nuclear chain reaction." Robert C. Scott, of the Environmental Protection Agency's water program, states that the "heat from the chain reaction would cause the trench to explode like a mud volcano," venting lethal plutonium into the area, which includes the tri-cities of Richland, Kennewick, and Pasco.

More than a million gallons of plutonium-contaminated waste are dumped each year into trenches like Z-9. Lined top and sides with concrete, the bottomless trenches allow the liquid to seep into the soil. Since plutonium does not dissolve in alkaline water like that at Hanford, the AEC assumed that the wastes would not percolate through the soil and thence to the water table and eventually to the Columbia River. The AEC was at

first reassured by its monitoring devices that its system was foolproof, but more sophisticated equipment introduced in 1971 indicated that trench Z-9 contained far more plutonium than was thought. A heavy snowfall and rapid thaw could flood the trenches, rearranging the plutonium into a configuration that would support a chain reaction.

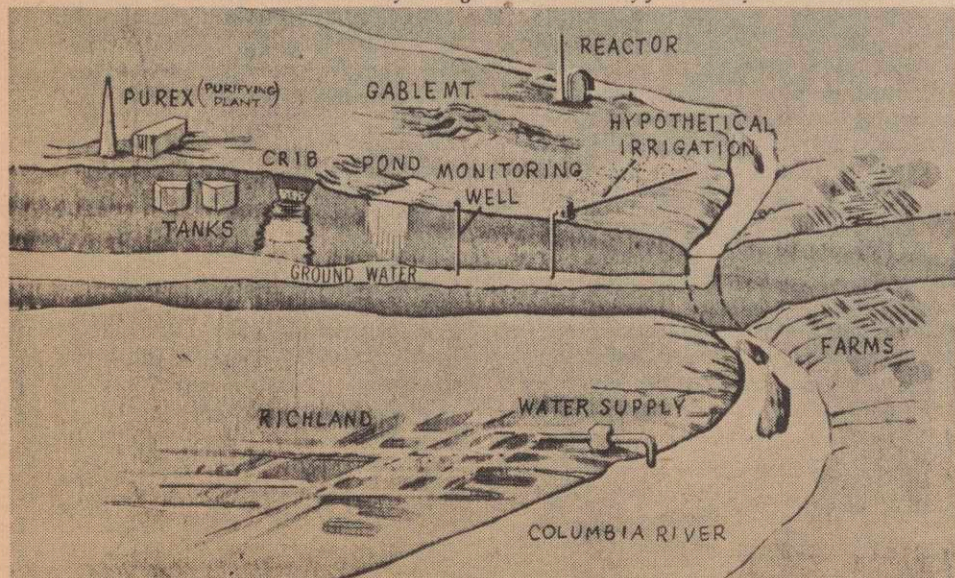
Nor can the AEC safely assume that the alkaline water of the Hanford area will always remain alkaline. Irrigation, industrial waste from non-nuclear plants, or septic tanks in rural subdivisions could make the water of the area more acidic or more highly saline, either of which could spell disaster.

Another problem — as if another were needed — is the leaking of high-level corrosive wastes from underground storage tanks, contaminating the soil further. During June of this year, the biggest leak to date allowed 115,000 gallons to escape over the period of one month before the AEC discovered and stopped it. Most tanks at Hanford are old and badly corroded. A total of 16 leaks have released over 400,000 gallons and thousands of curies of radioactivity into the soil. The AEC's theories notwithstanding, radioactivity has been detected in the Columbia River.

In considering better methods of short-term and long-term (read: permanent) storage of intermediate and high-level nuclear wastes, the AEC has compiled two lists of possible options; some are so common-sense (i.e., using stainless rather than the cheaper but less permanent carbon steel for tanks) that the AEC has no excuse for not having already done so; and others — most of the long-term options — are frightening and/or fantastic. Some of the latter include very deep injection into the core of the continent; burial in the Antarctic ice; disposal in underground caverns to be created by nuclear bombs; and disposal below a tectonic plate by placing wastes along the line where one of the plates of earth's mantle is sinking beneath an adjoining plate near the West Coast.

The FOE lawsuit is designed to force the AEC to prepare an environmental impact statement on its Waste Management Program; and certainly, if the Commission is seriously considering some of the options outlined above, they should be included in the statement. But you can bet the penguins won't have a chance to comment on the draft statement.

Ground water doesn't stay underground. It eventually finds its way to the Columbia River.



The Navy's Petroleum Reserves May Be Opened

Second Arctic Pipeline So Soon?

Reliable sources report that a second pipeline from Alaska's North Slope is already being planned, before Congress's votes on the trans-Alaska pipeline have even become cold. It is rumored that Senator Walter F. Mondale (D-Minn.) plans to introduce legislation during September that will open Naval Petroleum Reserve Number 4 (Pet 4) to exploration by commercial oil companies. If exploitable oil were found, it would be brought out through a pipeline that would cross the eastern Brooks Range below the Arctic National Wildlife Range. It would, therefore, cross the route of the trans-Alaska pipeline.

Pet 4, which covers 23,680,000 acres, lies west of Prudhoe Bay on the North Slope. The US Navy, which owns Pet 4, explored for oil there between 1944 and 1953. At that time, it was thought that what oil was found was not commercially exploitable. Representative Edward Hebert (D-La.) has said in the past that Pet 4 should be reserved solely for military uses.

New Moves to Ease The Gas Crisis

Nationalization Ahead?

It looks as though the oil industry stampeded Congress on the pipeline issue just in time. In a few months (weeks? . . . years?), there might not be an oil company powerful enough to twist arms anymore.

Public outrage over the "gas crisis" has begun to escalate as reports of shortages flood the papers. The crisis has hit Colorado especially hard, and many unsuspecting tourists have been stranded for days attempting to find an open station and then spending hours in line for fuel for their giant Winnebagos.

Litigation has kept pace with public opinion. Several new anti-trust suits have been filed. In Brooklyn, New York, a group of corporations and a number of individuals have filed a \$54 billion class action, antitrust suit in the name of consumers, charging that the defendants — Gulf, Exxon, Texaco, Shell, and Mobil — have been overcharging at least \$2 billion a year for the last four years.

In California, consumer advocate and Chairman of the State Board of Equalization, William Bennett, urged that the State of California itself go into the oil business as a means of solving California's fuel shortage. If California began selling gasoline, Mr. Bennett opined, "Then you'd see the oil companies start supplying the public."

The government's attempts to save the independents' skins from the teeth of the majors' virtual monopoly on supply by a voluntary petroleum allocation program have not worked. John A. Love, the White House energy chief, admitted that "There has been a noticeable deterioration in the compliance of most oil companies in the past two or three weeks. Some companies have given formal notice that they do not intend to comply further with the voluntary petroleum allocation program." Mr. Love hinted that a mandatory allotment system is just around the corner. In an interesting footnote to the Pipeline/Gas Crisis question, Mr. Love pointed out that even if the pipeline is built, the shortage will continue. The problem, he implied, is not (and has never been, we would add) one of supply, but one of demand.

There are signs, however, that a more far-reaching legislative solution to the problem may be upcoming. Senator James Abourezk (D-S.D.) and Representative Les Aspin (D-Wisc.) have introduced legislation that would permit any single oil company to operate in only one of four phases of the industry: production, refining, transportation by pipeline, or marketing. As yet, of course, not much action has been taken, but even if their

proposal turns out to be merely symbolic, it is at least an omen of things to come.

Standard Oil, perhaps just a bit nervous about its own sources of supply, sent out a controversial letter to its stockholders and employees, urging them to support "the aspirations of the Arab people," and "their efforts toward peace in the Middle East." Something more than international altruism motivated Standard, however. Standard obtains 61 percent of its crude oil from Iran and Saudi Arabia.

The outcry was immediate and vigorous, especially from Jewish leaders, who noted that the "aspirations of the Arab people" frequently include driving the Israelis into the sea. Standard's headquarters in Los Angeles acquired a partial, but eloquent, new coat of red paint, and there was talk of a boycott of Standard's products. Standard backed down quickly, assuring the public that the rights and sovereignty of Israel must, of course, be part of a just settlement of the Arab-Israeli standoff.

New FOE Legal Unit Sues EPA

New York Clean Air Delay Challenged

A suit has been filed in the US Court of Appeals in New York by Citizens for Clean Air, FOE, Natural Resources Defense Council, and a large number of individuals who reside in the New York City area, seeking to overturn the Environmental Protection Agency's (EPA) grant to New York City of a 19-month extension of the May 31, 1975 deadline for meeting federal air quality standards.

The Clean Air Act of 1970 required every state to submit an implementation plan capable of meeting the primary and secondary air quality standards. Certain heavily polluted urban areas — like New York — will require, in addition to federal emission controls, a transportation control strategy in their plans.

New York City's transportation plan was approved by the EPA — a mistake, we believe — and an extension was granted on the basis of its plan to reduce pollution by controlling traffic. The EPA gave New York City until December 31, 1976 to comply with the air standards.

In opposing the extension, Avis Ogilvy, Chairperson of FOE's New York Branch, noted that the delay will mean that New York City will fall short of federal air quality standards for both carbon monoxide and hydrocarbons by about 25 percent by May 31, 1975 — the original deadline. "This is hardly an insignificant amount," Ms. Ogilvy pointed out, "especially when one considers that the standards were set on the basis of what is 'requisite to protect the public health.'"

FOE also claimed that the individual control measures proposed in the plan simply won't do the job. Ms. Ogilvy explained that "Inadequate government funds, less than whole-hearted enforcement, and individual resistance to required changes in transportation habits might all work to subvert the plan's goals. FOE wants to be sure that the plan will accomplish the necessary clean-up."

New York City and the EPA have also failed to give sufficient consideration to other means of reducing traffic. FOE recommends a freeze on gasoline sales to 1972-73 levels — a measure EPA has proposed for other metropolitan areas, including Los Angeles, Philadelphia, Pittsburg, and northern New Jersey — as one potentially useful "back-up" measure.

Among the alternatives EPA will be asked to consider are: (a) ending commuter discounts on toll bridges; (b) raising the tolls on bridges for private vehicles occupied only by the driver and lowering the tolls for car pools; (c) sharply reducing or eliminating subway fares.

The suit is the first court challenge of a transportation control plan, and has got a surprising amount of coverage in New York and Washington newspapers. FOE's legal director, Robert Rauch, recently debated John Quarles, the acting administrator of EPA, on the "CBS Morning News" television show. Our east coast media consultant — possibly not the most objective audience — reported that, "We creamed them."

House Okays Alaska Pipeline

Congress Stampedes; "Ecology Be Damned"

GEORGE ALDERSON

The oil companies have succeeded in obtaining Congressional approval for the Alaska pipeline. Although the final details will not be settled until Congress re-convenes on September 5 and a conference committee can meet, both the House and Senate are in agreement on two major issues: (1) to let the Alaska pipeline go ahead, without prior consideration of alternative routes through Canada, and (2) to cut off litigation under the lawsuit of the Environmental Defense Fund, Friends of the Earth, and The Wilderness Society.

This decision came about in spite of a major campaign by FOE and many other citizen groups. The reason for the oil companies' success is basically that Members of Congress are afraid of being blamed by the voters for oil shortages, either now or in the future. Even though most Congressmen and Senators are from regions of the country that will not receive any oil from the Alaska pipeline, the average Congressman either consciously or unconsciously realizes that the oil companies are well equipped to stimulate opposition at election time, accusing him of fostering shortages by not voting for the Alaska pipeline. To drive the point home, some oil-company ads appeared this summer in selected Congressional districts, in the form of an open letter to the local Congressman, arguing that the oil companies are doing their best to meet the shortages.

★ **What You Can Do:** The scare tactics of the oil companies must be met by informed action of constituents, reacting to the Congressman's votes on the pipeline bill. It is essential to success on future environmental issues to write to your Congressman now, praising or criticizing, as appropriate. Key votes are shown below. (Your Congressman can be addressed at House Office Building, Washington, DC 20515.)

COMMITTEE TAKES UP THE BILL

The action on the House side began promptly after the Senate passed the pipeline bill on July 13, after adopting the Gravel Amendment to bar judicial review on a tie vote of 49-49, broken by Vice President Agnew, who voted in favor of the amendment. The House Public Lands Subcommittee began mark-up sessions the following Monday, July 16, taking up the bill introduced by the subcommittee chairman, Congressman John Melcher (D-Mont.) — summarized by the *Anchorage Daily Times* as a bill to "authorize construction of the pipeline, ecology be damned." The Melcher bill contained the controversial NEPA-override provisions, like the Gravel Amendment barring further judicial review of the pipeline under the National Environmental Policy Act. This provision was designed to put a stop to the lawsuit of the Environmental Defense Fund, FOE, and The Wilderness Society, which has stopped the project since 1970 because it was found in violation of NEPA and the 1920 Mineral Leasing Act.

THE NEPA ISSUE

The principal objective of environmentalists in the full committee mark-ups was to remove the NEPA override. Congressmen John Dellenback (R-Ore.) and Wayne Owens (D-Utah), both supporters of the Alaska pipeline, prepared a package of amendments to do this. Intensive efforts were made by FOE and other groups in the Alaska Public Interest Coalition to obtain support from committee members. After short mark-up sessions on July 18 and 20, the amendment was first offered on July 23. It was defeated, 18-20, but preparations began to try again the next day, focussing on the absentees and possible converts. The oil companies also focussed on targets they thought vulnerable.

Even before the day was out, FOE received a call from the staff of Congressman Antonio Won Pat (D-Guam), to the effect that the Congressman had wired instructions to Chairman Melcher to vote his proxy for the Dellenback-Owens amendment, instead of against it, as had happened on the first round. This change would tie the vote at 19-19.

But when the vote came up the next morning, Mr. Melcher did not vote Mr. Won Pat's proxy at all. In addition, two supporters of the Dellenback amendment dropped away — Manuel Lujan (R-N.M.) was absent, and Paul Cronin (R-Mass.) switched to opposition. The result was another defeat, 17-19.

On July 24, at 7:05 p.m., the committee

ordered the bill reported to the floor. The normal legislative obstacles disappeared as if beneath a steamroller, despite the best efforts of several Congressmen to gain time for more thorough consideration by the House. The oil companies and the Nixon Administration obviously wanted it settled before the August recess, in case more embarrassing facts were going to come to light. The State Department fiasco was problem enough; any major discoveries of collusion among the oil companies might have stopped the pipeline dead, if they had come at the right time.

THE FLOOR FIGHT

In the eight days available to prepare for the House floor debate, citizen groups put primary emphasis on the Dellenback-Owens amendment, judging that it had the greatest chance of success. Even supporters of the Alaska pipeline could vote for it. The additional objective was to pass the amendment providing for a decision by Congress after final studies of the Canadian alternative routes. FOE lobbyists joined with spokesmen from other groups to make a complete canvass of the House. Almost half the Congressmen were visited twice, the second visit providing more specific information to answer the legislators' expressed concerns.

Debate on the pipeline bill began about noon on August 2. After two hours of general debate, consideration of the amendments began. The first environmental amendment was offered by Congressman John D. Dingell (D-Mich.), in the section of the bill affecting all future oil and gas pipelines. His amendment was to prohibit the use of any national park or monument, national wildlife refuge, or wilderness area as a right-of-way for oil and gas lines, unless the Secretary of the Interior determines that there is no prudent and feasible alternative. The amendment was defeated by a recorded vote of 160-261.

The Dellenback-Owens amendment was the next major amendment. Its significance was highlighted by its opponents. Shortly before the vote, Speaker Carl Albert, from the oil state of Oklahoma, read aloud a letter from President Nixon urging support of the pipeline and containing clearly implied opposition to the Dellenback-Owens amendment. Then the powerful Chairman of the Rules Committee, Ray Madden (D-Ind.), called for approval of the pipeline (although he did not mention the NEPA issue, his remarks tended to identify him with the opposition). The amendment was defeated, 198-221. It would have taken a shift of just 12 votes to pass it. (The vote is shown in the accompanying chart.)

The amendment to provide for final study of the Canadian alternative and a decision by Congress upon its completion was offered by Congressman Morris K. Udall (D-Ariz.) and defeated on a non-record voice vote.

On final passage of the bill, 60 Congressmen showed their dissatisfaction by voting against it, in spite of potential oil-company reprisals. The vote was 356-60.

THE SITUATION

As this goes to press, environmental lawyers are studying the language of the Senate and House bills to determine whether litigation may still be possible on certain aspects of the pipeline issue. At stake is not only initiation of the pipeline, but enforcement of the conditions imposed on the builders, and enforcement of safety provisions when the pipeline is in operation. A further report will appear in a forthcoming issue of NMA.

George Alderson is Legislative Director of Friends of the Earth in Washington, DC. During the pipeline fight he has also served as coordinator of the Alaska Public Interest Coalition, a clearinghouse for labor, consumer, and environmental organizations opposing the Alaska pipeline.



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State Department Lied to Congress On Pipeline

Recent revelations indicate that the US Department of State deliberately misled the Congress with respect to the Canadian Government's attitude toward bringing Prudhoe Bay oil to the US through Canadian territory.

The chronology goes something like this:

—On June 1, Representative John Melcher (D-Mont.) asked the State Department to find out what the Canadian Government thought about a pipeline across Canada.

—On June 14, the American Embassy in Ottawa sent two long telegrams to State Department headquarters in Washington, outlining the Canadian attitude as derived from conversations with various Canadian officials.

—On June 20, Senator Henry Jackson (D-Wash.) inserted himself into the issue and wrote to the State Department asking about the Canadians' attitude, demanding an answer by June 25.

—On June 22, the State Department wrote to Mr. Jackson and Mr. Melcher stating that the Canadian government was not interested in negotiating about pipeline permits and was continuing to demand 51 percent ownership of any pipeline through their territory.

—On June 27, a written statement of the Canadian position was given to the American Embassy in Ottawa.

—On July 6, after an inexplicable delay of one week, the Canadian Chargé d'Affaires confronted State Department officials, asking why the summary of the Canadian position had not been sent to Congress and protesting the inaccuracy of State's June 22 letter. The document, containing answers to a series of questions posed by the US Department of State, makes it clear that the Canadian government is very interested in entertaining applications for pipeline permits and says that the Canadians would not require majority ownership of any pipeline. It also states that the maximum time necessary for completion of a Canadian line would be much less than the time spokesmen for the US Interior Department and Aleyka have claimed. On the same day, the Canadian Energy Minister made a

speech on the floor of the Canadian House of Commons, charging that the US State Department was suppressing the letter outlining the Canadian Government position.

—On July 7, the State Department sent the documents outlining the Canadian attitude to Congress.

—On July 16, The Wilderness Society, the Environmental Defense Fund, and FOE wrote to Congressman Melcher claiming that the State Department had deliberately misled the Congress with its June 22 letter.

—On July 17, the same groups wrote to Mr. Melcher again, enclosing copies of the June 14 telegrams, which by then had come into our possession. Congressman Melcher responded that he would consider scheduling hearings to investigate the matter further.

—On July 17, Senators Mondale and Jackson made speeches on the Senate floor accusing the State Department of playing fast and loose with the Canadian communications, but their warnings fell on deaf ears.

—On July 23, Senator Mondale pursued the matter in testimony before Senator Fulbright's Foreign Relations Committee. It is hoped that Senator Fulbright will follow up with further hearings.

(As background, it was confirmed by Representative Donald Fraser [D-Minn.], during House debate on the pipeline, that then Undersecretary of State John N. Irwin II called the Canadian Ambassador, Marcel Cadieu, into his office on May 11, 1973, and politely told him to shut up about the Canadian route. The US government, explained Mr. Irwin, had decided on the trans-Alaska route, and further interest in the matter from Canadian sources might make it difficult to get the Alaska route approved.)

The fight is not yet over. As lawyers deliberate future legal maneuvers, conservation forces in Washington are trying to keep the pressure on to convince Congress to reopen the pipeline debate. No one knows what other skullduggery lies buried in whose files, but no one doubts that there is more — much more.

★ **What You Can Do:** Write to your Senators and Congressman and ask them to demand further hearings on the State Department's mishandling of the Canadian information

"SAVE NEPA" Amendment (Dellenback)

The environmental vote is "Aye"

The vote was taken by electronic device, and there were—ayes 198, noes 221, not voting 14, as follows:

[Roll No. 420]

AYES—198

Abzug	Fraser	Pike
Adams	Frelinghuysen	Podell
Anderson, Calif.	Frenzel	Preyer
Anderson, Ill.	Frey	Price, Ill.
Andrews, N.C.	Fuqua	Pritchard
Andrews, N. Dak.	Gaydos	Qule
Annunzio	Gibbons	Railsback
Ashley	Gilman	Rangel
Aspin	Grasso	Rees
Badillo	Green, Pa.	Regula
Bafalis	Griffiths	Reid
Bell	Grover	Reuss
Bennett	Gunde	Riegle
Bergland	Gunter	Rinaldo
Biaggi	Hamilton	Robison, N.Y.
Blester	Hanley	Rodino
Bingham	Hansen, Idaho	Roe
Blatnik	Harrington	Roncallo, N.Y.
Boggs	Harsha	Rooney, Pa.
Boiland	Harvey	Rosenthal
Brademas	Karch	Rostenkowski
Brasco	Heckler, W. Va.	Roush
Breckinridge	Heinz	Roybal
Brinkley	Helstoski	Ruppe
Brown, Calif.	Holtzman	Ryan
Brown, Mich.	Horton	St Germain
Buchanan	Howard	Sarasin
Burke, Calif.	Hungate	Sarbanes
Burke, Mass.	Jordan	Saylor
Burlison, Mo.	Karsh	Schroeder
Burton	Kastenmeier	Seiberling
Carey, N.Y.	Kemp	Shoup
Carney, Ohio	Koch	Staggers
Chisholm	Kyros	Stanton
Clay	Leggett	J. William
Cohen	Lehman	Stanton
Collins, Ill.	Lent	James V.
Conte	Long, Md.	Stark
Conyers	Lujan	Steele
Cotter	McClary	Steiger, Wis.
Coughlin	McCloskey	Stokes
Cronin	McDade	Studds
Culver	McKinney	Sullivan
Danielson	Macdonald	Symington
Dellenback	Madigan	Taylor, N.C.
Dellums	Mailliard	Thompson, N.J.
Denholm	Mallory	Thomson, Wis.
Dent	Mann	Thone
Derwinski	Matsunaga	Thornton
Diggs	Mayne	Tierman
Dingell	Mazzoli	Udall
Donohue	Mezvinisky	Van Deerlin
Drinan	Minish	Vander Jagt
Dulski	Mink	Vanik
Duncan	Mitchell, Md.	Vigorito
du Pont	Mitchell, N.Y.	Waldie
Eckhardt	Moakley	Whalen
Edwards, Ala.	Moorhead, Pa.	Winn
Edwards, Calif.	Mosher	Wolf
Esch	Moss	Wylder
Evans, Colo.	Murphy, Ill.	Yates
Fasell	Nedzi	Yatron
Findley	Nix	Young, Fla.
Fish	Obey	Young, Ga.
Flood	O'Hara	
Foley	O'Neill	
Ford	Owens	
William D.	Patten	

NOES—221

Abdnor	Green, Oreg.	Perkins
Addabbo	Gross	Pettis
Alexander	Gubser	Peyster
Andrews, N.C.	Guyer	Pickle
Archer	Haley	Poage
Arends	Hammer-	Powell, Ohio
Armstrong	schmidt	Price, Tex.
Ashbrook	Hanrahan	Quillen
Baker	Hansen, Wash.	Randall
Barrett	Hastings	Rarick
Beard	Hawkins	Rhodes
Bevill	Hébert	Roberts
Blackburn	Henderson	Robinson, Va.
Bolling	Hicks	Rogers
Bowen	Hill	Roncallo, Wyo.
Bray	Hinshaw	Rose
Breaux	Hogan	Rousselot
Brooks	Hollifield	Runnels
Broomfield	Holt	Ruth
Brotzman	Hosmer	Sandman
Brown, Ohio	Huber	Satterfield
Broyhill, N.C.	Hudnut	Scherle
Burgener	Hunt	Schneebell
Burke, Fla.	Hutchinson	Sebelius
Burlison, Tex.	Ichord	Shipley
Byrd	Johnson, Calif.	Slack
Byrler	Johnson, Colo.	Shuster
Byron	Johnson, Pa.	Sikes
Camp	Jones, Ala.	Sisk
Carter	Jones, N.C.	Skubitz
Casey, Tex.	Jones, Okla.	Slack
Cederberg	Jones, Tenn.	Smith, N.Y.
Chamberlain	Kazen	Snyder
Chappell	Keating	Spence
Clancy	Ketchum	Steed
Clark	Kluczynski	Steinman
Clausen	Kucykowski	Steiger, Ariz.
Clawson, Del	Landrum	Stephens
Don H.	Latta	Stratton
Clawson, Del	Litton	Stubblefield
Cleveland	Long, La.	Stuckey
Cochran	Lott	Symms
Collier	McCullister	Talcott
Collins, Tex.	McCormack	Taylor, Mo.
Conable	McEwen	Teague, Calif.
Conlan	McFall	Teague, Tex.
Corman	McKay	Towell, Nev.
Crane	McKinney	Treen
Daniel, Dan	McSpadden	Ullman
Daniel, Robert	Madden	Veyssey
W. J.	Mahon	Waggonner
Daniels	Maraziti	Wampler
Dominick V.	Martin, Nebr.	Ware
Davis, Ga.	Martin, N.C.	White
Davis, S.C.	Mathias, Calif.	Whitehurst
Davis, Wis.	Mathias, Ga.	Whitten
de la Garza	Meeds	Widnall
Delaney	Melcher	Williams
Dennis	Metcalfe	Williams
Devine	Michels	Wilson
Dickinson	Miller	Charles H., Calif.
Dorn	Minshall, Ohio	Wilson, Charles, Tex.
Downing	Mizell	Wright
Edwards, Ala.	Mollohan	Wyatt
Eshleman	Montgomery	Wylie
Flowers	Moorhead, Calif.	Wyman
Flynt	Ford, Gerald R.	Young, Alaska
Ford, Gerald R.	Forsythe	Young, Ill.
Forsythe	Fontana	Young, S.C.
Frank	Fontana	Young, Tex.
Frederick	Froehlich	Zablocki
Fulton	Fulton	Zion
Gettys	Gaiamo	
Ginn	Ginn	
Goldwater	Goldwater	
Gonzalez	Gonzalez	
Goodling	Goodling	
Erlenborn	Jarman	Rooney, N.Y.
Evins, Tenn.	King	Smith, Iowa
Fisher	Landgrebe	Wilson, Bob
Gray	Mills, Ark.	Zwach
Hanna	O'Brien	

So the amendment was rejected.

Park and Refuge Protection Amendment (Dingell)

The vote was taken by electronic device, and there were—ayes 160, noes 261, not voting 12, as follows:

[Roll No. 419]

AYES—160

Abzug	Ford	Pike
Anderson, Calif.	William D.	Podell
Anderson, Ill.	Fraser	Preyer
Andrews, N.C.	Frenzel	Price, Ill.
Andrews, N. Dak.	Gaydos	Pritchard
Annunzio	Gibbons	Qule
Ashley	Gilman	Randall
Aspin	Grasso	Rangel
Badillo	Green, Pa.	Rees
Bafalis	Griffiths	Reid
Bell	Grover	Reuss
Bennett	Gunde	Riegle
Bergland	Gunter	Rinaldo
Biaggi	Hamilton	Robison, N.Y.
Blester	Hanley	Rodino
Bingham	Hansen, Idaho	Roe
Blatnik	Harrington	Roncallo, N.Y.
Boiland	Harsha	Rooney, Pa.
Brademas	Harvey	Rosenthal
Brasco	Heckler, W. Va.	Roush
Breckinridge	Heinz	Roybal
Brinkley	Helstoski	Ruppe
Brown, Calif.	Holtzman	Ryan
Brown, Mich.	Horton	St Germain
Brown, Ohio	Howard	Sarasin
Buchanan	Hungate	Sarbanes
Burke, Calif.	Jordan	Saylor
Burke, Mass.	Karsh	Schroeder
Burton	Kastenmeier	Seiberling
Carey, N.Y.	Kemp	Shoup
Carney, Ohio	Koch	Staggers
Chisholm	Kyros	Stanton
Clay	Lehman	J. William
Cleveland	Lent	Stanton
Cohen	Long, Md.	James V.
Collins, Ill.	Lujan	Stark
Conte	McClary	Steele
Conyers	McCloskey	Stokes
Cotter	McDade	Studds
Coughlin	McKinney	Sullivan
Culver	Macdonald	Symington
Dellums	Madigan	Taylor, N.C.
Denholm	Mailliard	Thompson, N.J.
Diggs	Mallory	Thomson, Wis.
Dingell	Mann	Thone
Donohue	Matsunaga	Tierman
Drinan	Mayne	Udall
Dulski	Mazzoli	Van Deerlin
du Pont	Mezvinisky	Vander Jagt
Eckhardt	Minish	Vanik
Edwards, Calif.	Mitchell, Md.	Vigorito
Esch	Moakley	Waldie
Evans, Colo.	Moorhead, Pa.	Whalen
Fish	Mosher	Wolf
	Moss	Wylder
	Murphy, Ill.	Yates
	Nedzi	Yatron
	Nix	Young, Fla.
	Obey	Young, Ga.
	O'Hara	
	O'Neill	
	Owens	
	Patten	
	Pickle	

NOES—261

Abdnor	Brooks	Clausen
Adams	Broomfield	Don H.
Addabbo	Brotzman	Clawson, Del
Alexander	Broyhill, N.C.	Cochran
Archer	Broyhill, Va.	Collier
Arends	Burgener	Collins, Tex.
Armstrong	Burke, Fla.	Conable
Ashbrook	Burlison, Tex.	Conlan
Baker	Burlison, Mo.	Corman
Barrett	Butler	Crane
Beard	Byron	Cronin
Bell	Camp	Daniel, Dan
Bevill	Carter	Daniel, Robert
Blackburn	Casey, Tex.	W. J.
Boggs	Cederberg	Daniels
Bolling	Chamberlain	Dominick V.
Bowen	Chappell	Danielson
Bray	Clancy	Davis, S.C.
Breaux	Clark	Davis, Wis.

So the amendment was rejected.

FARTHEST NORTH: ALASKA REPORT

By Jim Kowalsky

ALASKA NATIVES REBEL AGAINST THE PIPELINE

The Board of Directors of Doyon Limited, a native corporation of 31 villages in central Alaska, has raised speculations and some anger by its statement of unanimous opposition to the trans-Alaska pipeline. Doyon is the profit arm of the Tanana Chiefs Conference, the largest of the 12 regional corporations created under the Alaska Native Claims Settlement Act. Ten thousand natives live within Doyon's region, which reaches from the Yukon Territory, on the eastern boundary, to the crest of the Brooks Range in the Arctic, to beyond the Alaska Range on the southern boundary, and far into the western reaches of Alaska.

The action is confusing. Doyon's own president is heavily involved in State and native politics and has, with Doyon's executive director and other natives, been in Washington lobbying for the pipeline. At first glance, the Doyon Board of Directors seems to be vying for a better position for employment of natives by the Alyeska Pipeline Service Company. Their statement says, "All employment [on the pipeline] will be through unions. Only 1 percent of [native] workforce belongs to these unions."

But the statement goes much farther: "The catastrophic effect of the pipeline and the influx of outsiders coupled with the lack of protection of existing subsistence hunting and fishing and employment guarantees were overriding reasons for opposing the pipeline ... (and) the Board of Directors ... has voted unanimously to oppose ... construction of ... all roads west and north of Fairbanks" (emphasis added). "An influx of outsiders who take over the land [leaves] the native people in a worse situation than before because their subsistence hunting and fishing have disappeared." Clearly this is something more than mere opposition to the pipeline.

It is curious that urban native leaders have been lobbying for the very deprivations that their rural subsistence-oriented constituents explicitly fear. Maybe it isn't so curious: the cash settlement provisions of the Native Claims Act guarantees the corporations some \$500 million to be paid from mineral production royalties.

However, Doyon's board has clearly said, "The possible monies we, as a corporation, will receive from the royalty of the oil from the North Slope will in no way compensate for the existing life-style of our people. Our people must continue to live off the land for years to come. ... It matters little to us that other people may need jobs and fuel for their cars at the expense of over-running our villages with caterpillar tractors, trucks, and pipes."

ROAD BUILDING AND MINING IN GLACIER BAY?

Mines and roads in Glacier Bay National Monument? That's the big question, and everyone who has tried to find an answer has drawn a blank.

This is the situation: there is a body of copper-nickel sulfides within the Monument that might be able to produce over 100 million tons of ore. (In 1970, the US consumed 155,719 tons of nickel, but produced only 15,319 tons domestically.) Newmont Mining Company holds claims on part of the Glacier Bay ore, and would like to mine it. In 1936, Congress enacted legislation that left the Monument open to mining, but not to road construction. The National Park Service admits that Newmont wants a transportation route (i.e., roads) from tidewater to the mine site, under Brady Glacier. Newmont may also want a concentrator site, tailing dumps, and docking and dormitory facilities within the Monument. Newmont may be trying to negotiate with the Service to develop such a proposal but has made no official proposal;

they may be trying to operate out of public scrutiny.

Meanwhile, the Park Service has fielded its own team to assess biological and other values along the routes that Newmont has said it wants to use. The Service wants a strong position when negotiations officially begin, and wants information for the environmental impact statement that would have to be filed for any mining project.

The Revised Draft Environmental Impact Statement for a Wilderness Proposal for Glacier Bay gives a few clues to what's going on. For example, the Service takes a wishy-washy stand on whether or not to buy out the mining claims, or to allow mining in the Monument. The statement does, on the other hand, point out that developing resources on National Park Service lands is inconsistent with the organic act legislation that created the Service in 1916. The statement also says that using existing air and water access to the ore bodies is preferable to developing roads, and it rejects constructing a spur into the Monument from the proposed Juneau-to-Haines Highway.

Knowing some of the games the National Park Service has played in the past with concessioners and developers, I requested to be present at any meeting of the field team with the industry. A representative of citizen public interest should get in on the ground floor; put bluntly, the National Park Service needs to be kept honest. It may need outside support to stand tall in the face of industry pressures.

FOE's position would be that it would be an all-time tragedy to scar this roadless, coastal, mountain-glacier wilderness. Visitors now arrive to tour the 2,803,642-acre Monument entirely by air and travel by boats along its breath-taking bay and inlet coastline. Former National Park Service Director George Hartzog strongly opposed a road; the Service and the Interior Secretary should use all laws available to prevent such roads.

★ What You Can Do: Letters are needed to Ronald Walker, Director, National Park Service, US Department of the Interior, Washington, DC 20240. Tell him that: 1) More support is necessary for the Service's field team to continue its baseline research; 2) Newmont should use helicopters for all exploratory tests on their claim — no roads should be allowed for this; 3) If the ore body proves economical to mine, and mining proves necessary, railroads and various aerial methods should be strongly considered as alternatives to roads; 4) If mining does take place, all impact from any mining project in the Monument should be minimized.

DOES E. HOWARD HUNT RUN ALPS'S P.R.?

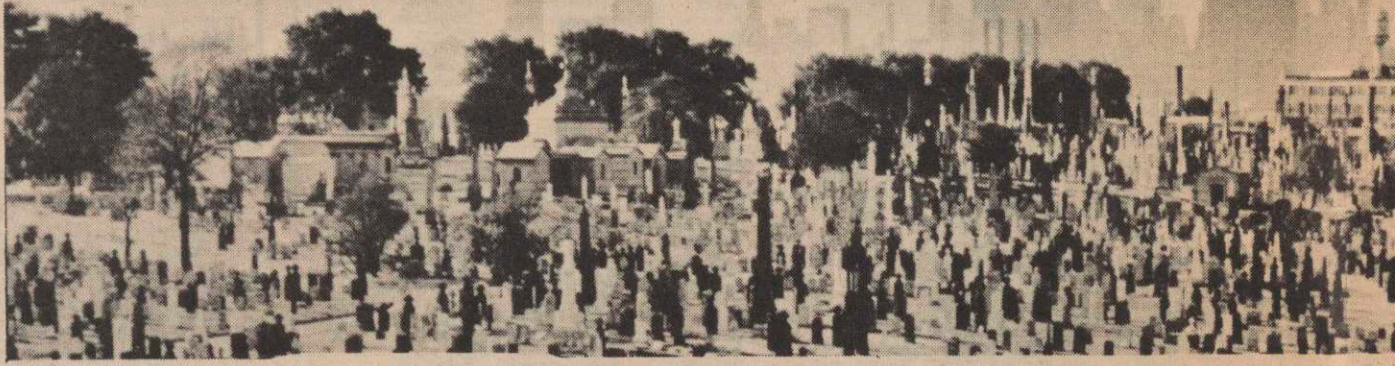
For years, the oil pipeline consortium in Alaska has insisted that it can safely build and operate a hot oil pipeline across Alaska. But the consortium — Alyeska Pipeline Service Company (ALPS) — has already spilled considerable amounts of fuel oil even before it has begun to lay pipe. In some cases, no one has even determined where the leaked oil escaped to.

Our earlier report on Alyeska's Happy Valley Construction Camp was incorrect; it has been the site of not two, but three diesel oil spills since 1970. Operation of Happy Valley is subcontracted by Alyeska to a Seattle firm, and it is run with the sloppiness and carelessness that make people who care what happens to fragile, unspoiled Alaska shudder at the pipeline project.

Since the May, 1973, spill of 8,000 gallons was reported, Happy Valley has become almost an armed camp. Visitors are all but run off, the personnel are defensive, and the superintendent (who, we hear, spilled the fuel in the first place), seems paranoid. New diversion trenches have been dug and are collecting fresh diesel oil. Fires between the storage area and the creek now burn 24 hours a day as personnel try to burn off the spilled oil.

Meanwhile, the simulated pipeline/caribou crossing study sponsored by British Petroleum (BP), the Interior Department, and Alyeska has shown that caribou are extremely reluctant to cross the pipe. It appears that the release of the study was purposefully delayed until after Congress voted on pipeline legislation.

In the meantime, a bladder fuel storage facility at a Home Oil Company drill pad site on the North Slope has begun leaking oil into the Arctic ecosystem.



Continued from page 1.

institutional change, and the diversion of capital to new needs are *not* inherently exponential.

Discovery of oil is not in the long run made easier by the fact that certain fields of oil have already been discovered. The next increment of pollution abatement is not directly facilitated by the increment that went before. One doubling of land yield does not enhance the possibilities for the next doubling. Any suggestion that these "exponential" technologies are inevitable is based on a profound misunderstanding of the inherent cause of exponential growth. The suggestion also implies a rather sweeping disregard for the social basis of technological change, for the second law of thermodynamics, and for the law of diminishing returns.

2. *There are physical limits to population and capital growth.* Our own impressions and much empirical data suggest that Malthus was right, that the world is finite in several important ways. [Thomas R. Malthus (1766-1834) was a British economist who predicted that uncontrolled population growth would eventually outstrip agricultural production, leading to widespread famine. Although ignored or dismissed, his theories have never been refuted. — Ed.] Our world models are built upon this Malthusian assumption. It seems to us not only more realistic, but more socially responsible and more useful to investigate the ways in which society might and should adjust the current growth processes to accommodate earthly limitations than to assume away all such limitations.

The world model expresses the idea of the earth's limits through four explicit assumptions: there is a finite stock of exploitable resources; there is a finite capacity for the environment to absorb pollutants; there is a finite amount of arable land; and there is a finite yield of food obtainable from each hectare of arable land. No one has exact information about where these limits are; they all seem to vary with time. We know that to a certain extent they are expandable by technology. We also know that they can be reduced by misuse.

By attempting to represent the world's

Our second concern was to represent not only the forces that can *increase* the earth's carrying capacity for human activity, but also the forces that can *reduce* it. From our admittedly Malthusian point of view, Western man is entirely too prone to rejoice in his newly-irrigated land, underwater oil-drilling rigs, Green Revolutions, and catalytic converters, and to ignore the eroded, salinized, or strip-mined land, the dumps of wasted resources, the depleted ore bodies, the simplified ecosystems, and the deprivation of other humans in other cultures that he leaves in the wake of his "progress." The world model assumes the possibility of considerable future progress, but it also assumes that the limits can be pushed downward, as well as upward, by man's activities.

There are, of course, other limits we have not included in the world model. The most obvious omissions are the limits to the sustainable rate of use of renewable resources — fresh water, timber, fish, and game, for example. We also recognized the importance of social limits, but omitted them from specific analysis. We stated in *Limits* that social limitations (unjust distribution, waste, wars) would only decrease the possibilities for growth allowed by physical limits.

3. *There are long delays in the processes that control the rate of physical growth in the world system.* Delays are the main source of instability in the global system. When rapid growth is coupled with a long delay between cause and effect, the growth may proceed far beyond sustainable limits before the effects that can stop it come into play. We have not assumed that people are unresponsive to the changing situation around them. We have simply assumed that social institutions respond only to problems about which they have information, that the information they act on is often incomplete and late, and that the social response is not immediate but is itself delayed by political, physical, or biological processes. The delay is increased by the time required to invent, construct, and test, and perfect new technologies. Many response delays are beyond control, such as the delays inherent in the population age structure or in the propaga-

tion of persistent materials — such as plutonium or DDT — through the environment.

4. *There are two possible social responses to the limits to growth: weaken growth forces or remove the symptoms of impending limits.* The common response of modern social systems to the pressure on growth caused by limitation of any resource is to remove the pressure so that growth can continue. Highways are jammed; build more highways. Copper reserves are depleted; import copper. Electric power is insufficient; develop new power plants. People are hungry (or the land depleted); buy fertilizer.

It is only very recently and very weakly that an alternative set of solutions has been seriously proposed; reduce the use of automobiles, use less electric power, extend the useful lifetime of material goods, have fewer children. This second set of responses recognizes that these scarcities are not problems themselves so much as symptoms, or signals, of the underlying problem; population and material growth against a finite resource base. The first set of responses serve to remove temporarily the adverse symptoms of growth. If they are not accompanied by responses that weaken the social values causing growth, further growth will eventually cause different resource scarcities. The real danger of responses that ease only the symptoms of the problem is that they are often used to discourage responses of the second type, those that control growth itself. The more successfully the signals of resource scarcity are masked and denied, the more likely it is that the necessary social value change will come too late.

As we stated in *Limits*, we have no desire to stop the development of technology. Combined with the necessary value changes that will control physical growth, carefully selected new technologies can create magnificent possibilities for human society. We are, however, concerned that technological successes have almost invariably been used to enhance, rather than reduce, the growth of population and capital towards the earth's limits. We oppose the present trend of technological "progress" that is not only poorly guided by social wisdom or restraint, but is used as an excuse not to develop that wisdom or restraint.

5. *The equilibrium state may be a desirable option, wherever the limits to growth may be.* It is not necessary to agree with the world model or to believe in the imminence of any physical limits to growth to become intrigued by the nature and potential of an equilibrium state. An equilibrium state is a society that has stabilized its population at a desired level and that supplies its material needs by using a minimum of nonrenewable, pollution-creating resources. We sincerely believe that some form of deliberate material and population equilibrium is attainable within a generation or two. We also believe that the understanding and planning of such a state is both exciting and useful; it might provide the realistic, sustainable, long-term goal that is now lacking in nearly every part of the world society. It seems impossible to us that material growth can be successfully controlled unless there is a clear vision of what growth is for. The specifics of that goal will change and develop as more is learned about the world. We feel that it is only important to have such a goal and to keep it consistent with present knowledge.

The idea of a physically non-growing society is so foreign to some people that they have invested the idea with some strange

Technological optimists look about rising life expectancies, more the advance of human knowledge, and Malthusians look at the same rising populations, destruction of the and increasing gaps between the
Is either of these perceptions

mental models of their own. They have suggested that an economy at material equilibrium must be stagnant intellectually or technologically; that it must be rigid and dictatorial; that it must preserve the present maldistribution of resources or income. We have already suggested in *Limits* that we would expect just the reverse. We would hope that more imaginative respondents will accept the challenge of thinking through the economics and sociology of a physically stabilized state. We suspect that the exercise would be more than theoretical, that it would illuminate some of the current economic and sociological problems of a growing state as well.

We have not suggested in *Limits* or elsewhere that the equilibrium state should be attained immediately, or that physical growth should be brought to a sudden halt. On the contrary we have pointed out long delays in the social system and the necessarily gradual nature of demographic change, and we have suggested that an orderly shift to equilibrium from present rates of growth may take as long as 100 years. Thus although the first steps toward equilibrium should be small ones, they should be taken soon. A good beginning might be a common recognition that physical growth cannot be forever substituted for the social resolution of difficult choices.

In summary, we believe the basic points of our modelling effort merit consideration even though no social model can be rigorously proved true. Together these points constitute a hypothesis about the world system that is generally consistent with real-world observations. We do not believe that the same can be said for the mental models on which important decisions with long-term implications are currently based.

MECHANISMS THAT CONTROL GROWTH: PRICE

Many critics of *Limits* believe that three mechanisms will allow mankind to sustain and control material growth without any changes in the current system — price, technology, and social value change. All three are included in the world model in implicit and oversimplified form. Of course all three are important, complex, dynamic subsystems in themselves. We will describe here, very briefly, how more complete representations of these subsystems might be constructed. None of the added details would alter the basic conclusions of our work.

Economic price is a function of two socially determined variables — the current value society places on a certain good or service and the apparent cost of supplying that good or service. Economists postulate that prices will help stabilize growing systems by signaling resource scarcities. They point out that price changes guide social values and the economic system so that the declining supply of a scarce resource is utilized more efficiently.

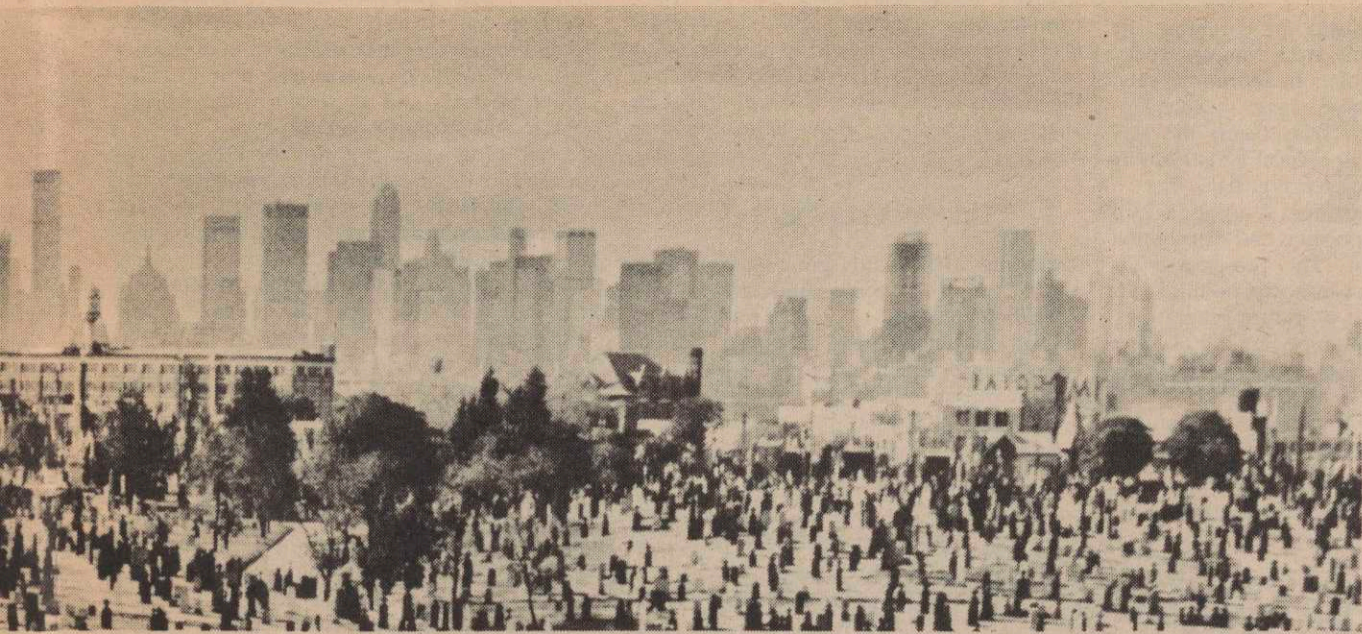
When increasing scarcity causes the price

Some people have suggested that an economy at material equilibrium must be stagnant, rigid, and dictatorial, that it must preserve the present maldistribution of wealth. The opposite would more likely be the case.

limits and the growth of the physical system toward them, we did not expect to gain any more precise information about the location or values of the limits themselves. We sought, rather, a framework in which many growth processes and limits could be considered together, to illustrate that solutions proposed for any one problem related to growth are meaningless without considering the system as a whole. The traditional approach of specialists in any one area amply illustrates how easily any single resource, food, pollution, or population problem can be mentally "solved." One need only assume that sufficient capital, energy, labor, land, material, and time can be allocated to that one problem. The world model forces one to explore the possibility that several of these problems may have to be solved simultaneously.

tion of persistent materials — such as plutonium or DDT — through the environment.

These three major elements — growth, changeable limits, and delays — combine to cause the "overshoot mode" of the model, wherein the human population grows beyond the physical limits, erodes them, and declines. The overshoot occurs only under the assumption that the social value system will promote population and material growth until counteracted by very strong forces. When, in the "equilibrium" mode, we assume a change in man's value system in favor of stability and against sustained population and capital growth, the overshoot no longer occurs. The overshoot could also be eliminated, or minimized, by assuming that the society can avoid the implications of delays by conducting accurate long-term planning. Our purpose in publishing *Limits*



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of some material to rise, numerous social responses may be triggered. There may be a more intensive search for natural deposits of that material, or increased recycling of discarded products containing it. Food shortages leading to rising food prices may stimulate farmers to adopt more efficient methods of production, governments to irrigate more land, or people to eat less food. These dynamic effects of the price mechanism will indeed influence the way in which a growing system approaches its physical limits.

Our world model contains several causal relationships between the real supply of some economic quantity (such as food, non-renewable resources, industrial capital, or service capital) and the response of the economic system to scarcity of that supply. In the models, we have simplified the real dynamics of the price mechanism so that a decrease in supply is represented as directly causing the social response, rather than acting through the intermediate price mechanism. Thus the ultimate regulating effect of the price system is included, although price does not explicitly appear in the model.

Prices are a source of *instability* in the real world under two conditions — if they reflect actual resource costs only after a delay, and if cost information, though transmitted immediately, goes to institutions that can adjust their production or consumption patterns only after a long delay. In either case, the delay between decreased availability and social response will reduce the stability of the economic system as it adjusts itself to any limit. Thus, by assuming in our model that the price system works instantaneously, we have omitted a source of system instability. To the extent that prices are actually delayed signals of scarcity, our model will *underestimate* the tendency of real economic systems to overshoot physical limits.

TECHNOLOGY CONTROLLING GROWTH

We view technology, like price, as a social phenomenon — it is the application of man's general knowledge about the world to the solution of a specific, perceived problem. Again, the technological solutions to a problem are often delayed by the time it takes to perceive a problem, develop the technology to deal with it, and institutionalize that technology.

Nearly every causal relationship in the world model could conceivably be changed by some sort of new technology. In the past, various technologies have, directly or indirectly, improved birth control effectiveness, increased land productivity, and increased the average generation of persistent pollution per unit of industrial output. The advance of technology has created more costly and destructive weapons, increased life expectancy through medical advance, and hastened the rate of land erosion. It is by no means certain that technologies will continue to do any of

these things in the future, since the human values and social institutions that govern technological development are always subject to change.

In other words, we view technology as socially determined, discontinuous, infinitely varied, and delayed. It is nevertheless an important determinant of the functioning of the world system. We built technological change into each relationship as we formulated the model, by assigning possible technologies to three categories: those that are already feasible and institutionalized; those that are feasible but not institutionalized; and those that are not yet feasible.

Some causal relationships have historically been altered by technology and continue to be altered regularly today. These are in areas where there is social agreement about the desirability of change, and where resources and institutions to bring about that change are already integral parts of the system. Examples are medical technology to improve health, industrial technology to raise production efficiency, agricultural technology to increase land yields, birth control technology to plan family size, and mining technology to discover and exploit lower-grade, nonrenewable resources. A significant fraction of the world's people have adopted the value system that will continue to promote these technologies as long as their costs can be afforded. They are effectively built into the world socio-economic system. Therefore, they are also built into the relationships of the world model, with the assumption that they will continue to develop and spread through the world, without delay, as long as there is economic support for them.

There are other technologies that have not been so widely accepted that they can be considered a functioning part of the world system. It is not yet clear that all the nations of the world are willing to institutionalize and pay for technologies such as pollution control, resource recycling, capture of solar energy, preservation of soil fertility, alternatives to the internal combustion engine, or increased durability of manufactured goods. All of these technologies are feasible, and there are signs of the social value changes necessary to incorporate them into the real world system. It is not possible to know when or even whether they will be adopted on a worldwide scale. Therefore we have not assumed them in the model relationships, but have included many of them as functions which a person operating the models can "turn on" to test the possible impact of any or all of these technologies and the relative advantages of adopting them sooner rather than later.

Technologies resulting from discoveries we cannot possibly envision from our perspective in time were left out of our model. No model, mental or formal, can incorporate these unimaginable technologies as they will actually occur. That is one reason why no model can accurately predict the future. Any long-term model that is being used to aid the policy-making process must therefore be updated constantly to incorporate surprising discoveries as they occur, and to assess how they may change the options of human society.

It is possible, of course, to assume that some unimaginable discovery will come along in time to solve every human problem, including the limited resource base of the earth. Many mental models seem to be based on that assumption. However, our own bias is to search for understanding and for better policies based on the constraints of the system.

as it appears now, not to rely on developments that may or may not come in the future.

VALUES THAT CONTROL GROWTH

We have already indicated that both technology and price depend directly upon the values, needs, and choices characteristic of given human society. The whole socio-economic system might be thought of as a constant interplay of human desires and goals within physical and biological constraints. Therefore, although the world model is not intended to be a model of social value change, it contains some assumptions about the dynamics of human values insofar as they influence and are influenced by the processes of physical growth.

In this difficult task of modeling human values we have tried to include only those most basic values that all people can be considered to hold in common, beginning with the requirements for survival, such as food, and going on to include a hierarchy of other desires; for longevity, children, material

country. We believe that such value changes are possible to achieve in the future, but only by a concerted and conscious effort. The shift in values that normally accompanies industrialization is the very value shift that leads to the overshoot and decline mode in the model.

THE MODELER And THE REAL WORLD

It has been suggested that the world model arose only because of the sudden widespread concern about the environment in modern Western societies. Of course, computer models, like any product of man's intellect, must be evaluated as part of the culture within which they are constructed. This statement is also true for the mental models of the critics of *Limits* and for the models that guide current public policy.

Every model of a social system must omit some details of the real world; simplification is the essence of model building. Human judgment is inextricably involved in the choice of the issues to be addressed by a model and the identification of those "unim-

Scarcities are not problems themselves so much as symptoms, or signals, of the underlying problem; population and material growth against a finite resource base.

goods, and social services such as education. Some of these values are represented explicitly in the model as variables that influence economic decisions. Others are included implicitly, for example in the allocation of service output to health services or in the quantity of nonrenewable resources used per capita.

All the values included in the models are assumed to be responsive to the actual physical and economic condition of the system. The patterns of dynamic value change included in the model, however, are limited to the patterns of change historically observed in individual countries over the last hundred years or so. During that time, the major force behind value change in the world system has been the process of industrialization, a process that is still underway in most of the nations of the world. Therefore the values that both shape and respond to the development of the model system follow the historic pattern of industrialization. As industrialization increases in our model (measured, say, by the level of industrial capital per capita), the aggregate social demand is assumed to shift in emphasis from food to material goods and finally to services. Other changes occur in the model in the preferences for numbers of children, education, and health care, and in the distribution of various goods and services throughout the population as it industrializes.

We have not built into our model any global shifts in values other than those that might be expected to take place as the world becomes more industrialized. The model cannot predict value changes, but it includes test switches that can be used to activate postulated value changes at any date specified by the operator. We have used these switches extensively to test different assumptions about future value changes. As we demonstrated in *Limits*, an appropriate set of value changes can bring the model system into a stable and desirable equilibrium state. That equilibrating set of value changes has *not* occurred historically in any industrializing

portant" details that may be eliminated without detracting significantly from the explanatory power of the model. Every model is thus inevitably influenced by prevailing social values and goals, including ours.

However, our model has one advantage over the mental models of our critics. Its assumptions and biases are explicit. The constituent assumptions of formal, or written, models are necessarily precise, and therefore critics may easily identify errors or unwarranted biases. Most critics of *Limits* have not defined the bias that underlies their own approach, nor have they presented assumptions explicit enough to be judged by their audience.

The accusation that the world model has been unduly influenced by the prevailing environmental concern seems to imply that the models are addressing random, unimportant, or spurious issues. The latest wave of environmentalism may indeed turn out to be a fad. However, the current concern with the environment *may* be a result of the first glimmerings of human understanding about total systems and the first public perception of a real worldwide negative impact of man's activities on the ecosystem. If so, the world model may represent a small manifestation of a healthy social reaction to the changed perception, a reaction that will lead to new values, technologies, and economic prices that attempt to adapt socio-economic systems to the newly perceived constraints. In that case the critics, the technological optimists who claim that there are no constraints and no reasons to change from the present pro-growth values, represent exactly the social and institutional delays that tend to destabilize the system and send it shooting past its ultimately sustainable limits.

GROWTH AND INCOME DISTRIBUTION

Some critics have rejected the no-physical-

growth argument as irrelevant to the "really important" problems of the composition and distribution of wealth. We find it impossible to view the rate of physical growth, its composition, and its distribution as independent or mutually exclusive problems. Human societies will not achieve a more equitable distribution of wealth until they better understand the processes of growth. Historically, growth of population and of capital and rising gaps between the absolute incomes of the rich and the poor have been closely related. We believe that there are at least two basic reasons for these trends. First, when there are fewer available resources per person, there are also fewer real social options to resolve conflicts of interest. Therefore power

groups and mechanisms for cornering the scarce resource supply are a common social response to overpopulation. Second, by relying on the false promise of growth, social institutions are able to delay facing the very important and difficult tasks of redistributing wealth and of defining social goals.

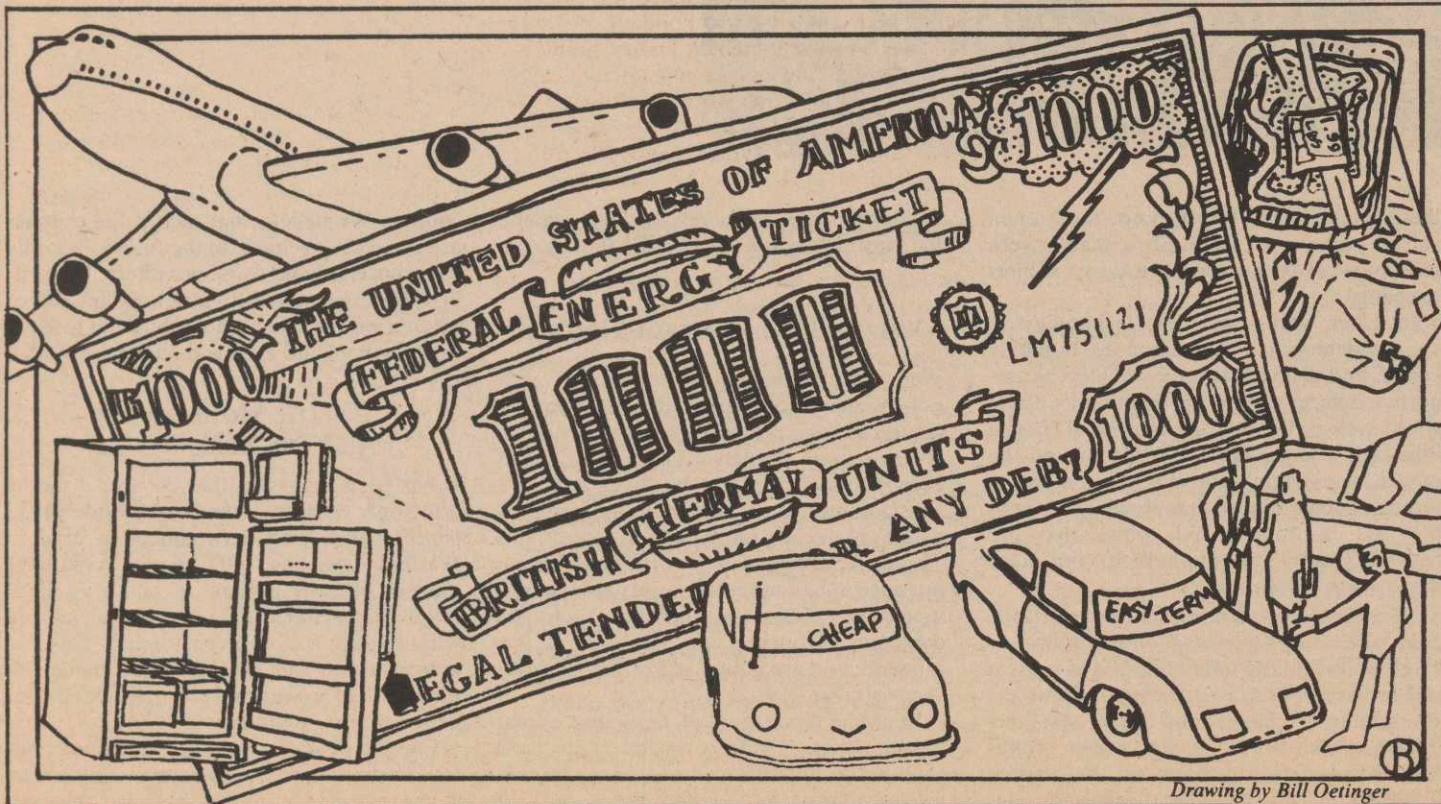
The no-growth argument is an appeal for readjusting the composition and distribution of economic output. The pro-growth argument is an attempt to postpone this readjustment, to confer it on future generations. Simultaneously, continued growth ensures that those generations will have fewer resources and thus fewer real choices to make. Our own socio-political concerns are actually quite similar to those who argue that redis-

tribution must come first. . . . We simply differ in our perception of which mechanism — more growth or more careful consideration of the population/resource balance — will be effective in bringing about a just resource allocation.

THE CONCEPT OF MAN

This brings us to the final point that we regard as basic to all discussions among ecologists, "environmentalists," Malthusians, economists, industrialists, pessimists, and optimists. The pro- and anti-growth factions are organized around two very different concepts.

The concept of man held by advocates of indefinite growth is that *Homo sapiens* is a



A Proposal For an Energy Quotient

MALCOLM SLESSER

Few would argue that modern society is an economically driven system. Many of us have misgivings about where that system is taking us. One of the most searching studies into this has been the world model developed by Dennis Meadows and his associates for The Club of Rome, described in their book, *The Limits to Growth* (See page 1). It demonstrates that sooner or later a "collapse" is going to occur. Reading the technical report to this work, which has recently been made available (*The Dynamics of Growth in a Finite World*), one cannot escape the feeling that the collapse occurs because society is economically motivated. This need not be. In an economically motivated world system there is no immediate feedback between a resource and its consumption, or between immediate desires and the long-term future.

The model's principal weakness as a long-term forecasting tool is that much of it is couched in money terms. But money is not the driving force of the modern economy. The true driving force is energy, and it has been amply demonstrated that as an economy is intensified so, too, is energy use. Dr. Meadows, himself, has suggested that the joule (an internationally accepted unit of energy) be adopted as the international monetary unit. In the end, energy will be the limiting physical factor in global development through one of two causes. Either man simply will not be able to get energy at a fast enough rate from acceptable sources, or, since all energy finishes up as waste heat, there will be a limiting amount of energy that the earth can conveniently dissipate into space. What that amount may be is still uncertain, but enough informed opinion has put the figure at about 1 percent of the total solar input for us to take that as an immediate criterion for action.

YOU GET WHAT YOU PAY FOR

Either of these two potential limitations must mean an ultimate limitation on personal energy use. How then can one resolve an

economic system which encourages growth, with the eventual limit on energy use? One way, undoubtedly the best, is to evolve a better model for running the global system, as The Club of Rome is now doing. But one seriously doubts whether the dangers of the present system are sufficiently apparent to enough people for such a magnificent reappraisal of human affairs to be effective. It is for these reasons that I propose an alternative but immediate tactic. This tactic is the energy ration card. It would work as follows:

Each person would be issued annually an energy ration card containing a large number of energy units. For example, let us assume that each individual's card would contain an energy allocation equivalent to the present-day per capita energy use in the USA, some 350 million BTUs (British Thermal Units) per year. When Americans buy goods or services, not only would they pay the cash price, determined as before by the so-called free market system, but goods or services would contain on their price tags the energy that went into creating them. For example, a two-pound loaf of bread produced under American conditions would require some 1,200 BTUs. A pound of beef from a feed lot would require 12,000 BTUs, but from a free-ranging animal only some 5,000 BTUs. The purchase of an automobile would require some 150 million, and a gallon of gasoline to go with it, some 140,000 BTUs.

Convenience foods might tend to cost more in energy terms, while fresh foods would cost less, and those grown in the garden almost nothing, unless one goes in for a lot of artificial fertilizer.

THE PRICE IS RIGHT — OR — TRUTH AND CONSEQUENCES

The effect on services would be startling. A flight to Europe from New York would dock 26 million BTUs from your ration card, whether you take a peak-hour or off-peak flight. A jaunt by auto to Los Angeles from New York and back again would use almost two-fifths of your energy ration. There would be every encouragement to share the trip with a friend, or at least pack in all members of the family — or, better still, go by train or bus.

Americans would find that suddenly their consumption could not just grow indiscriminately as and when they had money only. Monied or not, they would be forced to

make choices, energy choices: whether to make that trip to South America or heat the family home to 75° Fahrenheit; whether to indulge in a mass of electrical gadgets costing energy both to produce and to run, or extend the family home; whether to buy a 40-horsepower outboard for the boat or use a canoe and go farther afield weekends; whether to commute by car or have air-conditioning or share the commuting and have both.

This way, informed public taste would dictate which industries would flourish and which would become superfluous. The Madison Avenue Society would perish because advertising couldn't get around the energy tag on each article. Given what you've got on the ration card, some cautious saving on the energy front on the superfluities of life might mean better spending on real things. A spree would have a social cost, paid by the spree-er.

Energy ration cards might even be incorporated into the structure of local government. The local government would have to apply an energy tax, in terms of coupons, for the energy expended in the name of the community. Federal energy expenditures, of course, would come off the top and be budgeted for each year, before the announcement of the annual citizens' energy quota.

The incentive to save energy would, hopefully, lead to development of less energy-intensive and thus more labor-intensive production, helping relieve unemployment. It would lead to low-energy technology and many of the ideals outlined in *The Ecologist's* "Blueprint for Survival."

Finally, justice suggests that the rich get the same energy as the poor. But the poor use less. Will a black market arise in energy coupons? Doubtless it will, but would not that be a tax on the rich to the benefit of the poor?

Malcolm Slesser is a senior lecturer at the University of Strathclyde, Glasgow, Scotland, and one of the signatories of *The Ecologist's* "Blueprint for Survival." He has published articles on energy policy in *The Ecologist*, *The Journal of the Science of Food and Agriculture*, and in *Technological Forecasting and Social Change*.

We would add one comment to Dr. Slesser's proposal: the annual energy quota per capita would have to be set far below 350 million BTU, because the earth could not sustain that much energy being generated for every person in the world.

very special creature whose unique brain gives him not only the capability but the right to exploit for his own short-term purposes all other creatures and all resources the world has to offer. Underlying this view — reinforced as it is by the stunning technical achievements of the last few centuries — is also the belief that mankind's social, economic, political, and technical institutions operate flexibly and without error, reacting instantly to counter any obstacle, and that the best response to any apparent problem is to encourage these institutions to do more of whatever they have done in the past.

The opposite concept assumes that man is one species with all other species embedded in the intricate web of natural processes that sustains and constrains all forms of life. It acknowledges that man is one of the more successful species, in terms of competitiveness, but that his very success is leading him to destroy and simplify the natural sustaining web, about which he understands very little. Subscribers to this view feel that human institutions are ponderous and short-sighted, can adapt only after very long delays, and are likely to attack complex issues with simplistic and self-centered solutions. They would also point out that much of human technology and "progress" has been attained only at the expense of natural beauty, human dignity, and social integrity, and that those who have suffered the greatest loss of these amenities have also had the least benefit from the economic "progress." People who share this concept of man, as we do, would also question strongly whether technology and material growth, which seem to have caused many problems, should be looked to as the solutions of these same problems in the future. Technological optimists invariably label this view of the fallibility of man as "pessimistic"; Malthusians would simply call it "humble."

We see no objective way of resolving these very different views of man. Technological optimists look about them and see only rising life expectancies, more comfortable lives, the advance of human knowledge, and improved wheat strains. Malthusians look at the same world and see rising populations, destruction of the land, extinct species, urban deterioration, and increasing gaps between the rich and the poor. Is either of these perceptions entirely correct? Should social policy be based entirely on either of these concepts of man?

THE CHALLENGE

One glaring problem confronts mankind, if it should choose to view itself as a humble part of a complex biosphere. There is essentially no body of knowledge from which to design the new institutions and values consistent with that concept of man. Two hundred years of growth has left biases and blind spots throughout the physical and social sciences, to say nothing of our established economic and political institutions. There is today no economic theory of a technological society in which there are essentially zero interest rates, no net accumulation of society's productive capital, and in which the principal concern is equality rather than growth. There is no equilibrium political science in which we might look for clues to the ways democratic choice could be exercised when short-term material gain is ruled out as the basis for political success. There is no social encouragement for equilibrium technology that places high emphasis on the recycling of all matter, on the use of the sun's pollution-free energy, and on the minimization of both matter and energy flows. There is no psychology for the steady state that might provide man with a new self-image and with feasible aspirations in a system where material output is constant and in balance with the globe's finite limits.

Each of our traditional disciplines could respond to the challenge of working out the details of a viable and attractive equilibrium society. The effort would pose many difficult technical and conceptual problems, but their solutions would be intellectually satisfying and enormously valuable to society. After all, we are not merely talking of a distant and unattainable Utopian state. Physical growth of population and capital will stop on this finite planet. The only uncertainties lie in when it will stop and how — by deliberate social choice and under careful human management, or by the harsh backlash of a disturbed and depleted natural environment.

The Meadows are on the faculty of Dartmouth College. This article is copyright 1973 by Dennis Meadows.



Photo by E. L. Frost.

Sarpy Creek Revisited

Montana Passes Strict Reclamation Law

EDWARD DOBSON

It has been ten months since NMA sounded the alarm on the strip mining proposals for the northern plains — Sarpy Creek, Montana in particular (NMA, November 1972) — and this update is overdue. Some strong progress has been made. The new Montana reclamation law has been billed as the strongest in the nation. Montana's Senator Lee Metcalf (D) and Congressman John Melcher (D) have been playing key roles in the formulation of federal legislation.

Strong local support has made this possible — much of which can be traced, in varying degrees, to FOE's education work. The travelling education program we present is long — about an hour — and is heavily weighted with data and sophisticated interpretation, but it has been well received. The Executive Director of the Montana Optometric Association, whose annual convention recently hosted the FOE program, wrote, "Your views on environmental concerns . . . were down-to-earth and easily understood in a way that struck home to every one of us. . . ." The FOE program, constantly updated and improved with the assistance of a number of concerned Montanans, has travelled tens of thousands of miles.

If it is not feasible to press, again, for the abolition of strip mining, we must at least critically monitor and analyze the granting of permits and the general enforcement of the law. Everyone familiar with strip mining law enforcement understands that it has been a losing battle. But state officials, from Governor Tom Judge on down, are predicting a different story in Montana.

WHO OWNS THE COAL?

A critical test of the new law may be approaching. As NMA readers are aware, Westmoreland Resources, a Pennsylvania-based corporation, has leased coal owned by Crow Indians and located under land owned by ranchers (many of whom have since sold out to Westmoreland). These leases were auctioned by the Bureau of Indian Affairs (BIA) in August, 1970, after the National Environmental Policy Act (NEPA) took effect. No Environmental Impact Statement on mining this coal was ever released, however. (A flurry of local activity has produced a draft statement, which is about to be released.) The situation is complex, and a number of major questions remain unanswered.

Who owns the coal in the first place? When the Crow Tribe ceded the land in question to the federal government (33 Stat., 353), they did "... hereby relinquish to the United States all right, title, and interest which they may have. . . ." That was in 1904. Much later, when homesteaders got their patents, they found that the federal government had retained title to the coal. Then, in 1958, the government gave the coal back to the Crow Indians.

By what authority did the federal government convey Sarpy Creek coal to the Crow Indians? Should this coal be mined before the issue is settled? FOE feels that no federal coal should be disturbed until federal law is enacted and rules and regulations promul-

gated for industry compliance.

Another important question is whether Sarpy Creek — or any federal coal — should be mined before the issuance and circulation of an impact statement under NEPA covering the entire federal involvement in the Fort Union coal field region. The impact statement should indicate how coal mining in the Fort Union region will comply with pending federal strip mining legislation.

REGULATING MINING

The Department of State Lands currently has authority to regulate mining on the surface of Sarpy Creek land and will continue to do so unless federal legislation establishes a national regulatory body. Under Section 9 of the new Montana reclamation law, permits shall be denied where compliance with the purposes of the act is not possible. One of the purposes of the law is "to provide a suitable permanent diverse vegetative cover capable of: (a) feeding and withstanding grazing pressure from a quantity and mixture of wildlife and livestock at least comparable to that which the land could have sustained prior to the operation; (b) regenerating under the natural conditions prevailing. . . ." Section 9 also provides for the denial of mining permits where, because of special characteristics of biological productivity or ecological fragility, the land's ability to . . . return to its former ecological role in the reasonable foreseeable future . . . is at stake.

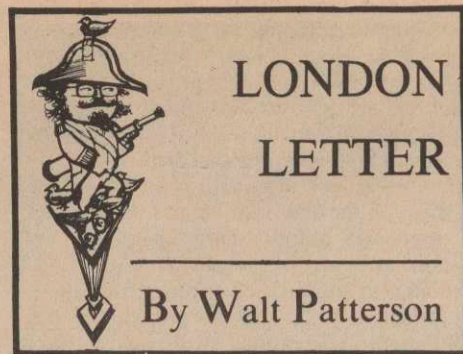
Some of the cultivated wheat fields that Westmoreland wants to strip mine near Sarpy Creek have produced around 50 bushels to the acre (bu/acre) without irrigation or fertilization. Of course, productivity varies with the weather, but that figure is hard to beat. The average is likely to be more like 30 bu/acre, which is still good dry-land farming.

Slowly but surely, "informed sources" are beginning to admit that we are considering an awfully long stretch before stripped Montana land will do the same things it did before — how about 50 years for openers? The point is, nobody really knows. Since the land will not be productive for a long time, the reclaimers claim that recreation is a "higher use." The Bureau of Outdoor Recreation, to judge by its press releases, seems to swallow this rationalization hook, line, and sinker.

But Sarpy Creek is some of the most productive land in southeastern Montana, perhaps in the whole state this dry year. If 50 years is a minimum for productive land (given the fact that nature is eventually going to restore something on her own, and our efforts at fertilization and irrigation may just get in the way), the maximum could be, as Dr. Robert Curry, Environmental Geologist at the University of Montana, points out, "... longer than we expect man to inhabit the earth." Of course, no doubt something will grow there, but the question is whether the growth will actually satisfy the requirements of the law cited above. On Sarpy Creek, the answer is obviously "No."

★ **What You Can Do:** Your comments and suggestions should be sent to Ted Schwinden, Commissioner, Department of State Lands, Helena, Montana 59601.

Edward Dobson is FOE's Northern Great Plains Representative. In a brief note that accompanied his manuscript, Mr. Dobson tersely suggested another dimension of the problem. His note said: "Empty meat markets — price of beef going up. We strip rangeland. It costs \$60 to take a calf to 500 pounds on the grasses — \$150 in a feedlot."



After the obsessive cetacery of June, July turned centrifugal again, so much so that by the end of the month the office was almost empty. Fortunately 'twas holidays, not antipathies, which scattered the bodies: holidays both overdue and not a moment too soon. This screed will be your reporter's last Friendly undertaking before hying himself a-castling in Wales with wife and sprog for a long-awaited week. *A-castling we will go, a-castling we will go. . . .*

Ahem. Probably the most dramatic environmental event of the month — for 'environmental' read 'anti-environmental' — was publication of the Government's megalomaniac plans for paving over southeast Essex. By hindsight it's apparent that only FOE, the Defenders of Essex, and our more perceptive colleagues had really understood the implications of plans to site a new London airport on Foulness Island and the Maplin Sands. As rumblings of discontent spread even through the Tory backbenches, as Ministerial evasions and circumlocutions — not to say downright lies — piled up, it became clear that Heath and Company are now viewing 'Maplin' through the same grandiose spectacles that have so long been used to bestow a rosy aura around the looming hulk of Concorde. The consequences are similar; it is impossible to get straight answers about costs, about social effects, about ecological effects, even about economic justification and indeed need for the project. Instead we get patronizing assurances that the government knows best (better, in this case, than the airlines, the Civil Aviation Authority, British Rail, the harbour authorities, the Essex County Council, Essex MPs, and hundreds of thousands of inhabitants of Essex, all of whom want no part of 'Maplin'); and we get warnings that the residents around Heathrow and Gatwick must not be forced to put up with more noise; and we get appeals to national pride and glory that would have brought tears to the eyes of General de Gaulle.

No one has explained, apart from all the other arguments, how noise-abatement implies that you build a huge new airport on the coast — and then build under its flight-paths a city of half a million people. However, this could be a whole issue of NMA on its own, and your reporter is starting to froth at the mouth. Suffice it to say that apart from Ted Heath and his soi-disant Secretary of State for (sic) the Environment, Geoffrey Rippon, plus presumably the collective construction industry, no one in Britain seems to regard the Maplin plan as other than deranged. The coming battle, in which FOE will figure prominently, should be a lulu. Just to keep our hand in, some Friends staged a

pantomime — St. George slaying the Maplin Monster — in the forecourt of the Department of the Environment buildings, and got some useful press coverage as well as freaking out at least one junior bureaucrat and disciple of Mayor Daley, who would gladly have used tanks against them if tanks had been available. What with Concorde, Maplin, and the Channel Tunnel, don't be surprised if you next hear that Mr. Heath is planning to link London and New York with a bridge. Probably named after himself.

While we're considering the care and feeding of the construction industry let it be said that the South-east is not their only habitat. British contractors are now roaming up and down the western coast of Scotland, trying to find a place to set up shop to build concrete oil production platforms for use in the North Sea. Mention was made in these columns of an application for planning permission for a site opposite the Isle of Skye. The same firm — still without an order on its books — has now filed another application for a site at the resort hamlet of Ullapool, to the north. It looks to our North Sea Oil Coalition people as though the companies are into a shotgun technique, applying everywhere, knowing that the small communities cannot find the resources necessary to mount opposition everywhere where opposition would normally be indicated. We down South are going to have to do something about this: perhaps a campaign to demand that companies making such applications contribute to a fund from which local opponents can receive support. Be assured that we are not going to back down without one helluva fight.

Pete Wilkinson, Colin Blythe, Colin Hines of Population Stabilization, and your reporter have initiated a series of informal but promising discussions with staff members of several of the major trades unions, to seek out common ground and — possibly — to devise ways of cooperating for mutual benefit. We already have a good, on-going liaison with the railmen's unions in Transport 2000, the public-transport pressure group; now we've been meeting with the National Union of Mineworkers, registering our support for coal as a vital long-term resource, and generally establishing some open channels of communication. We have also met with other unions and with the Trades Union Congress, the overall coordinating body, and it looks as though — particularly on matters of transport and energy policy — we may have begun a valuable colloquy. The example of the Shell strike and the OCAW-environment group teamwork in the US has been of inestimable value in establishing our bona fides.

With the usual trauma we brought forth a four-sided tabloid Annual-Report-cum-membership-dinner in the format of a new monthly which will be appearing regularly as from this autumn, called *Spaceship Earth*. It won't, at least initially, be any threat to NMA, but it might be fun. Who knows? We might even find a relief man for your ever-faithful reporter. *A-castling we will go, a-castling we will go, hi-ho the merry-o. . . .*

GROWING PAINS & associated ills

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Hells Canyon, photo by Boyd Norton.

PACIFIC NORTHWEST NEWS
By Harvey Manning

NEW LEGISLATION MAY PROTECT HELLS CANYON

CATHERINE JOHNSON

The Hells Canyon-Snake River area may finally win the protection it deserves and so desperately needs. After a dam-building history described by Senator Bob Packwood as "perhaps the most confusing in conservation annals," a new bill to create the Hells Canyon National Recreation Area has been introduced by all four Senators from Idaho and Oregon. Such unified and wholehearted support on the home front augurs well for the bill, known now as S. 2233. Though termed a compromise bill, S. 2233 is not the watered-down sop to all interests that compromise

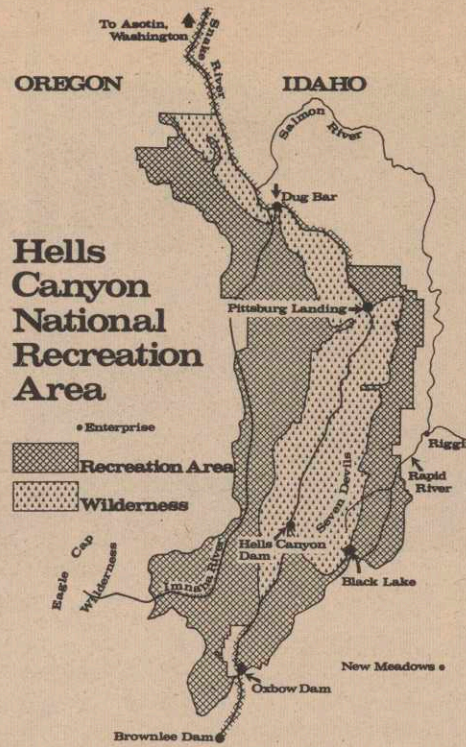
Pete Seeger in Hells Canyon, photo by Larry Williams.



bills often turn out to be. Considering the earlier bill introduced this year by Senator Hatfield and Representative Ullman of Oregon, which conservationists called "worse than no legislation at all," the "compromise bill" is remarkably strong.

The major features of S. 2233 are:

1. Creation of a Hells Canyon National Recreation Area, including a 1/4-mile buffer on either side of the Snake River from Brownlee Dam to Oxbow Dam, a distance of about ten miles.
2. Creation, within that area, of a Hells Canyon Wilderness, to consist of the canyon walls and rims, including Seven Devils Peaks in Idaho, Black Lake, a heavily used recreation site, is excluded from wilderness.
3. A total prohibition on construction of any more dams along the Middle Snake River in Hells Canyon.
4. Protection of upstream water rights. (Lack of this concession helped kill Senator Packwood's National River bill in the last Congress.)
5. Continuance of existing grazing rights.
6. Limitations on the current condemnation powers exercised by the Forest Service in acquiring private lands in Hells Canyon. A 5 percent limit is set on condemnation for purchase, though there is no limit on condemnation for scenic easements.
7. Preservation of multiple use management on all parts of the Area, excepting wilderness. All of the area on the Oregon side and the Rapid River drainage in Idaho are designated for wilderness study, and these areas must be managed during that time as if they were wilderness. In multiple use management of the remaining lands, recreation would be given special emphasis, and timber cutting would be allowed only on a selective basis (i.e., no clearcuts).
8. Authorization of funds — \$60 million — to improve public access to Hells Canyon at Pittsburg Landing on the Idaho side and Dug Bar on the Oregon side.
9. Designation of the Snake River between Hells Canyon Dam and Asotin, Washington, as part of the National Wild and Scenic Rivers System. Specifically, the river would be divided into three segments: from Hells Canyon Dam to Pittsburg Landing, a Wild River; from Pittsburg Landing to Dough Creek, a Scenic River; from Dough Creek to Asotin, a Recreational River.
10. Deauthorization of Asotin Dam.



11. Development by the Forest Service of a comprehensive management plan for the entire Area, with consideration of alternative methods of transportation. Although the bill allows power boats to continue to use the river, the Forest Service is authorized to regulate their use to prevent undue congestion.
12. No new Wilderness Areas within the Area may be designated without congressional approval.
13. Withdrawal of all federal lands within the Area from new mining and mineral claims, though existing operations and claims are allowed insofar as they are "compatible" with the Act.

It seems fairly certain that Hells Canyon legislation will make it through this session, but how strongly the final act will resemble the yet-unamended S. 2233 is uncertain. Power companies are already up in arms, predictably exploiting the omnipresent "energy crisis"; a spokesman from Pacific Northwest Power Company called the sponsors' support of the bill "incredible in this time," adding that a reservoir would provide more recreation than the river does now. The guarantee of upstream water rights is one concession already made to the power companies who own and operate dams on the Snake, but since new dams are utterly irreconcilable with the notion of a Hells Canyon National Recreation Area, any legislation will have to preclude dams. A moratorium on dam building on the Snake has thrice passed the Senate (to be killed in the House Commerce Committee), and the governors of Oregon, Idaho, and Washington have gone on record opposing further dam construction; the wounded cries of the power companies seem to stem more from habit than hope of forestalling action.

Objections to the bill from environmentalists have been few and far between. Admittedly, jet boats do not belong on a Wild River, and a guaranteed minimum streamflow would be an added assurance, but the general feeling is that conservationist efforts are better spent in trying to retain the excellent — and bound-to-be-controversial — parts of the bill than in objecting to its flaws.

Most damage to the Hells Canyon legislation can be expected in the House, which so far has been reluctant even to stop dam building on the river. The Ullman bill, while it contains nearly the same boundaries of the Area as the new Senate bill, leaves nearly all the management decisions up to the Forest Service. The Oregon Environmental Council has criticized that bill's directives as "no different from the management goals... implied in the Multiple Use Act."

A Senate-House compromise is virtually certain, in light of the apparent determination of Congress to get some sort of Hells Canyon legislation through this session. In anticipation of a conference committee, the Senate bill should be as strong as possible, and input from citizens can help this come about.

★ **What You Can Do:** Letters to your senators, especially ones on the Interior Committee, should be sent, and people in the Northwest should watch for announcements of field hearings in Oregon and Idaho. Hells Canyon and the Snake River have been up for grabs for 20 years — now we have a chance to keep it from the grabbers forever.

CONGRESS IN-ACTION
By George Alderson

Congress will re-convene after the August recess on September 5 and will probably work straight through until December, except for short recesses on holidays.

ENDANGERED SPECIES: The Senate version of the Endangered Species Act of 1973, based on Senator Harrison Williams' (D-N.J.) bill, S. 1983, passed the Senate on July 24. Senator Warren Magnuson (D-Wash.), Chairman of the Commerce Committee, commended FOE for its contributions to the legislation. The bill was designed to remedy a salient defect in the 1969 Endangered Species Act by providing protection for domestic endangered species and to broaden the circumstances in which a species would be declared endangered.

The Senate Commerce Committee, under pressure from state fish and game agencies, added provisions allowing the state agencies to retain control over the management of endangered species if the Secretary of the Interior determines the state program to be adequate. The states' influence was augmented by adoption of amendments offered by Senator Ted Stevens (R-Alaska) that permit the states to retain jurisdiction for 15 months before having to demonstrate a satisfactory plan.

The Secretary of the Interior, however, retains ultimate responsibility for listing domestic as well as foreign endangered species. The bill emphasizes habitat acquisition and lifts the ceiling on available funds for this purpose.

EASTERN WILDERNESS: The Senate Interior Committee's Subcommittee on Public Lands has completed mark-up sessions on the Eastern Wilderness Areas Bill, S. 316. The bill, which will be taken up by the full committee in September, establishes wilderness areas in the eastern national forests, and also designates study areas, which would receive interim protection while they are being studied for possible wilderness status.

GRAND CANYON: The Senate Interior Committee's Subcommittee on National Parks and Recreation is expected to mark up early in September Senator Barry Goldwater's (R-Ariz.) bill, S. 1296, which deletes 38,000 acres of land from Grand Canyon National Monument for the benefit of cattlemen. Senator Goldwater has agreed to a new draft bill that eliminates most other controversial features of the bill. Under the new draft, the proposed transfer of land to the Havasupai Indian Reservation is only to be studied.

After FOE and the Sierra Club testified against the bill at the June hearings, Senator Goldwater reacted by resigning from the Sierra Club, claiming that because he consulted Sierra Club people in drafting the bill, the club should have supported it. John A. McComb, the club's Southwest Representative, replied that the club had never agreed to the deletions from the park. In fact, the club has been outspoken in its opposition to the deletions.

Senator Goldwater has also pledged opposition to the bill, introduced by Senator Clifford Case (R-N.J.) and backed by FOE and the Sierra Club, to enlarge Grand Canyon National Park to 1,965,000 acres. He wrote to Mr. McComb: "I can tell you now that the Case Bill will never pass; it probably won't even get out of committee, and I will dedicate myself to seeing that this comes about. The only bill that has a chance of passing is my bill..."

Hearings will probably be held on the similar House bill this fall in the House Interior Committee.

★ **What You Can Do:** FOE's chief objective at this point is to defeat the provision deleting 38,000 acres from Grand Canyon National Monument. Please write to your Senators, urging them to oppose the deletion when the bill comes to the floor. (Aside from this, the bill is a harmless reshuffling of boundaries to create a larger Grand Canyon National Park.)

by carving portions out of the national monuments and adjacent national recreation areas.)

TIMBER BILLS: A move is afoot to attach the Hatfield timber bill (S. 1996) to the log-export control bill (S. 1033) when it comes to the Senate floor in September. The Hatfield bill is a rewrite of the Timber Supply Bill, defeated by the House in 1970. Like S. 1775 (NMA, August 1973), it contains an earmarked fund, using timber-sale revenues to pay for management activities on the national forests. FOE is flatly opposed to this provision because it would create an unsupportable dependence upon timber revenues, leading to a bias in favor of excessive timber cutting by the Forest Service.

★What You Can Do: Urge your Senators to oppose any amendment to S. 1033 that would create an earmarked fund based on timber-sale revenues.

NANTUCKET SOUND: The Senate's Subcommittee on National Parks and Recreation held a field hearing on Martha's Vineyard on July 16 concerning Senator Edward M. Kennedy's (D-Mass.) bill, S. 1929, to establish a Nantucket Sound Islands Trust (NMA, January 1973). Voices of both support and opposition were heard — the most significant of the latter being a prepared statement from Senator Edward Brooke (R-Mass.), who said: "I am not yet convinced that it is necessary for the federal government to intrude so pervasively into the lives of my fellow Islanders." Henry Beetle Hough, organizer of the FOE Vineyard Branch and editor of the *Vineyard Gazette*, testified strongly in support of the Kennedy bill.


EVERGLADES: On August 1, the House Interior Committee reported out a bill to establish the Big Cypress National Preserve, including a provision for "legislative taking" of all land in the boundaries — a procedure that transfers title to the US government upon passage of the bill, thus avoiding the price escalation that accompanies normal condemnation and negotiation procedures. The bill, which has the support of FOE, will come to the House floor in September. The Senate Interior Committee has not yet acted on the bill.

In a related development, Dade County, Florida, has recommended adoption of Site No. 14 for relocation of the Big Cypress Jetport. The site was previously endorsed by the Everglades Coalition, of which FOE is a member. Training flights on the Big Cypress runway will cease, and the site will be abandoned as soon as the alternative has been built.

LAND-USE PLANNING: Mark-up sessions are in progress on the Land Use Policy Bill in the House Interior Committee's Subcommittee on Environment, but final action in committee will not come until September or October. The subcommittee's current draft includes many of the improvements advocated by FOE and other environmental groups. It is important that these provisions in the areas of subdivision land protection, sanctions, and funding levels receive support in order to ward off weakening attacks.

"People are slob"

—says John DeLury,
President of the
N.Y. Uniformed
Sanitationmen's
Association




Garbage

The History and Future of
Garbage in America
by KATIE KELLY
\$7.95, now at your bookstore
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And Katie Kelly is inclined to agree. Her new book, *GARBAGE: The History and Future of Garbage in America*, is a lively and fact-packed account of the garbage crisis in America and how it affects our environment and all of us.

"This catchy, fascinating book . . . lends an important perspective to a sorely neglected and overwhelming subject."—*Newsweek*

"Blessed by restraint and good humor . . . A book you shouldn't recycle."—*Boston Globe*



PARTICULATE EMISSIONS

By Usually Reliable Sources

FOCUS ON ENERGY: "You can fuel some of the people all of the time, all of the people some of the time, but not all of the people all of the time" . . . There's gonna be a hot time for the old nukes tonight, and for many more to come. Energetic citizens all over the country are organizing themselves to battle reactor-pushers. Among the foremost: a coalition of FOE branches in Kansas and Missouri that is vigorously opposing a gaggle of nukes proposed for that area, and a group including environmental and labor groups in North Carolina, who shudder at the prospect of some 15 of the beasts to be built in their back yards in the next ten years . . . Not so enlightened, apparently, are our Brazilian brothers: The *Christian Science Monitor* reports that the first Brazilian nuke is under construction on the coast between Rio and São Paulo. Its capacity will be 500 megawatts, and it's being built by — you guessed it — Westinghouse.

ALASKAN OIL MAY GO TO JAPAN, BUT IT CERTAINLY WON'T GO TO JAPAN: Robert Zelnick, quoting Senator Ted Stevens, in the *Anchorage Daily News*: "... no oil from Alaska is going to be sold to Japan. Some of it may be delivered, but it will be delivered to satisfy contracts made by Japan with the Middle East." . . . Colorado and Utah residents are bracing themselves to battle an oil pipeline that would run from the northwestern Colorado oil-shale fields to the area of Lisbon Valley, Utah. Critics of the plan worry that the line would disrupt scenery, archeological sites, recreation land, and wildlife. Who hopes to build the line? Your friend and mine, Atlantic-Richfield.

FOEFOLK: David Sive, a member of FOE's Executive Committee, will help draw up a new zoning code for Huntington Town, New York, applying ecological concepts along with conventional ideas on planning. Got his name into *The New York Times* for that! . . . Tom Turner wrote to President Nixon about the trans-Alaska pipeline. This is the reply he got, in its entirety: "The President has asked me to thank you for your recent communication. He appreciates the interest which prompted you to share your views with him. Sincerely, Glen E. Pommerening, Acting Assistant Attorney General for Administration." A precedent for all the people . . . Henry Beetle Hough, chairman of FOE's Martha's Vineyard Branch, reports that Senator Brooke (R-Mass.) came out against the Nantucket Sound Islands Bill after being visited by "the principal figure in many Vineyard tourist enterprises." The bill would give the Department of the Interior a strong role in directing use of the Vineyard, Nantucket, and the Elizabeth Islands; Brooke's statement of opposition came right on the heels of his vote against the Mondale-Bayh Amendment to the trans-Alaska pipeline bill.

TO GET USED TO ADVERSITY is not to be able to survive it: Maurice Strong tells the story that as a school boy experiment, he would drop a frog into boiling water. The frog leapt right out. But if he put a frog into room-temperature water, then brought it to the boil, the frog sat there, adapting so well that it boiled to death.

JUDGE WILLIS RITTER, whose good ruling on the Rainbow Bridge lawsuit was just overturned, ranged not far afield when he told a group of river tour promoters in early June that the Park Service should do everything possible to preserve the ecology of Grand Canyon. He then refused to suspend the National Park Service's limits on the number of tours allowed to go down the Colorado River. The Service wants to assess the impact of use

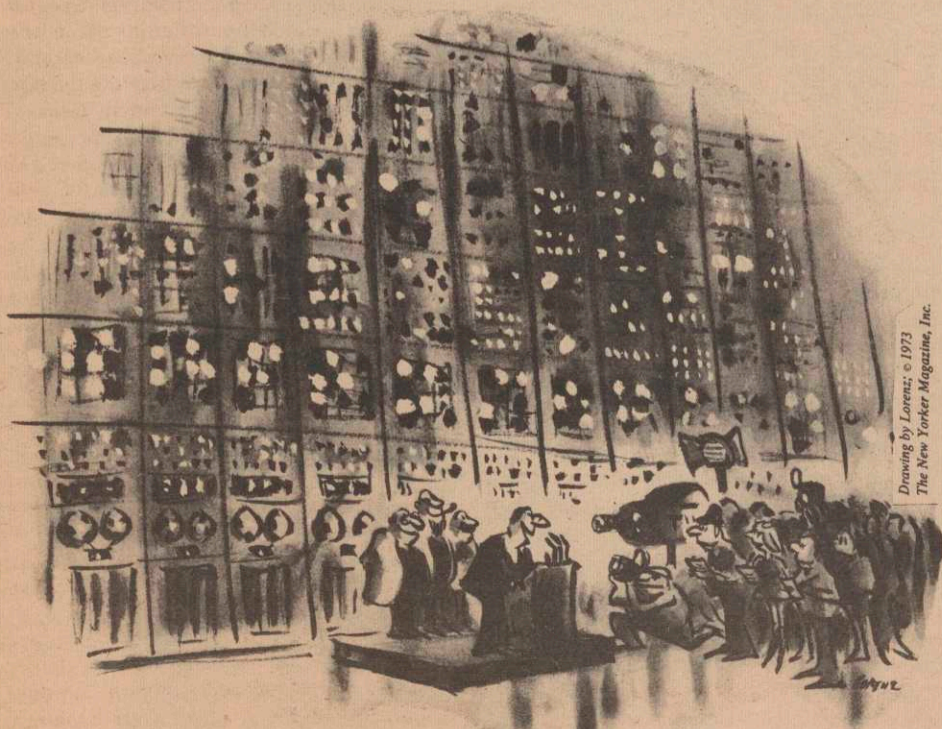
on the Canyon, and hold the line while they figure out what's going on . . . Zero Automobile Growth announced that it will sponsor a "Lemon Day Festival" on September 22. Featured will be a bicycle race and a car-bash (with sledge-hammers) in Indianapolis. ZAG would like to see anti-car rallies all over the country on Lemon Day; write to Ed Arszman, The Committee for Zero Automobile Growth, PO Box 44666, Indianapolis, Indiana 46204 for information.

'TIS MANY A SLIP twixt copy-writing and press run: Our plug last month for *National Lampoon's* "Techno-Tactics" should have said, "Spray likely bug hiding places with insecticides containing DDVP or 2,4,5-T unless you like the idea of giving chiggers and silverfish nothing more than a perfumed sitz bath"; now is it funny? (It's their joke, not ours.) Thanks to NatLampCo for pointing out the error, and we hope they'll get this little swarthy guy with the long teeth and burnoose off our foot real soon.

MILITANT VEGETARIANS are gloating, and unregenerate carnivores moping disconsolately at the empty meat shelves in supermarkets. But are Phase IV restrictions really to blame for the beef shortage? Or has there been another Administration cover-up of a political movement so explosive it must be hushed up at all costs? We refer, of course, to the hitherto unexplained closing of all airports, ports, radio, telegraph, and postal systems of Mauritius, rendering the island completely incommunicado. But our intrepid correspondent managed to escape via air mattress with the following dispatch:

"All the hotels and camping grounds are full, and business is booming. But not with Japanese tourists, or Egyptian and Greek royalty in exile. The latest arrivals are — cows, bulls, and steers, by the thousands, from the USA. The recent immigrants are close-mouthed about the purpose of their visit, but informed sources reveal that they are part of a new political movement — the Bovine Liberation Movement (BLM). Following an elaborate series of instructions, they apparently snuck over the Mexican border over a period of weeks — with puzzled ranchers attributing their disappearance to rustlers, coyotes, bookkeeping ineptitude, and hoof-and-mouth disease — and were shipped here in a fleet of secret Albanian freighters skippered by renegade, Neo-Trotskyite Hindus who seem to consider them a 'nation of slave deities.'

"They plan to establish an Independent Nation of Ungulates, free from the depredations of slick, cagey carnivores. Their spokesman, Mr. L. Taurus, late of Texas, pithily explained the relationship between American nutrition and Bovine politics: 'You call it protein,' he said, 'But we call it genocide.'"



Drawing by Lorenz; © 1973 The New Yorker Magazine, Inc.

"We've called you here today to announce that, according to our computer, by the year 2000 everything is going to be peachy."

A Supreme Display Of Poor Judgment

DANIEL F. FORD And HENRY W. KENDALL

This article is taken from a longer work (An Assessment of the Emergency Core Cooling Systems Rulemaking Hearing), of which NMA published another extract in June. From reading the longer report, it is easy to discern why FOE and Ralph Nader felt compelled to take the AEC to court. It further illustrates the AEC's shoddy attitude toward the safety of nuclear reactors, and the cavalier manner in which it deals with its critics, both inside and outside the agency.

This rulemaking hearing has allowed the public to study in detail the manner in which Atomic Energy Commission safety policy is developed. The activities of the AEC Regulatory Staff task force that reviewed ECCS [emergency core-cooling systems] in the spring of 1971 and formulated the Interim Policy Statement are documented on the hearing record. [NMA note: the Policy

The head of the task force gave a clear example of his disregard for the technical report he asked Aerojet Nuclear Company to prepare: he never read it.

Statement promulgated ECCS standards called the Interim Acceptance Criteria, intended to assuage anxiety about reactor safety.] CNI [the Consolidated National Intervenors, consisting of 60 citizens groups] is shocked by the magnitude of the regulatory failure that has been exposed. The Commission [AEC], in adopting the Interim Policy Statement, merely accepted the advice of the Regulatory Staff.

It can be established on the basis of the record of this proceeding that the Commission's reliance on the Regulatory Staff's technical judgments, diligence, and thoroughness was misplaced. The Regulatory Staff's failure to provide the Commission with reliable and complete information on ECCS as a result of their spring 1971 task force review should be understood by the Commission in assessing whether it will continue its reliance on Regulatory Staff positions.

The Regulatory Staff ECCS task force exhibited a great lack of diligence in searching out and acquiring data from the reactor vendors on the technical basis for the vendors' ECCS designs and LOCA [loss-of-coolant accident] transient analysis models [mathematical models used to estimate changes in variables such as temperature and pressure during a LOCA]. The Regulatory Staff task force did not make a systematic study of the ECCS hardware of the different vendors, nor of such important aspects of ECCS design as the location points for emergency core coolant injection. Although the ECCS of Westinghouse was designed using the FLASH code [a computer program], the Staff themselves did not run the code, an exercise that would have been prudent in order to gain insight into the systems in question. The Regulatory Staff ordinarily accepts the calculations of the vendors at face value and it is evident on the record that much of the computations accepted by the Staff are inadequately supported.

The Regulatory Staff task force apparently relied heavily on extremely casual information exchanges with the vendor organizations to provide them with needed information. Thus, Dr. Hanauer described the formulation of the Interim Acceptance Criteria by the Regulatory Staff task force:

"You should be made aware that the task force made no attempt whatever to reach a decision on the record. A large amount of technical information was received informally from industry people, particularly the technical experts from the reactor manufacturers. I have rough notes of some of the meetings, but not by any means a record."

That the Staff failed to acquire, in its in-

formal dealings with the industry, sufficient technical information to approve each vendor's ECCS and evaluation model is apparent. [NMA note: evaluation models are computer programs developed by reactor manufacturers to indicate whether their ECCS meet the Interim Acceptance Criteria.]

The hearing record brought out numerous gaps in Regulatory Staff knowledge of fundamental information relevant to this task. For example, the Regulatory Staff did not ascertain fundamental information relevant to flow blockage . . . until six months after they promulgated the Interim Acceptance Criteria, and even then, the only information the Regulatory Staff had concerning internal pressure variations within a core (necessary for estimating core-wide blockage) was the information contained in Westinghouse answers to CNI interrogatories.

An amazing indication of the Staff's lack of diligence in gathering necessary information

on ECCS are the Staff's volumes of questions submitted to each reactor vendor in June of 1972, one year after the promulgation of the Interim Acceptance Criteria. . . .

We believe that these interrogatories make very clear the fact that adequate review of the vendor evaluation models had not been made by the Regulatory Staff. For example, in June of 1972, the Regulatory Staff asked of General Electric [GE] the following question about the evaluation model that it approved in June of 1971:

"Describe how the broken loop and leakage paths are modeled for a postulated double-ended recirculation line failure."

How could the Regulatory Staff have decided whether the GE model properly represented the broken loop and properly represented the flow of water to the break if it has to ask in June of 1972 precisely what the GE model did in those respects?

Another example relates to the distribution of core spray assumed by GE. GE performed tests involving air up-flow with non-heated simulated [fuel rod] bundles as the basis for its core spray distribution assumptions. [NMA note: the ECCS in boiling water reactors (BWR) of the kind manufactured by GE would spray emergency coolant on the reactor core from above. In an accident, fuel rod bundles in the reactor core would be intensely hot - 2,000° F. or more. (The sky's the limit.) The intense heat in an accident would create an updraft of steam, tending to interfere with coolant reaching the core. GE's simulation used an "air up-flow," produced with fans, and unheated simulated fuel cannisters. The simulation, to say the least, would be imperfect.] In June of 1972 the Regulatory Staff asked GE to describe the basis upon which it could conclude that these air up-flow tests are applicable to the reactor situation. These tests were performed many years ago by GE, and they have been the basis upon which GE boiling water reactor ECCS have been evaluated for several years, and they are the basis upon which the model approved by the Regulatory Staff in June of 1971 determines how much emergency cooling water is delivered to the core. In asking this question, the Regulatory Staff raised the most fundamental doubt about the kind of review that it made of the GE LOCA analysis during all these years in which it has been allowing GE reactors to operate.

The Regulatory Staff's approach to the evaluation of the GE model, as documented by CNI discussions with the Regulatory Staff code consultants and by references to material in the record, makes very plain that the GE code has hardly been the subject of any systematic or rigorous scrutiny by the

Regulatory Staff. So little is known about what precisely is the GE code and so extensive are the unjustified assumptions and simplifications made in that code, that we are led to conclude that the Regulatory Staff, in approving the GE code without benefit of so much clearly necessary information, was simply saying to GE that GE could assess the consequences of LOCAs in GE reactors however it wanted to.

In Robert Colmar's testimony [Mr. Colmar is a member of the AEC Regulatory Staff who worked on ECCS, and particularly on problems of coolant flow blockage], he noted that Westinghouse has blunted a request for confirming data on the FLECHT flow housing [apparatus used in Full Length Emergency Cooling Heat Transfer tests], that PWR [pressurized water reactor] FLECHT data was incompletely reduced, and that the use of incomplete data was questionable. It was improper for the Staff to have failed to insist on acquisition of the confirming data and, additionally, to have allowed questionable data-analysis techniques to remain unadjusted.

Colmar criticized the ECCS task force for its lack of diligence in resolving problems in

All Too Human

Does criticism of the AEC imply criticism of people who work for it?

By no means. Individually, AEC personnel certainly possess virtue in at least as great measure as their counterparts in other agencies, in industry, in academia, and in the public at large.

It is an ancient observation, though, that men will without hesitation do things as members of a group that they would flatly refuse to do in their individual capacities. This is as true of AEC personnel as it is of anyone else, no doubt, and helps explain how an organization composed of good people can do bad things.

Adherence to a double standard of morality - one individual, the other corporate - appears to be a universal human failing, and it would be unjust to blame AEC personnel for exhibiting it.

Another universal human weakness is the tendency to deceive oneself almost without limit, if need be, to avoid facing an unpleasant truth - facing the fact, for instance, that the work one has dedicated one's life to is not entirely in the public interest. It is not to be expected of an advertising executive that he be first on his block to decry the evils of artificially stimulated "demand" for "durable goods" with premature obsolescence designed into them, nor can you expect many industrialists or economists to be among the early critics of growthmanship and the early converts to a steady-state economy. It would be equally unreasonable to expect of AEC personnel that they be among the quickest to perceive and proclaim the dangers we are exposed to by "the peaceful atom." Human nature almost irresistibly compels them - like us - to turn a blind eye toward any harm being done by the cause they have dedicated their careers to.

Unless NMA names names, therefore, its criticism of the AEC should not be interpreted as criticism of any individual associated with it.

another critical area. To determine blockage [of coolant channels] and swelling [of fuel rods, from overheating, causing blockage], it is necessary to have realistic estimates of (1) rate of temperature rise of fuel rods, (2) maximum temperature, and (3) internal pressure described throughout the core. Mr. Colmar indicated that such information had not been subject to review by the ECCS task force at any time. He further indicated that this lack led to a hastily formulated, simplistic representation of the extent and description of blockage in the core. . . .

The ECCS task force, in its deliberations prior to the formulation of the Interim Acceptance Criteria, failed to consult experts at Oak Ridge National Laboratory (ORNL) who were uniquely competent to criticize and to supplement information otherwise available to the task force. CNI believes this to have been a supreme display of poor judgment; ORNL is where the Commission's ac-

knowledgeable experts in fuel rod failure and other disciplines are located. ORNL Director Alvin Weinberg's February 1972 letter to AEC Chairman Schlesinger confirms CNI's conclusion that this was a serious defect:

" . . . that we were not involved in preparation of Interim Acceptance Criteria reflects a deficiency in the ORNL-AEC relation that troubles me."

Many of P.L. Rittenhouse's criticisms of Regulatory Staff treatment of flow blockage and fuel rod swelling are contained in Chapter V. [Rittenhouse is an Oak Ridge expert in the areas just mentioned.] He criticized the Staff treatment of swelling, saying that he did not believe Regulatory Staff technique constituted good engineering practice. . . . Moreover, he noted that no one on the Staff panel was a metallurgist and that no one had the expertise necessary to carry out the techniques themselves. Chapter V also notes the Staff misunderstanding of the threshold for the onset of clad swelling [the swelling of hollow rods in which fuel is "clad"] and further that the Regulatory Staff had not demonstrated to him [Rittenhouse] either through their writing or in their oral testimony that they had a technical understanding of rod swelling and flow blockage during a LOCA. The ECCS task force treatment of [fuel rod] embrittlement was based, in CNI's view, on at best a high school level understanding of reaction rates. Rittenhouse stated that he could not make any sense of embrittlement criteria based only on a temperature limit as in the Interim Acceptance Criteria [whose most explicit criterion is that emergency cooling systems must prevent reactor cores from overheating beyond 2,300° F. during a LOCA].

Other examples of Regulatory Staff weaknesses in technical areas were identified by Dr. Rosen. He said that evaluating the analytical models required expertise which was not available within the Regulatory Staff itself, and that neither he nor Mr. Colmar felt there was enough information available to the Staff to evaluate the full scope of the codes. Dr. Rosen said that the Regulatory Staff alone does not have sufficient expertise to do a professional job of evaluating vendor models. . . . Despite the Regulatory Staff's unchallenged need for expert consultants in order to evaluate vendor ECCS claims, Dr. Rosen testified that the Regulatory Staff basically disregarded the knowledgeable opinion it received from its principal source of information, Aerojet Nuclear Company (ANC). As Chapter IV explained, ANC was disregarded because its views were inconsistent with reactor licensing. Dr. Hanauer [who headed the task force] gave a clear example of his disregard of the major technical report he asked ANC to prepare: he never read it. Browsing through the document was sufficient to establish in Dr. Hanauer's mind that a document which discussed the fact that required aspects of LOCA analysis were "beyond the scope of engineering science" was "useless" - from the point of view of licensing.

The superficiality of Regulatory Staff technical analysis is not limited to the task force review in the spring of 1971. Consider the Regulatory Staff rebuttal testimony on blowdown heat transfer [transfer of heat from core to coolant during depressurization of a reactor in an accident]. In contrast to the detailed analysis of ANC on blowdown heat transfer, the Regulatory Staff has treated this important area in the most superficial manner.

The record is replete with evidence that the competence and thoroughness of the Regulatory Staff is inadequate to the demands placed on it. Specific Regulatory Staff weaknesses include (1) great lack of diligence in searching out and acquiring data from the reactor vendors on the nature and character of the support for their assurances of safety; (2) superficial reviews, not infrequently accompanied by misuse or neglect of available engineering advisory support, of many technical areas of importance to the proper operation of emergency systems; and (3) the fact that many conclusions reached by the Regulatory Staff are unsupported, or contradicted, by the entire array of available evidence, perceptively understood. Staff errors in a number of situations have demonstrated at best a superficial comprehension of the sometimes complex phenomena and circumstances relevant to the physics and engineering problems of LOCAs.

We believe that the Commission should weight heavily the accumulated evidence of the unreliability of Regulatory Staff ECCS analysis in making its ultimate policy determination on the basis of this record.

STOCKHOLM CONFERENCE

ECO JOINTLY PRODUCED BY THE ECOLOGIST AND FRIENDS OF THE EARTH

STOCKHOLMS-KONFERENSENS EKO ЭХО СТОКГОЛЬМСКОЙ КОНФЕРЕНЦИИ

ECO DE LA CONFERENCE DE STOCKHOLM

ECO DE LA CONFERENCIA DE ESTOCOLMOU

斯德哥尔摩会议 回声



The Stockholm Sensation

ECO Reverberates Again!

It was an unofficial paper, but delegates stole copies from each other. In the press room, correspondents from the world's press had copies before them as they wrote their own stories.

It was praised, reviled, quoted (usually without credit), slaved over. And we think it made a difference.

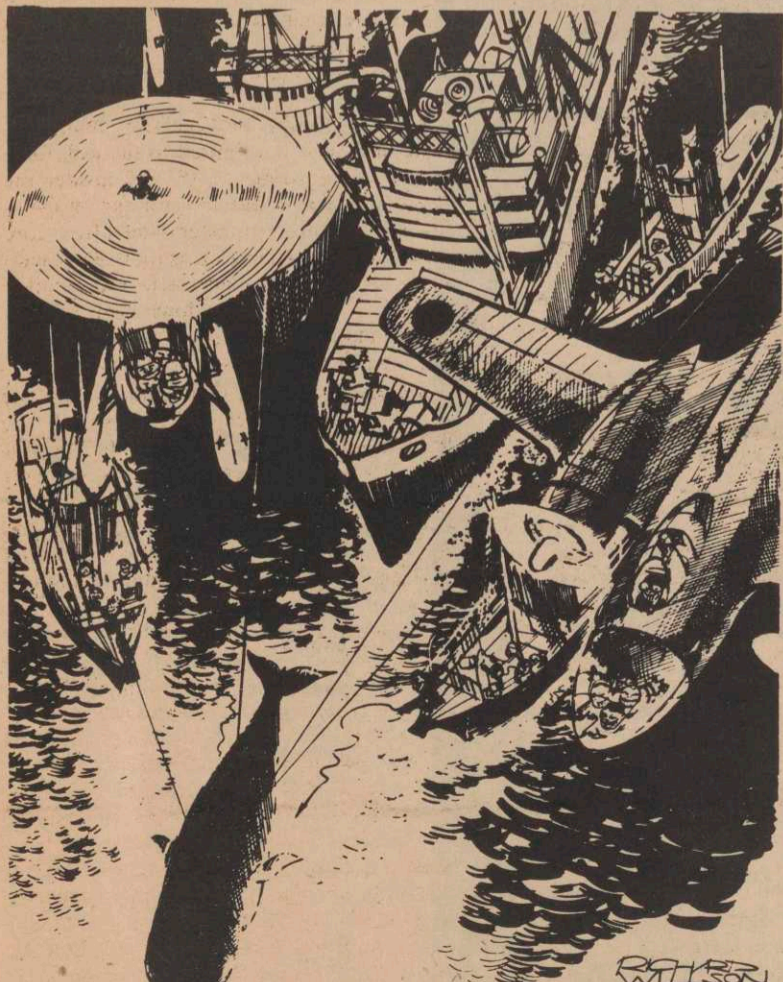
The Stockholm Conference ECO was all this, but it was something significantly else. It was a Friends of the Earth invention (born at the Frankfurt Book Fair, 1971), given its essential assist by The Ecologist and their creative crew, drawn into a logistical fact of life by Lennart Daleus and Jordens Vhner, and it was the Stockholm Conference's only independent daily.

Its independence was inevitable. The crew came from Sweden, the UK, Switzerland, France, Yugoslavia, West Germany, and the US.

THE NIGHT WRITERS OF STOCKHOLM

The editors were in musical chairs. The crew would meet in the NGO Lounge of the Old Parliament Building for second breakfast and review the day's assignments, meet at lunch at the Hamlet (across from the Stockholm depot), trade notes on what had been learned and what must yet be learned, assemble in two borrowed rooms of a school building to write, rewrite, type, illustrate, and paste up. The crew was always a few minutes late in giving Mr. Daleus the next morning's issue, which the printers would nevertheless accept even as late as 2230 hours and have in print a few hours later. Before breakfast, the beautiful young people did the rest. With bicycles, tram rides, baby strollers, and afoot they got the copies to the delegates' hotel room doors, out in the suburbs if that was where the audience was, in the press-room, at conference doorways.

The papers were read. They were heeded be-



Going... Going...

awing by Richard Willson, from Spaceship Earth, a monthly publication of Friends of the Earth, Ltd, London.

cause their ingredients were chips that fell where they might. No nation escaped the criticism or praise the crew thought was useful.

The initial idea had been to have a paper that would praise what it could; criticize such error as it recognized, outline what it wished had been done instead, mixed with humor, informality, but consistently dependent upon a hard search for international environmental facts.

It could have been based on any number of fine ideas, all of which would have failed, had the crew been less than bright, hard-working, and not to be fooled.

Summed up, ECO was one of the finest things Friends of the Earth (all the sister organizations) could have put together. Near the conference end, we asked if people wanted it to keep going. We wondered if there were others who agreed with a US delegate who, in spite of the periodic roasting the US got in ECO, said, "The crew that put this paper together should go to all international conferences so we'd know what he hell is going on."

ECO #2 IS HEARD FROM

Sessions in Stockholm, in London, New York, San Francisco (and perhaps elsewhere) sought out ways to keep ECO sounding off. Before we could find the answer, ECO #2 was needed.

One of the severest environmental threats of all--an unsafe nuclear-power technology--needed such world-wide exposure as FOE et al. could give it. The exact occasion was what would otherwise have been obscure, extended testimony about the hazards in the emergency core-cooling systems of reactors--a most difficult subject to dramatize, for all its importance.

We therefore put together the world's only every-other-daily, distributed it to the world press and conservation leaders, and to Members of Congress and key officials. We tried our best, around the clock at times, to interpret what was going on in an unmarked building in Bethesda, Maryland, beyond the range of the regular press.

It was well that we did. Our crew, assembled from Cornwall, London, New England, California, and Washington, DC, loaded with knowledge, talent, and perseverance, dropped several pebbles and a few boulders in the water, the waves from which are still bearing tidings where they had not been borne. We were of major assistance to the Union of Concerned Scientists, the Consolidated National Intervenors, FOE groups abroad who were concerned with the same urge for a nuclear-reactor moratorium, and (indirectly and almost imperceptibly at first), the press.

NEW CONFERENCES NEED ECO

ECO #1 and #2 got many people started on the way. With our experience and with two subsequent discussions in London and an announcement in New York, our nomadic hunter-gatherer newspaper has embarked on the following plan.

1) We will cover meetings of primary environmental importance in the global view--one or two a year. We're aiming now at Santiago (Law of the Sea) and Bucharest (Population).

2) We will assemble all the original crew we can afford, including our topflight illustrator, and hie to the meeting place, wherever on earth it is.

3) We will bring crews familiar with, and originating in, the various countries and worlds, prepared independently to call things as they see them, but in a Friends of the Earth friendly way. We will try to make no mistakes and to quickly admit those we or others discover.

4) We will establish a reprint

format that is collectable, for the environmental bibliophiles we hope to encourage.

5) We will look for financial help where we can find it and will hope to build our own following, in at least three categories:

- a) Conferees who want to know "what the hell is going on."
- b) Subscribers, already environmentally oriented, from all over, who want to support the effort.
- c) Other subscriber-supporters (libraries, press) and point-of-sale impulse buyers.

AND NOW...INTERECO!

Initially on a monthly basis, The Ecologist and Not Man Apart will carry a monthly ECO supplement. It will be available to the several other sister FOE groups and, as we discover how to do it, to other NGOs

ECO will be edited in Cornwall, by The Ecologist's crew, with assistance from all FOE groups and from the Nairobi office. Just as soon as we can complete the arrangements, we intend to help Maurice Strong's United Nations Environmental Programme succeed--getting word into it, and out of it. We want to have individuals from the many FOE groups put in some detached service in Nairobi, and we want to find funds to make it possible. We will each need to know how the other looks from that vantage point. We are sharing our office space in Nairobi with the nascent Marafiki wa Dunia (FOE in Swahili), all of it African, which will provide insights into Third World thinking

Duly written and edited, the monthly interim ECO will tell us all what is coming up, will encapsulate what has taken place, will editorialize will carry short features from the respective sisters, and will then take to airmail in film, ready for instant incorporation in the respective FOE (or other) newsletters.

We would like our respective imprimaturs to retain their identity (this is our child)--and let our egos end with that. The private egoworlds of the hundreds of essentially different conservation organizations on earth have their own high purposes and their own severe limits, just as the earth does. We shall try to keep readers aware of both, with emphasis on the hardest concept of all for developed--and developing--countries to accept:

A finite earth must have limits, and too many have already been passed.

HOW CAN YOU HELP?

- 1) Keep caring.
- 2) Become a Supporting ECO Subscriber.
- 3) Buy back-issues for yourself or for a library (a tax-deductible gift).
- 4) Echo the reverberations yourself, whenever pen, phone, or platform let you. (Note: ECO #1 cost some \$7,000, exclusive of travel expenses, with no salary included; ECO #2, about \$10,000. A substantial amount was recovered from sales and advertising, and will help subsequent efforts but neither issue would have appeared without personal savings up front.)

We invite you to share the support

David R. Brower

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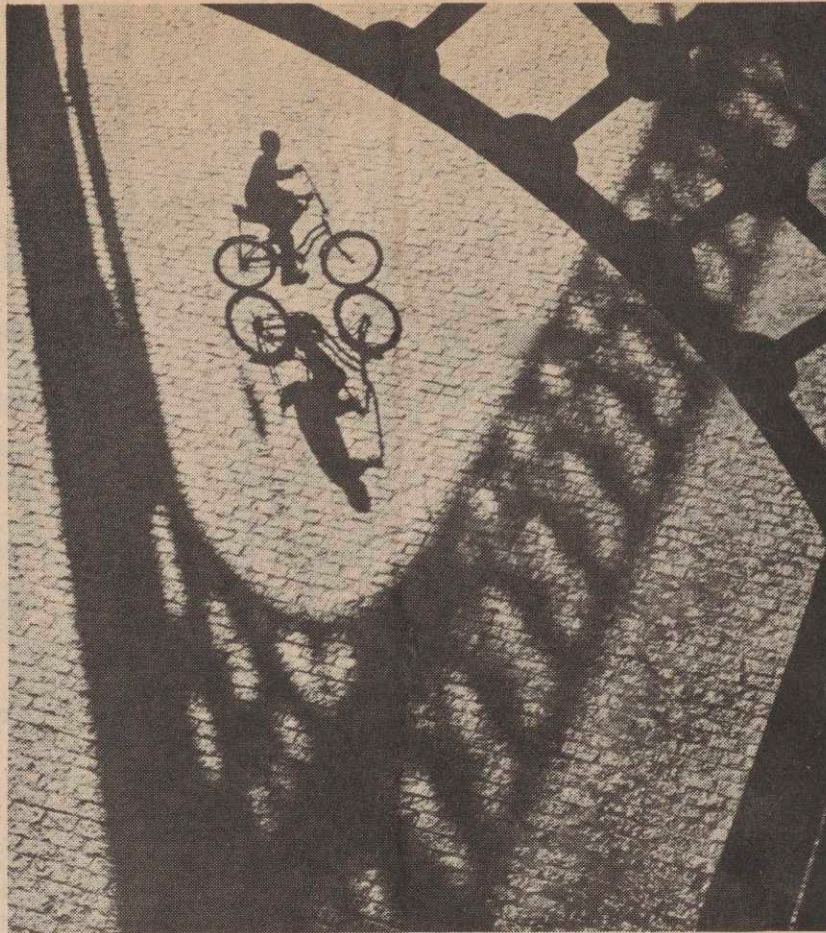


Photo by Arthur Tress.

Much of human technology and "progress" has been attained only at the expense of natural beauty, human dignity, and social integrity, and those who have suffered the greatest loss of these amenities have also had the least benefit from the economic "progress."

—Donella and Dennis Meadows

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April 13, 1974

JWF

MEMORANDUM

To: Carroll L. Wilson

From: Gilbert W. Low *GW*Re: Initial Impressions on the Mesarovic-Pestel Presentation

On April 8, Mesarovic and his colleagues presented what was billed as their "alternative world model system" at the Woodrow Wilson International Center in Washington. The formal presentation lasted three hours, followed by drinks, dinner and another 2 1/2 hour discussion. This memo summarizes my impressions of the discussions and a few remarks by Mesarovic and Pestel at breakfast the following morning. I shall concentrate on what appear to be the important features of the modeling approach, rather than on the specific conclusions of the model.

The conference previewed a two-week seminar in Austria starting later this month. The audience, as seen from the attached guest list, was drawn largely from public policy institutions, many of whom were familiar with econometric modeling, operations research and system dynamics. Eight people attended from the World Bank, including McNamera who stayed through the evening session. No documentation was distributed, although I did get a look at part of the large technical report, which is available from Raiffa's institute in Austria. A hard-sell approach was evident, with almost a dozen project participants making enthusiastic and competent presentations. The guests seemed disappointed about not receiving any documentation (to see "if there really is a model"), skeptical about some of the specific formulations, and constructively sympathetic toward the overall effort.

The model divides the world into 10 geographical regions, each of which consists of eight "levels", which were shown on a slide as follows:

<u>Levels</u>		
Norms Formulation Stratum	{ 1. Human biological 2. Psychological 3. Socio-political	} Individual Strata
Organizational Stratum	{ 4. Institutional 5. Economic	} Group Strata
Causal Stratum	{ 6. Technological 7. Ecological 8. Geophysical	} Natural Strata

Not all of these categories are completed in the model, although I gather that much of items 5 - 7 are modeled. The presentations focused on energy, food and population.

The eight levels conform to a "hierarchical" organization, with each level imposing constraints on the lower levels. In normal behavior modes, the levels can operate relatively autonomously, but in a "crisis" the levels merge and are crucially interrelated. The conditions defining crisis, or the manner in which levels merge is not clear to me, but the notion appears to be consistent generally with Forrester's comments about different growth modes: In the period of exponential growth, many different sectors can operate relatively free from outside constraints, so that trade-offs are minimized and in many situations objectives can be optimized; in the transition, the rate of growth declines as subsectors of the system impose limits upon each other, and sub-optimization and trade-offs become necessary.

Mesarovic and Pestel put this distinction between growth phases neatly in their "Report to Salzburg" (which was not mentioned at the conference): There are two stages in the growth process -- undifferentiated growth and organic growth. The first is pure exponential, unconstrained increase; the second is related to a function specific to part of an integrated pattern. Undifferentiated growth is characteristic, for example, of early cell division in an organism, where each cell is like all the others. Organic growth exhibits a process of differentiation "in which the cells become organ-specific according to the development process of the organism" (p. 35). In the world system, growth should be controlled to conform to the requirements and constraints of the overall system. "It is organic interactions which, by themselves and due to specialization, provide control for undifferentiated growth. If such undifferentiated growth persists locally (or even in some, e.g. developed regions) it represents actually a cancer-type phenomenon which is bound to kill the entire organism unless brought under control." (p. 38) In their view, the growth process cannot be analyzed fruitfully in the context of a "monolithic" world model (read, WORLD2 and Limits to Growth) but only in a system which distinguishes among interacting regions and thus brings out the diversity of the real world. Pestel and Mesarovic made much of the contrast between "monolithic" models, which make a sin out of growth per se, and their own "multi-level, hierarchical" model, which places growth in the context of the "world organism".

The time frame of the model is roughly the next 50 years, presumably because of the system delays involved in developing and executing policies. The choice of 50 years, vs. 25 or 100, for example, was not

really explained.

The type of output generated by the model was somewhat different from that of a system dynamics model. As far as I could tell, Mesarovic et al. are interested in making predictions more than in analyzing behavior modes. The model does give time series output similar to DYNAMO plots, but the emphasis seems to be on comparing different policy rules on the basis of values at particular points in time. For example, an optimal price of oil, from the viewpoint of the producing countries (\$9), was developed on the basis of maximizing output for the producing region in the year 2025. The time path of price or other variables did not seem to be as important.

The use and source of data also differs from system dynamics modeling. There are numerous product categories and statistically-estimated parameters, and the discussion gave the impression that subjective, non-data-based elements are avoided whenever possible. With respect to a particular problem in the agricultural sector, one participant said, "We didn't want to open that can of worms, because we didn't have the data." To be fair, however, there were conflicting comments about the importance of subjective data. A numerical data orientation is, of course, not unusual; but, with respect to the Mesarovic model, it seems to reflect three motivations: (1) to give the model more credibility relative to "other world models" so as to attract the attention of economists and other social scientists; this is consistent with the effort to enlist the aid of Klein, Hickman and other econometric model-builders; (2) to capture the diversity necessary for analyzing the growth issues posed above; there are extreme examples of disaggregation -- e.g. in the demographic sector where population is divided into 86 age groups; (3) to provide more specific policy instruments

than can be extracted from WORLD2, etc.

The extensive use of statistical (least-squares) estimation gives rise to model abstractions which one tries to avoid in system dynamics. In economic models, equations commonly represent conditions that depend on or reflect certain implicit behavioral assumptions. Thus, while the usual equilibrium conditions in a macro-economic model reflect assumptions about competition, utility maximization, and information flows, they do not reveal explicitly the actual decision processes or parameters that are meaningful to people engaged in the processes being modeled. In the Mesarovic model, for example, there are many production functions whose parameters (exponents of labor and capital) are estimated in the usual log-linear fashion, mostly based on 20 (annual) observations. These estimated parameters tell us little about real decision mechanisms, nor, for that matter, about the next 50 years, when modes of behavior probably will differ from those experienced during the observation period.

Although we were not given any model equations, it appears that the causal structure is not strictly state-determined and does not retain the rate-level dichotomy. There is extensive use of simultaneity, although the form was not clear (input-output matrices, econometric simultaneous equation relationships, etc.). Mesarovic said privately that he considers simultaneity appropriate under certain conditions of causality and seems to distinguish between simultaneous causality and causality wherein the causal agent precedes the dependent variable in time. He said that his forthcoming book spells out the different types of causality in mathematical terms. Practically speaking, it appears

that the acceptability of simultaneity is determined by conventional economic theory (e.g. very rapid price adjustment relative to other determinants of demand and supply) and computational convenience. Apart from simultaneous functions, the model does contain integrations, but I gather that the process is constrained by equating the DT with normal (annual) sampling periods, rather than by fixing the DT in relation to underlying integration processes.

Another system dynamics principle which may be violated is that which requires the representation of conserved flows of physical processes under certain conditions. I base this impression on a comment that was made with respect to international trade -- that the trade flows are constrained by the condition that world imports equal world exports. In a system dynamics model, inventory depletion and accumulation would automatically reflect this condition at all times, and one would not have to impose it on the system as an exogenous constraint.

Mesarovic and others emphasized the model's flexibility with respect to policy scenarios. The model can operate in an "interaction", or gaming, mode, where the "interactor" supplies certain necessary parameter values (e.g. allocation proportions, conversion factors) for each (annual) iteration and interacts with the model as it marches through time. The interactor can supply different "scenarios" as well, which seemingly can include the addition or elimination of feedbacks as well as simple parameter changes. Thus model structure can change throughout an interaction run, and the distinction between model structure and scenario is vague. The purpose of model/human interaction is apparently to familiarize the policy-maker with the model, rather than to enable the model to run (it

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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Memo to *JMJ*

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can operate without an interactor) or to allow the model-builder to improve his theories by observing an interactor's responses and decisions. The policy-maker learns through interacting with the model, and, hopefully, he can develop policies (decision rules) that yield more satisfactory model outcomes. Pestel distinguished their model, "a planning and decision-making tool", from "world-models".

In conclusion, I have discussed several methodological distinctions between the Mesarovic- Pestel model and system dynamics models. The analysis is suggestive and certainly subject to change and elaboration once we receive documentation. Mesarovic and Pestel are undoubtedly sincere and are trying to offer something substantial and constructive. They both emphasized the importance of new approaches and a future-orientation which cannot be based simply on observing recent numerical data. Yet I do get the impression that underlying their model is a fairly conventional set of social theories and validation approaches.

LETTERS

Ultrafast Streak Camera

The Research News update on "Laser spectroscopy: Probing biomolecular functions" (6 June, p. 1002) was timely and interesting. Jean L. Marx quite appropriately conveys the explosive flurry of research activity that has increased the understanding of large biological macromolecules since the advent of a number of laser spectroscopic techniques—in particular, the picosecond light probe. We would like to point out a very important development—the application of the ultrafast streak camera.

Streak cameras have been in existence for some time, but recent tube developments by Bradley and co-workers (1) have resulted in transit time spreads sufficiently small to demonstrate resolution of events as short as 500 femtoseconds. Briefly, the camera works as follows. Light from a picosecond event enters the slit of the camera and is focused onto a photocathode where electrons are released via the photoelectric effect, the number of electrons released at any particular instant being proportional to the light intensity on the photocathode during that period of time. The electrons are accelerated through an anode and then deflected by a voltage ramp which streaks them across a phosphorescent screen so that electrons released at different times strike the screen at different positions. A densitometer trace of a photograph of the resulting phosphorescent "streak" then gives an accurate measure of the lifetime of the event. By including additional image intensifier stages, the sensitivity of the camera can be improved to the point where individual photoelectrons can be observed. Compared to the alternative techniques, the streak camera has powerful advantages, such as high resolution, high sensitivity, commercial availability, and a simpler and more reliable experimental arrangement.

Streak cameras have recently been used to measure picosecond fluorescent lifetimes for a number of dyes (2). Our group at Los Alamos has been using these devices to investigate the fluorescent properties of pigment molecules in photosynthetic systems. For example, we have measured fluorescent lifetimes of various pigments in vitro (α and β carotenes, chlorophylls a and b, and phycocyanin) (3), algae [*Chlorella pyrenoidosa*, *Anacystis nidulans*, *Agmenellum quadruplicatum* (PR-6), *Chlamydomonas reinhardtii*] (3), and higher plants (chloroplasts and leaves of spinach, jack bean, lettuce, and tobacco). Perhaps not surprisingly, we have found that all chloroplast-bearing plants and algae have

nearly the same fluorescent lifetimes in vivo (40 picoseconds), which suggests a universal chloroplast behavior for the higher plants.

A statement in the Marx article that recent results are consistent with the picture that the excitation energy spreads through photosystem pigments by means of a resonant dipole-dipole energy transfer is a well-known hypothesis, first postulated by Förster in 1948. Since then, plausible analyses have been performed by Bay, Pearlstein, Dexter, Robinson, Knox, and Montroll, to name but a few. Experimentally, there has been some indirect, although not entirely convincing, evidence to support this view. Recently, we demonstrated directly in the time domain that such a dipole-dipole interaction is appropriate (4), at least in the case of chlorophyll in vitro at concentrations comparable to that found in chloroplasts. The lifetimes as a function of pigment concentration and the non-exponential form of the fluorescent decay were consistent with existing theory. However, based on the decay rates we measured, we estimate that each chlorophyll a homotransfer in vivo takes only 0.2 to 0.3 picosecond. This is so rapid that, perhaps, as has long been suspected by theoreticians, a delocalized or coherent exciton description may be necessary. These and other recently developed experimental techniques may soon lead to answers to many of these fundamental questions.

A. J. CAMPILLO

V. H. KOLLMAN, S. L. SHAPIRO

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Los Alamos, New Mexico 87544

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Economic Growth

Glenn Hueckel, in his article "A historical approach to future economic growth" (14 Mar., p. 925), asserts that "the history of technological advance suggests an optimistic outlook for future economic growth." This statement and the text of the article which purports to support this point of view reflect the adoption of an overly narrow time perspective on the part of the

author. In effect, he has taken a minute segment of human history and projected interactions which occurred within this brief time span into the future.

Until the beginning of the 19th century, energy consumption and population growth remained relatively stable, with very slow growth in both indices. Between 1800 and 1974, however, the growth of these variables has been exponential. Hueckel suggests that, in the past, technology has served to remedy resource shortages and that, in the future, the market system will serve to allocate resource utilization away from those inputs which are scarcest. However, this analysis is based upon the *brief* experience of industrial societies.

Human societies have been on a consumption and production binge for the past 200 years. This period represents a unique and temporary transition from pre-industrial social structures. Hueckel overlooks the commonality of the dynamic factor which made this type of growth possible, in both energy consumption and in population—man's extension of his tool-using capabilities through the use of fossil (terrestrial) fuel reserves which have accumulated over millions of years (1). Thus, the basis of the accelerated energy consumption and population growth over the past 200 years has been energy reserves which we now recognize are rapidly dwindling.

The extreme dependence of industrial societies on fossil fuel for terrestrial energy resources has facilitated the development of social and economic structures which are inconsistent with long-run basic ecological and thermodynamic principles (2). The primary structural changes requisite for the establishment of a tractable economic and social structure compatible with basic physical and ecological restrictions are unlikely to be promoted by the indirect allocation signals generated by the market mechanism. This is not to say that market signals do not perform a useful function. Given the long-run trajectory of the economic and social system, fluctuations which occur within this trajectory can, in part, be modulated through economic signals. It is unrealistic, however, to expect market signals to interpret and alter the trajectory itself.

Indeed, the best we can do in the context of thermodynamic constraints—in an evolutionary time perspective—is to "buy time." And perhaps the best way to do so is to focus our attention on the structural parameters of the system and to devise policies which—viewed in toto—can alter the trajectory. This does not require the identification or agreement of what is best or optimum. Rather, it necessitates the contin-

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COVER

Portion of central China. Lines on side show trend of the Altyn Tagh (alternatively Astin Tagh or A erh chin) fault, perhaps the greatest active continental strip-slip fault in the world. See page 419. [ERTS photo (8) No. 14-490-40625-A0]



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ual evaluation of where the system is headed and which directions are undesirable.

To paraphrase an editorial comment appearing in a *New York Times* feature story (3) on a recent American Economic Association meeting, economists appear to be busily rearranging and optimizing the arrangement of deck chairs on the Titanic. It is not simply a question of *how* we are getting there; we must determine *where* we are going.

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1. For a more detailed discussion, see N. Georgescu-Roegen, *The Entropy Law and the Economic Process* (Harvard Univ. Press, Cambridge, Mass., 1971).
2. H. Koenig, T. Edens, W. Cooper, *Proc. IEEE* 63, 501 (1975).
3. S. Golden, *New York Times*, 6 January 1974, sect. F, p. 17.

Hueckel's article warrants the same kind of optimism as that expressed by the man who has fallen halfway down from the top of the Empire State Building without yet encountering any substantial limits to his acceleration. Backward-looking empiricism has its limits and must be supplemented by rational deduction from first principles. I presented (1) a commonsense argument against continuous growth, based on the first principles of diminishing marginal utility and increasing marginal cost. Hueckel claims that I misused the concept of diminishing marginal utility (by applying it to income rather than to a single commodity) and thereby somehow smuggled my own value judgments into the argument. If I misused the concept of marginal utility then so did one of its originators, E. Bohm-Bawerk, who also applied it to income as well as to single goods (2). The only assumption in Bohm-Bawerk's treatment is that there exists for the individual a hierarchy of wants, and sensible people satisfy their most pressing wants first, whether in alternative uses of a single commodity or in alternative uses of income. The modern textbook definition as the "partial derivative of a hypothetical utility function" requires the assumption of cardinally measurable utility and some specific utility function, both of which are at best heuristic analogies, and at worst unscientific pretensions. But if one wants to assume cardinal utility, then I confess that I find the "Bernoulli hypothesis" very convincing.

The simple argument was this: if marginal benefits of physical growth decline while marginal costs rise, there will be an intersection beyond which further growth is uneconomic. The richer the society (the more it has grown in the past), the more

likely it is that marginal benefits are below marginal costs and that further growth is uneconomic.

The best attack on this argument is not to question the shapes of the curves, but to argue that the curves themselves continually shift apart so that the intersection always stays ahead of us, and thus growth remains economic. But there are physical limits to efficiency (how far down cost curves can be shifted), and I suspect that our rush toward growth-permitting technologies (for example, fission power) is more likely to push the cost curve up than down, once all costs are counted. Also our efforts to push the benefit curve up by creating new wants too rapidly and too artificially are, in my view, more likely to pull down the benefits curve than to push it up. Probably Hueckel would dismiss these claims as personal value judgments. But they are not value judgments, they are personal judgments of fact. What in fact are the real costs and benefits at the margin? We do not measure costs of growth in our social accounts—or rather we do measure them, but count them as benefits. Deciding just what is a cost and what is a benefit involves value judgments, but is also in large part a judgment of fact. That the properly accounted marginal benefits of growth in the United States are below the properly accounted marginal costs, or at least soon will be if physical growth continues, is a judgment I consider reasonable, though it cannot be conclusively demonstrated. But neither can the contrary proposition be conclusively demonstrated, yet Hueckel and other growth economists accept it as the only conceivable possibility.

Hueckel says that even granting the diminishing marginal utility of income, my argument still runs into the grave problem of "identifying the point at which . . . society moves from the classification of 'poor' to 'rich.'" If we cannot distinguish poor from rich, then what is the justification for growth in the first place?

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Hueckel's discussion of some crucial issues in the "limits to growth" debate is more careful and sophisticated than most, but it still begs too many important questions to be persuasive.

First, Hueckel argues as if ecology had never been discovered. Suppose, for example, that it does become economically

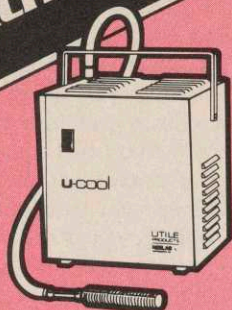
and technologically feasible to extract metals from seawater and ordinary rock. What would the ecological consequences be of processing (in an extremely energy-intensive fashion) the huge volume of materials needed to supply our current demand, much less the expanded demand he envisions? After all, the ecological problems and costs of exploiting the relatively high-grade Western coal and oil-shale resources have provoked considerable controversy (and even some loose talk about the necessity for "zones of national sacrifice"). In the past, the scale and intensity of human economic and technological activity has been below the threshold that would cause serious ecological degradation, and technological development could therefore proceed unimpeded. Now, there is little or no slack in the ecosystems important to human well-being, and every technological "solution" seems inevitably to create additional problems.

Second, Hueckel appears to overlook the enormous planning and management problems attached to continued growth. Starting from our already high level, the implications of future growth are daunting, not only in terms of the quantities involved (for example, the construction of as many as 900 nuclear power plants in the next 25 years), but also in terms of our ability to orchestrate the work of innovation, construction, and environmental management to form a reasonably integrated, safe, and harmonious whole (unlike the present situation, in which undesirable social and ecological "side effects" abound and thorny safety issues remain unresolved). Technology cannot be implemented in a vacuum. In fact, something like the ecological "law of the minimum" applies: the factor in least supply governs the rate of growth in the system as a whole. Where, for instance, shall we find the staggering amounts of capital we will need to build all those nuclear power plants *and* exploit offshore oil *and* create new coal mines *and* so on?

Third, ironically, economist Hueckel neglects important political-economic issues. For example, the market price mechanism handles modest incremental change with relative ease, but it tends to break down when confronted with genuine scarcity (for example, famine) or marked discrepancies in supply and demand (for example, monopolies and cartels). Nor does it deal appropriately with common property resources. Moreover, discounting can make ecologically priceless future resources (like a breathable atmosphere) effectively worthless to today's economic decision-makers. Furthermore, although letting the market take its course can adjust supply and demand most of the time, the social

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consequences are often so painful that governments will usually go to considerable lengths to avoid it. Including the social costs of production in market prices, as Hueckel and others suggest (although the practical difficulties of doing so are substantial), would remedy some of the defects of the market alluded to above, but only by increasing the painfulness of the market's impact on individuals. The critical question therefore is, Do we have the political will to reform the market if this will involve personal sacrifice? or, more colloquially, Who will bell the environmental cat?

This by no means exhausts the issues Hueckel has failed to consider—thermodynamic limits to technological advance, limits to the invention and application of knowledge to human problems, and many other questions only hinted at above (for example, the social and political implications of accepting the "Faustian bargain" of modern technology) that I have discussed in detail elsewhere (1). Hueckel has considered technology and the market price system in artificial isolation from ecological and other practical realities. His optimism about future economic and technological growth would therefore appear to be ill-founded.

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Hueckel criticizes the Meadows-Forrester assumption that, with continued economic growth, "world resource usage will approach the corresponding U.S. rate." Hueckel promotes instead the sound theoretical economic position that the technology employed to achieve a given end will reflect the "prevailing structure of the relative prices of those inputs [capital, labor, and resources]." It would seem to follow that poor countries characterized by surplus labor, few natural resources, and a scarcity of machine capital would be utilizing labor-intensive, resource-saving technology.

Hueckel uses the examples of 19th-century England and 19th-century United States to bolster his contention. At that time, appropriate technologies were in the initial evolving state in both countries. Hueckel ignores the fact that today's non-industrialized country imports technology along with a host of social images reflecting what is the appropriate salary and lifestyle of an employee in the modern sector. The despair of development economists is that, lacking indigenous technologies, underdeveloped countries are forced to "select" the capital-intensive, labor-saving

technology which appropriately enough reflected the then optimal input mix of the Western countries creating it.

The continuation of this practice seems certain for as long as the most promising students from underdeveloped countries are sent abroad for a postgraduate education in the "most advanced" technologies. Attempts are now being made to create research institutes in underdeveloped countries themselves, but whether these centers will come up with technologies that will weaken the relationship between economic growth and increased use of nonrenewable resources is a question open to much debate, as is the question of how soon such innovations would be dispersed in the field. The lag time between innovation and widespread acceptance is also a crucial factor in forecasting the West's needs in a time of changing resource prices.

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Hueckel states that "the high pressure [steam] engine was cheaper to build but apparently was more extravagant in its fuel requirements." High pressure steam means high temperature steam which gives a greater thermodynamic efficiency according to the following relationship.

Efficiency =

$$\frac{\text{Inlet temperature} - \text{Exhaust temperature}}{\text{Inlet temperature}}$$

A high pressure steam engine delivers more power for less fuel than a low pressure engine. In addition, a high pressure engine probably produces more power per unit weight, which would mean that less material would be required for its construction.

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Although much of my article was devoted to the question of physical limits to economic growth, of the letters printed here, only Edens' is explicitly concerned with that issue. Ironically, Edens accuses me of "an overly narrow time perspective" and then raises the same issue as that raised by Mishan—that the development of the modern industrialized nations has depended upon the availability of fossil fuels—an issue which I criticized in the article as "the result of a lack of sufficient [historical] perspective."

The past two and one-half centuries clearly have been unique in human experience; but, as I argued in the article, Edens' "dynamic factor" in past growth has not

been society's dependence upon fossil fuels but rather society's ability "to advance its technological knowledge to the point where those resources could be employed for the satisfaction of human wants." It is, after all, that knowledge that makes a given material useful to society; and the fact that terrestrial deposits of those materials might some day be exhausted does not necessarily imply that economic growth must stop, only that knowledge must continue to advance. The fact that past technological change has not been random and capricious but rather has occurred in a systematic manner in response to market forces causes me to take an optimistic view of the probability for future advances in knowledge.

Clearly if we confine the discussion to our own planet [a constraint which O'Neill (1) argues is unnecessary], no one can deny that there is a physical limit to energy and mineral use—a point made by Daly and others elsewhere (2) and suggested by Ophuls' reference to "thermodynamic limits." That, however, is an obvious and rather uninteresting statement; the relevant question is whether society is now sufficiently close to that limit to warrant concern, and it is here that I must respectfully disagree with my critics. As Brooks and Andrews have noted (3), "the literal notion of running out of mineral supplies is ridiculous. The entire planet is composed of minerals, and man can hardly mine himself out."

Of course, those authors warn that the effort to obtain those resources might involve costs in the form of pollution, changes in land use, changes in the international distribution of wealth and power, or other disturbances which society is unwilling to bear—a fact of which I am quite aware, in spite of Ophuls' charge that I argue "as if ecology had never been discovered." Indeed, I find such a charge surprising, particularly in light of his reference only two paragraphs later to the very policies I proposed to reduce environmental damage. He criticizes those policies on the ground that they do the job "only by increasing the painfulness of the market's impact on individuals"—a rather perplexing criticism, since the external costs of production, of which pollution is only a part, are already borne by individuals. The effect of "including the social costs of production in market prices" simply would be to monetize those costs and to reallocate them so they are borne by those individuals who consume the goods and services whose production is causing the pollution. If the policies can be enforced efficiently, there would be little increase in the total cost borne by society. Obviously such a reallocation would involve personal sacrifice for some, but that sacrifice would be com-

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compensated by a cleaner environment. Ophuls questions society's "political will to reform the market if this will involve personal sacrifice." Is it any more likely that society would have the "political will" to undertake policies deliberately designed to stop economic growth? I doubt it.

I certainly agree with Ophuls that there are certain circumstances under which the market will fail to yield the desired allocation of resources. Indeed, his examples of "common property resources" and "discounting" are precisely the issues I treated in the last section of the article. He is quite right to include cartels in this category as well, though it is important to realize that even the strongest such organizations must be concerned with the degree to which consumption of the product declines as price rises—a fact of which the OPEC (Organization of Petroleum Exporting Countries) is becoming increasingly aware.

In the final analysis, however, the problems raised by Ophuls and Daly are contained in the question of the desirability of further growth. While certainly an important issue for national debate, this question is clearly more difficult to settle since, as Daly puts it, the problem is to evaluate "the real costs and benefits [of growth] at the margin." Unfortunately, in spite of Daly's efforts to devise one, there does not exist a generally accepted nor scientifically defensible standard with which to measure those magnitudes. Consequently, whether one labels these evaluations "personal judgments of fact" or value judgments makes no difference; the crucial point is that reasonable individuals can legitimately differ over their evaluations of the costs and benefits of growth. This is the meaning of my sentence of which Daly quotes only a part at the end of his letter. Obviously there is no problem in distinguishing for ourselves "poor" from "rich" and thus (in Daly's scheme) the point at which further growth becomes "uneconomic." But it is, in my view, the height of arrogance to presume to make that judgment for an individual other than oneself.

One final point of clarification is necessary in response to Leighly. He is quite right to expect a priori that the high pressure steam engine was more economical in fuel use—a point which historians of technology have noted (4). The difficulty arises in the details of the early 19th-century engine. Watt's low pressure engine employed a separate cylinder in which the steam was condensed to form a vacuum below the piston, the power being supplied by the operation of the atmosphere (or of steam at atmospheric pressure) above the piston. The early high pressure engines dispensed with the condenser and used steam at pressures around 50 pounds per square inch, venting

it directly to the atmosphere. It appears that, in the early years of the engine's development, the sacrifice of the vacuum in the condenser reduced the fuel economy relative to the standard low pressure engine (5), although the new, high pressure engines could be considerably smaller per unit of power produced, as Leighly notes. One would expect that the best features of both engines would be combined. This occurred in Cornwall in 1812; and for the next three decades Cornish engines, operating with high pressure steam and a condenser, were widely renowned for their economy of fuel. This event is yet another example of technological advance conditioned by resource availability, for Cornwall was a county with abundant tin and copper (thus requiring steam power for mining operations) but peculiarly lacking in coal or wood for fuel.

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Traditional Tobacco Substitute

I agree with Julia F. Morton (Letters, 16 May, p. 683) that more land should be made available for food crops by eliminating the growing of tobacco. However, we already have a much more suitable alternative than cabbage, lettuce, or papaya leaves, and one which would not make use of food or food-producing materials. I am referring to corn silk, a traditional substitute for tobacco. It should be allowed to dry before harvest, of course, so that its role in seed fertilization would be over.

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Filming of Behavior

The article "Anthropological film: A scientific and humanistic resource" by E. Richard Sorenson (20 Dec. 1974, p. 1079) deserves comment, first because of its rele-

vance not alone to anthropological research but to all behavioral research, and second because Sorenson does not mention very exciting ongoing research in the field of human ethology.

I agree completely with Sorenson about the urgency and need to record human behavior on film, but I would add that his argument holds for many other species as well, particularly those which are endangered by extinction, either through man's wanton slaughter or through the destruction of their habitats. Indeed, students of animal behavior have long recognized the usefulness of motion picture films for the documentation and analysis of behavior patterns. To this end the *Encyclopaedia Cinematographica* was established by G. Wolf, director of the Institute for Scientific Films in Göttingen, West Germany. Each film depicts a single type of behavior and is accompanied by a short descriptive publication. Leslie P. Greenhill at Pennsylvania State University is the director of the American Archive of the *Encyclopaedia Cinematographica*. Films on animal and human behavior are available.

In addition to the film studies which Sorenson mentions, the reader should be aware of the important studies of human ethology by I. Eibl-Eibesfeldt and his coworkers in the Research Unit for Human Ethology, a division of the Max Planck Institute for Behavioral Physiology, Percha, West Germany. They are filming rituals and unstaged social interactions, such as play, greetings, courtship, and child-parent relationships. They are particularly interested in similarities and differences in these behavior patterns in different cultures. By studying populations of cultures which have had minimal contact with outsiders they have attempted to capture on film behavior patterns in their purest form. This is exactly what Sorenson is arguing for. The films are published in the Human Ethological Film Archive of the Max Planck Association (1), and descriptions of the film studies are to be found in such journals as *Anthropos*, *Current Anthropology*, *Homo*, and *Zeitschrift für Tierpsychologie*.

Undoubtedly there are also other groups active in this exciting area of research. Let us hope that Sorenson's timely article will serve as a rallying point to bring together persons working in human ethology and focus their attention on the urgent need for film documentation of behavior.

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L-5 NEWS

A Newsletter from the L-5 Society

Number 2, Oct. 1975

System Dynamics Applied to Space Communities

The power of system dynamics, as developed by Jay Forrester and others, is in the testing of alternate policies for both long-term and side effects. To date, system dynamics has been used to tell us what won't work, and to explain some of our perplexing failures our social system has experienced.

Recently, J. Peter Vajk of Lawrence Livermore Laboratory (LLL), has developed a 3-sector model, including a space communities sector, based on earlier work with developed and underdeveloped world sectors. This earlier model was developed by D.R. Tuerpe, also of LLL, under the auspices of the Atomic Energy Commission.

Initial results of this work have been made available to the L-5 News. Adjustments in the model are being made in response to suggestions by Dennis Meadows, one of the authors of *Limits to Growth*, and the energy relationships in the model are being refined with the assistance of H. Newkirk at LLL. Low cost energy from Solar Satellite Power Stations (SSPS) and the exponential growth of the space communities sector are the key factors in the improved model performance.

For those unfamiliar with World Dynamics models who wonder how population could be reduced other than by migration, birth rates in these models are controlled by wealth in the same fashion as empirical data has indicated.

Assumptions and parameters in addition to the Tuerpe model are as follows:

- (1) Energy, currently close to 6% of the gross national product (GNP) for both developed and underdeveloped countries increases somewhat, reaching 7% by the year 2020. This is because, as resources become more scarce, more energy is required to process or recycle them.
- (2) Busbar cost of power in the underdeveloped countries changes slowly from the current rate of about 3 times that of the developed countries to the SSPS power cost.
- (3) A four fold decrease in power cost increases the rate of growth of capital investment by about 2.
- (4) Over a 50-year period, productivity in building SSPS's improves by a factor of 3. Power cost decreases by the square root of the productivity increase. Initial busbar electricity cost of 15 mils per KWH falls to 9 mils in 2020. Note that, compared with the Mark Hopkins article below, these costs are conservatively high.
- (5) Market penetration takes from 1990, date of first energy transmission, until 2012, at which point most electrical energy is SSPS-derived. The manufacture of synthetic fuels from electricity takes 10 years after this point to penetrate 40% of the traditional markets for liquid and gas fuels. Another ten years brings the synthetic fuel market up to 75%, and in an additional twenty years to 90%.

By the year 2020, per capita income in the developed world has increased by 12%. Due to factors mentioned above, and a lower base, underdeveloped world wealth per capita has increased by 60%. In 2020 world population stands at 3.55 billion in the underdeveloped world, 1.33 billion in the developed, and 0.03 billion in the space communities. This compares with baseline two sector model runs of 4.39 billion in the underdeveloped world and 1.82 billion in the developed. In the three sector model, the total population increase rate is leveling off rapidly, at 12 million per year in 2020. Half of this increase, mostly from

the underdeveloped world, is leaving the earth for the space communities. Transporting this number of people, including a 700 kg per person baggage allowance, requires 1/3 of 10% of SSPS energy production.

The model results will be presented, at least informally, at the "Limits to Growth '75" conference.

The "Limits to Growth '75" conference, to be held near Houston Oct. 19-21, is sponsored by the Club of Rome, University of Houston, and the Mitchell Energy and Development Corp. This is the first of five biennial conferences to consider the implications of alternatives to growth. Keynote speakers will include Dennis Meadows, Jay Forrester, and Herman Kahn (a noted critic of *Limits to Growth*.)

Support from the Club of Rome to at least carefully investigate the world dynamic potentials of space communities would be a major advance for our work. L-5 members who can help by attending should call Jura Schaf, (312) 324-6913 for registration materials. Registration closes Oct. 15. Please let the L-5 staff know if you are coming.

Sending the workers to the conference that Peter Vajk has requested will be a heavy drain on the resources of the L-5 Society. Those who can assist us should send their contributions to:

Conference Fund
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1620 N. Park
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Economic Analysis

An unpublished paper written subsequent to the Summer Study by one of the participants, Mark Hopkins, a graduate student at Harvard University, entitled "Economic Considerations of Initial Space Colonization," is available to members of the L-5 Society. This paper analyzes the cost, benefits and possible methods to finance the project, partly based on post Summer Study developments. While the results must be treated carefully, the possibility is presented of power from space starting at less than one half of the current busbar price, (8 mils per KWH) and falling to less than one quarter of the current price (3.5 mils per KWH). This work is being reviewed by the Federal Energy Administration.

NASA/AMES - STANFORD - ASEE SUMMER STUDY

The first issue of the newsletter reported the 10-week summer study on space communities held at the Ames Research Center (ARC) of the National Aeronautics and Space Administration (NASA). A 10-page preliminary report has since been made available, which outlines, in brief form, the team's purpose, design criteria, and conclusions. The team, composed of 28 physical and social scientists from academia and industry, included Mark Hopkins, of Harvard University, Magoroh Maruyama, of Portland State University, T. A. Heppenheimer, of the California Institute of Technology, Eric Hannah, of Princeton University, and Eric Drexler, of MIT. The summer study was sponsored by NASA/ARS, Stanford University, and the American Society for Engineering Education (ASEE).

The team finds "no fundamental scientific obstacles" to establishing space communities, and goes so far as to hail the concept as "an evolutionary step comparable to the transition of life from the sea to the land or the transition of our own progenitors from life in the primitive forests to the open plains."

The team's habitat design involves a wheel-shaped construction over a mile wide located in the Moon's orbit 240,000 miles from both the Earth and the Moon. One revolution per minute would simulate Earth gravity for the 10,000 residents. The rim of the torus would house shops,

schools, light industry, and closed-loop agriculture. Total mass would reach about 500,000 tons, like the largest ocean super tankers. The team proposes heavy industry be located "outside," to take advantage of weightlessness and high vacuum. Such industry would be dedicated to a) the manufacture of other habitats, and b) the manufacture of satellite solar power stations (SSPS), to be placed in geosynchronous orbits above the Earth. An SSPS would gather sunlight almost constantly, and beam the energy down to receiving stations on Earth as low-density microwaves, which would be converted to electricity and fed into normal distribution systems.

Raw materials would be obtained from the Moon. A Lunar detachment of 100-150 persons could mine and ship a million tons of material to the space habitat to be refined to extract aluminum, titanium, silica, and oxygen.

In designing the space habitat, the team recognized that "living in an entirely man-made structure at high population densities remote from other communities may lead to serious psychological problems... a design was chosen permitting lines of sight of over half a mile, a feeling of spaciousness, and proximity to growing things. Considerable thought was given," their report continues, "to architecture and community planning, to permit diversity of development and adaptability while also providing the privacy essential in a population density of more than 60 people per acre." The team estimates that 111 acres would be necessary to produce vegetables, cereals, poultry, ham, and dairy products for a population of 10,000 persons. Animal, plant, and human wastes would be converted to water and agricultural chemicals, and with fast recycling, only small quantities of water and other essentials would be necessary. The total cost of the first habitat is estimated at \$100 billion.

After presenting these findings, the report proposes that such space habitats may "offer a way out from the sense of closure and of limits which is now oppressive to many people on Earth." The report continues: "Particularly in the Americas and other former colonies, growth has been a vehicle of rapid and often progressive social change; it has been a source of opportunity for millions of people. Many people view with distaste a future in which opportunities would become increasingly restricted, and in which new and oppressive political institutions would have to be devised in order to allocate equitable resources which were insufficient to meet the demands. Space colonization may offer a way to bring new wealth to the Earth, and new opportunities to its people, without the environmental damage which has so often accompanied growth in the past."

The team concluded by emphasizing that it was "speaking for itself," and did not represent any official government or university institution. It recommended the U.S., "possibly in cooperation with other nations, take specific steps toward the goal of space colonization."

The final and complete report of the summer study is to be published during the next few months. When publishing details are available, they will be presented in the newsletter. In the meantime, copies of the preliminary report are available to L-5 members.

SPACE RESEARCH AND DEVELOPMENT CORPORATION PROPOSED

A proposal to establish a Space Research and Development Corporation to finance space colonization and other space development has been drafted. Those who would like to examine the draft and submit comments should contact Carolyn Henson, L-5 Society, 1620 N. Park, Tucson, Arizona 85719. The proposal would have the following advantages:

1. Long-term funding could be obtained so that monies would not be dependent on uncertain annual appropriations;

L-5 NEWS

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L-5 Society

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2. The funding would be treated as an investment rather than a current expense, and thus would not appear as red ink on the federal books;

3. Private capital could join in research and development efforts;

4. The investments could be treated as investments or loans and paid back if the space developments proved economically profitable, thus generating a revolving fund to support further activities.

The proposal is modeled after the Reconstruction Finance Corporation, originally proposed by Herbert Hoover in 1932, and on such other institutions as the Export-Import Bank. Legislation to create this type of institution for research and development generally has been introduced by Representative Thomas Downey as H.R. 7841, 94th Cong., 1st Sess (1975), based on the report of the Committee on Consumer Affairs of the Association of the Bar of the City of New York (RECORD of The Association of the Bar, December 1974, p. 718). A similar concept for rebuilding blighted areas has been proposed by Representative Charles Rangel (H.R. 9341, 94th Cong., 1st Sess. [1975]).

Horizons Day Meeting Planned for 1976

The Committee for the Future, Inc., has established June 26, 1976, as Horizons Day, when groups in the U.S. and abroad will join in a one-day meeting to search for consensus on new horizons for humanity. Local initiatives can be sponsored by representatives of the Bicentennial Committees, but local communities and groups who wish to participate may do so. Further details may be obtained from Ms. Barbara Marx Hubbard, the Committee for the Future, 2325 Porter Street, N.W., Washington D.C. 20008. To defray large information distribution expenses, \$2.00 is requested when applying.

L-5 members may wish to use this event as a forum.

AAA Contest In Cultural

Futuristics

The American Anthropological Association (AAA) is sponsoring a Contest in Cultural Futuristics, the winners of which will be invited as speakers at a futurism symposium to be held during the 1976 AAA general meeting. Contestants may select from three categories: a) A future cultural alternative for a large, complex society such as the U.S.; b) Post-Industrial international development; and c) Extra-terrestrial (L-5) communities.

Manuscripts, which must be between 20 and 50 double-spaced pages long, may be essay treatments or fictional pieces. Essays should avoid general rules and theories, concentrating on the specifics of the imaginary society. Fiction pieces should emphasize the different social aspects and their interrelationships, avoiding excessive dialogue or complex "plots."

Entries must include a long (250-500 word) abstract and a short one (under 100 words). All winning entries will be published, and the most interesting ones will receive \$100 awards. The contest rules specify that all interested persons may enter, regardless of professional background or rank. Deadline for entries is January 5, 1976. Further information, including guidelines for the three categories, may be obtained from one of the organizers, Dr. Magoroh Maruyama, P. O. Box 751, Portland State University, Portland, Or. 97207 (503/299-4961). Dr. Maruyama was a participant in both the Princeton conference and the Stanford-NASA/Ames-ASEE Summer Study (see other article in this newsletter).

SSPS Paper Submitted

Among the longer drafts of submitted articles L-5 News received this month, is one by William N. Agosto, project engineer at Microwave Semiconductor Corp, Somerset, N.J. Titled "Space Production of Satellite Solar Power Stations: An Option for United States Energy Independence Before 2000," it has been submitted to the Institute of Electrical and Electronic Engineers Spectrum and is under consideration. The article contains an in depth technical review of the SSPS concept as modified for space manufacture, and the associated economic and ecological considerations. Members who need a copy of this article should write the L-5 Society.

Coming next issue: Eric Drexler's work on the vapor deposition of massive structures in space; a preview of T.A. Heppenheimer's article, "R&D Requirements for Initial Space Colonization" which will appear in the Dec. issue of "Astronautics and Aeronautics", and a report on the "Limits to Growth '75" conference.

Some of the people who are currently giving talks on space communities are Eric Hannah of Princeton, William Agosto of Microwave Semiconductor Corp., Summer Study co-administrators William Verplank (now at MIT) and Richard Johnson (NASA/ARC); Peter Vajk of LLL, and T.A. Heppenheimer of California Institute of Technology.

LETTERS

Nova's Ark

And the Sons of Science said unto NASA, "Make yourself an Ark of glass and aluminum, the length of which shall be two thousand cubits and its height shall be four hundred cubits. Make it of the Moon and the Sun and the Earth and the Air and set its orb as of the Moon to sail the Heavens. And tie a Docking Station five hundred cubits from the Ark to receive the covered chariots.

"You shall come into the Ark, you, your wife, your sons and your daughters of all the Families of Humankind. And you shall bring seven pairs of rabbits and two goats to keep them alive with you; they shall be male and female. And take with you every sort of high yield food that is eaten and plant it in styrofoam and water it with mist and it shall serve as food for you and for them.

"For in seven years will be visited upon the Earth forty years of Hunger and Smog and Oil Embargoes and Warfare and Plagues and Ice and Weeping and Despair. But the Ark of glass and metals shall keep the Earth from falling into utter desolation, for it shall send back to the peoples of the Earth Sunlight and Manna and Hope from the Heavens. And it shall be called Nova's Ark."

Philip M. Blackmarr
Menlo Park, California

Why?

The colonization of space, for me, needs no other justification than man's adventurous willing ability to do so. However, the average person, struggling with an already too heavy tax burden and a sagging economy, will rightly demand a well-defined, profitable reason for taking on so vast a project. When asked "why?", any colony advocate would wield a powerful and convincing argument.

To date, the benefits of the American space program rarely surface in everyday life. The technical advances, while greatly useful in manufacturing and many industrial areas, lay one level below individual existence; popping up annoyingly on occasional television commercials in pens that write upside down and strange little moon men pitching breakfast drinks. Likewise, the large stores of knowledge brought back to Earth aid the average individual only circumspectly, never directly.

The space colony project will offer two very tangible, very direct benefits to the taxpayer in ways (s)he will easily understand.

L-5 SOCIETY MEMBERSHIP FORM (PLEASE TYPE OR PRINT)

NAME: _____

COMPLETE ADDRESS: _____

AFFILIATION(OPTIONAL): _____

TITLE or POSITION (OPTIONAL): _____

I am am not interested in being active locally.

Check here if membership is to start with issue one.

Please enroll me as an L-5 Society Member. I am enclosing a check for \$ _____ (regular membership \$20.00; student membership \$10.00).

Please enter an institutional membership to receive the "L-5 News" for our organization/library as indicated above. We enclose a check for \$ _____ (institutional or library membership \$100; special library subscription with one month delayed mailing \$20).

Energy is a key word. One of the many important functions of the colony will be the construction of solar energy satellites. These satellites will provide an inexpensive, never-diminishing supply of energy. Any person (corporation, government) that must purchase energy will recognize this as a solid, real aid to their life.

Secondly, the most immediate effect of the colony will be economic. Government spending on this scale will circulate the tax dollars, stimulating economic growth and generating millions of jobs (good news for the unemployed!). Economics is a good reason for the immediate initiation of the space colonization project.

The other benefits of space colonization will evidence themselves in many ways, but none so dramatically and directly as the economic and energy stemming from the colony. Even though there will always exist those whom logical and good reasons leave unpersuaded, energy and economics can stand alone as justification for the colonization of space.

Shirley Ann Varughese
North Plainfield, N.J.

(Ms. Varughese is the author of "The Planet Xeno" in *Cultures Beyond the Earth*, Magoroh Maruyama and Arthur Harkins, eds., Vintage Books, 1975.)

L-5

NEWS

System Dynamics Applied to L-5 Communities
NASA/ARC-Stanford-ASEE Summer Study
Cultural Futuristics Contest

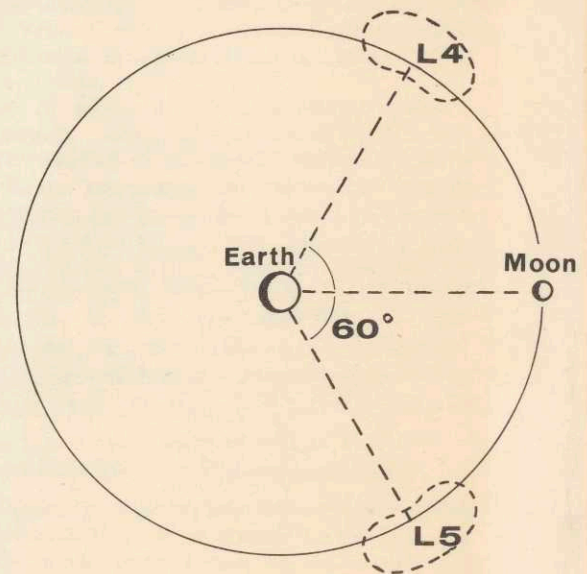
L-5 Society
1620 N. Park
Tucson, Az. 85719

The L-5 Society

The L-5 Society is being formed to educate the public about the benefits of space communities and manufacturing facilities, to serve as a clearing house for information and news in this fast developing area and to raise funds to support work on these concepts where public money is not available or is inappropriate. We will send membership cards and newsletters to those who respond. The effectiveness of the society depends on your response. It would be appreciated if you were to copy this newsletter and send it on to others who would be interested. Our clearly stated long range goal will be to disband the society in a mass meeting at L-5.

ADDRESS CHANGES

Please send in address changes as soon as possible. Type or print clearly and include Zip Code.



or upper-middle class. (A good deal of attention has been paid to the fact that many subjects of medical research are poor and members of a minority. Here is a situation in which the affluent were experimented on.) Although efforts were made to match subjects and controls as fully as possible for characteristics including number of previous pregnancies, health and social status, there were two areas in which matching proved to be very difficult. One was religion. Forty-four percent of the controls were Roman Catholic women who refused amniocentesis. The other was maternal age. Women in the control group tended to be younger.

The question of age presented the researchers with an ethical dilemma that they resolved by sacrificing a study with perfectly matched subjects and controls in favor of what they regard as the well-being of the individual women. There are a number of indications for amniocentesis, the most general being maternal age. It is well established that the risk of bearing a child with Down's syndrome (mongolism) increases significantly as a woman grows older. It is one of the more common of some 100 chromosomal and metabolic disorders that can be detected in utero and research physicians recommend that all pregnant women 35 years of age or older at least consider having diagnostic amniocentesis. Therefore, none of the researchers participating in the study was willing to randomly assign such women to the control group. All were offered the opportunity of having amniocentesis. Investigators estimate that, on the basis of maternal age alone, there are approximately 300,000 women a year for whom amniocentesis might be appropriate.

Other indications for amniocentesis are related to the genetic makeup of a fetus's parents. If a man and woman have already had one child with a genetic disorder, there is, of course, a chance they will have another. The woman would be an obvious candidate for amniocentesis. The procedure is also indicated when a genetic disease is known to run in the family or when both man and woman have been screened and found to be carriers of the gene for some heritable disease. Tay-Sachs disease, which destroys the central nervous system and kills its victims by the time they are four, is a good example of the latter case because it meets all the criteria that make it suitable for screening. It occurs primarily in a fairly limited, identifiable population—in this case Jews of eastern European ancestry. Its carriers can be detected and the disease itself can be diagnosed in utero. During the past 3 or 4 years—since techniques for detection have been refined—thousands of Jewish men and women have gone

for testing before conceiving a child. In those cases in which both parents are carriers, amniocentesis is then offered during pregnancy to see whether the fetus has Tay-Sachs.

But There Were Errors

Although the NICHD study, officially called the National Registry for Amniocentesis, yielded mostly positive data, it also pinpointed some problems and raised questions about future public policy. While the matter of safety to mother and child was laid to rest as far as the investigators are concerned, the difficult and sensitive question of accuracy remains. Michael Kaback of Harbor General Hospital, which is affiliated with the University of California at Los Angeles, reported that data collected from the nine centers shows that the accuracy of diagnosis is 99.3 percent.

Among the 1040 women who had amniocentesis, 19 women were carrying fetuses with chromosomal anomalies and 15 others had fetuses with genetically caused metabolic disorders. In addition, 11 women were carrying male fetuses that had a 50 percent chance of being afflicted with a sex-linked disorder such as hemophilia and Duchenne's muscular dystrophy. (In these cases, it is not yet possible to detect the disease itself in utero. By identifying the sex of the fetus one can tell whether there is a risk, however. A female fetus would not have the disease.)

The trouble is that not all of the diagnoses were accurate. Of 1040 diagnoses made, 6 were wrong. Two babies were born with Down's syndrome even though prenatal diagnosis indicated they would be normal. In three cases, sex was identified incorrectly. And in one case, a fetus was diagnosed as having a metabolic disorder known as galactosemia. In that case, perhaps because the disease is treatable, the parents did not have an abortion. When the baby was born, it turned out that the diagnosis was wrong; the baby was perfectly healthy.

The errors, which seemed to the researchers to be particularly tragic in the two cases in which Down's syndrome was missed, were the result of human error, as far as can be determined. It is possible that samples of amniotic fluid were mislabeled in one or two cases and that, in the cases of incorrect diagnosis of sex, that the investigators were looking at maternal rather than fetal cells but did not realize it.

The possibility of error is one of the most disturbing aspects of prenatal diagnosis and must receive considerable attention if the use of amniocentesis is to spread. In spite of Cooper's (or Alexander's) enthusiasm for amniocentesis for the prevention of certain birth defects, and

with it the promise that HEW may increase its educational efforts with the hope of "reaching the entire population," it is naive to think that the demand for the procedure will increase dramatically overnight. Conservative practicing physicians are not going to change their minds just because of some study, and it will take time before large numbers of women begin insisting on prenatal diagnosis. If they did, what is now a potential problem would suddenly become a reality of crisis proportions.

At present, there are not enough laboratories qualified to handle the potential demand. Amniocentesis—the procedure itself—takes about 5 minutes and can be performed in the office by a physician, who can be trained in the technique without major difficulty. The problem comes in the subsequent analysis of the fetal cells that will be taken from the amniotic fluid and cultured for analysis. In the NICHD study, the rate of error in diagnosis may have been small but can hardly be discounted. Here one had the very best people, in the most sophisticated centers, working with experienced laboratory personnel, and still there were mistakes.

In his remarks at the pediatrics meeting, Cooper said that, in the short span of 7 years, midtrimester amniocentesis "moves clearly from the realm of a research procedure to a part of clinical practice." Until now, all analyses of amniotic cells have been done in a research laboratory. "What is the best method to provide laboratories that will do these analyses when they have lost the excitement of research and become routine, while at the same time providing the quality assurance required by the life-death decisions hanging on the test results?" Cooper asked rhetorically. Answering his own question, he said the approach that seems to be in favor at HEW would be to have the Public Health Service, through contracts with existing medical centers, establish incrementally a network of state or regional laboratories. However, he acknowledged that because there is great pressure to reduce federal spending, there is bound to be opposition within the Administration to launching a new and expensive program.

Analysis of fetal cells falls into two categories—cytogenetic and biochemical. Cytogenetic studies involve analysis of chromosomes and are the type that would be carried out on women over 35 for prenatal diagnosis of Down's syndrome which is marked by the presence of an extra chromosome number 21. The fetus has a total of 47 rather than 46 chromosomes. The extra chromosome 21 can actually be seen under microscopic examination. Cooper said that the greatest increase in

demand is likely to be for this type of chromosomal analysis. Prenatal diagnosis of a metabolic disorder is, for now, a more sophisticated matter. Fetal cells are cultured for about 4 weeks and then examined for the presence or absence of whatever enzyme is involved in the disease for which a woman is being screened. These genetic disorders, known as inborn errors of metabolism, are comparatively rare and are not something for which one would screen a large population. Cooper predicts that "existing research laboratories would, for the near future at least, continue to provide the facilities for biochemical analyses."

Even though amniocentesis seems to be on the verge of coming into its own as a medical procedure—some insurance programs cover its cost which usually is not more than \$250—it is certainly not the final answer to prenatal diagnosis. It cannot be performed safely until the 13th week of pregnancy. Depending upon what disorder one is looking for, it can take between 2 and 6 weeks to grow fetal cells in culture and analyze them appropriately. Therefore, if, on the basis of test results, a woman does elect an abortion, it will have to be performed later in pregnancy than one would wish.

Furthermore, there are many, many ge-

netic disorders—some of them relatively common—that cannot as yet be diagnosed in utero. Prenatal diagnosis of sickle cell anemia and of Cooley's anemia has been reported just recently, and only in a handful of cases. In utero detection of cystic fibrosis remains to be perfected.

And finally, there is the matter of what science can offer a family if the fetus is found to be genetically defective in some life-threatening way. As Cooper noted at the conclusion of his address, "a preventive technique dependent on elective abortion is not a final answer to the problem of birth defects."

—BARBARA J. CULLITON

Limits to Growth: Texas Conference Finds None, but Didn't Look Too Hard

The Woodlands, Texas. Houston is a city in boom, sucking in new settlers at the rate of a thousand a week. Twenty-five miles north of the city, a new town called The Woodlands is designed to be home to 150,000 citizens come the year 1990. The town is the brainchild of a millionaire geologist named George P. Mitchell who made his money by sinking oil wells in the right places and who is father to ten children.

A conference on the theme of "Limits to Growth" was held on 19 to 21 October at The Woodlands under Mitchell's sponsorship. It could not have had a more paradoxical venue or benefactor. Yet, as it happened, little came out of the conference likely to give offense to Mitchell, or the burghers of Houston, or the boards of *Fortune's* 500, many of whom had sent delegates at Mitchell's personal invitation.

Limits to growth, as every stripling knows, is the name of the computer game which predicts that industrial economies will collapse within a hundred years, unless someone does something, because of raw materials shortages and poisoning from pollution. The exercise was performed for the shadowy Club of Rome by a team under Dennis L. Meadows, a management expert at Dartmouth College. A preliminary report, titled *Limits to Growth* and written by biophysicist Donella H. Meadows, was issued 3 years ago in a blaze of publicity (*Science*, 10 March 1972) that obscured its more serious aspects.

The howls of "Foul!" emanating from the general direction of economics departments soon made clear that the report had

struck home somewhere. What had jarred the professors of a subject which is almost synonymous with growth was the use of their own stock-in-trade (computer simulation and the assumption of exponential growth) to arrive at the antithesis of the profession's most hallowed premise.

The scatological eschatology of death by waste in a century need not perhaps be taken too solemnly. But the general theme which *Limits to Growth* seeks to illustrate, that exponential growth in a finite world may not be indefinitely possible, is at least intuitively plausible. It has served as a rallying point for many current angsts, such as conservation, concern about materialist values, and zero population growth. If this potpourri of presentiments somehow lacks the tang of final proof, so too does the conventional counterargument or faith, that technology will find fixes that allow everything to go on as usual.

The chance for a public debate on the issue arose when oilman Mitchell read *Limits to Growth* 2 years ago and allegedly declared to an aide, "Dammit, we ought to do something about this." After conversations with Meadows, Mitchell decided to sponsor five conferences on the theme, of which last month's was the first, the others to follow at 2-year intervals. Mitchell also took up an idea of Meadows to award prizes for essays on the consequences of declining economic growth. He gave away \$20,000 in prizes last month (the \$10,000 first prize went to Bruce M. Hannon, a computer specialist at the University of Illinois) and plans to distribute \$50,000 the

next time around. Mitchell also put up the initial money for the conference, most of which will be recovered since the conference is expected to break even or make a small profit.

Since Mitchell's generosity is likely to be an important factor over the next 10 years in public debate about growth, it is worth noting a few facts about him. He has drilled more than 3000 oil and gas wells in the United States, about half of them producers, and 600 in "wildcat" or unproven areas. Ten years ago his company, Mitchell Energy and Development Corporation, began to diversify by buying up 20,000 acres north of Houston on which to build a new town. Mitchell has already invested \$90 million on the project and earlier this year, faced with a disastrous real estate market and canceled federal grants, he transferred another \$10 million from his profitable energy business. He now expects The Woodlands to be making "a good profit within 3 to 4 years."

Mitchell's interest in the limits to growth issue seems to consist chiefly of a general belief that there are problems which he would like to see discussed, particularly among the business community. He gave the organizers a free hand in arranging the conference program and deciding on speakers. He invited the University of Houston to join his company and the Club of Rome as sponsors of the conference. Mitchell has close connections with the university, having donated 400 acres at The Woodlands as the site for a new campus. The Texas state legislature will decide next year whether to vote funds for the campus. Asked if holding the Limits to Growth conference at The Woodlands might give incidental help toward a favorable decision, Mitchell said, "Anything like this helps the project and helps to broaden the horizons of the University of Houston, which is why they were interested in the conference, but that was not its

thrust. The legislature will decide on the basis of the fact that the project is in a growth area of the state." A university spokesman said in answer to the same question. "It certainly can't hurt. Whether it would have any effect on the legislature I don't know, but it could not but help make an impression of some kind."

The conference program was put together chiefly by Dennis Meadows and John Naibitt, a professional conference organizer at the Center for Policy Process in Washington, D.C. Overall, the conference was a success. It brought together some interestingly diverse speakers and exposed a large audience, drawn about equally from universities, business and government, to a wide range of ideas in favor of and against the limits to growth theme.

Yet in academic terms, if that is a fair yardstick, it had little to offer. Few speakers said anything which they or others had not said before. No new ground was broken, no basic premises examined, no areas of agreement or disagreement delineated. Speakers were paid fees, and the overcrowded structure of the conference encouraged star performances rather than a dialogue among participants.

Maybe because of the pressure to perform, at least two of the stars found themselves being publicly accused of frivolity. Herman Kahn of the Hudson Institute was visibly shaken to be told at the end of his address that he had entertained his audience without providing anything of substance. The charge was neither wholly true nor wholly unmerited. Another speaker, economic columnist Elliott Janeway, was described as a "stand-up comedian," an undeserved bouquet since his rant about foreign oil-producer "nuts" lacked wit as well as relevance.

Among the sea of whites at The Woodlands conference were two blacks, one of them the local cop. That was probably a tactical error, at the least, because anti-growth arguments are vulnerable to portrayal as the rationalizations of elitists seeking to preserve their own upper middle class privileges. Any serious debate has to include the poor, both at home and abroad, because they are the first victims of any pause in growth. The price of attending the conference, about \$450 a head plus travel costs, excluded the former, and no representatives of the latter were invited unless two delegates from Iran count as such.

Probably the most substantive address at the conference was given by Herman E. Daly of Louisiana State University, editor of *Toward a Steady State Economy*. Our present economic system, Daly said, aims to maximize the throughput of goods and materials whereas, if we wanted a stationary state, we would aim to minimize it.

One way of economizing on the use of scarce materials would be for the government to set up a system of auctionable depletion quotas for each such commodity. Having purchased its "right-to-buy" quota, a firm would then go to the marketplace as usual. The quota payment would drive up the net price of the material, reducing both its use and the amount of pollution contingent thereon. For nonrenewable resources, the quota price should be set so as to give a net price at least as high as that of the nearest renewable-source substitute.

In Daly's stationary state economy, the quota prices would capture the scarcity value of the resources in question, and the revenue would be used to finance another necessary institution of the steady state, a distributive system designed to limit the range of inequality in incomes. Daly suggests that the minimum family income might be set at \$7,000, say, and the maximum at \$70,000, beyond which there are diminishing returns anyway.

Population control is another necessary condition of a stationary state, to which end Daly proposes the transferable birth certificate, "an orphan brainchild of Kenneth Boulding's which I am willing to adopt." The mechanism of salable certificates would probably work well, if adopted democratically, but people are not yet ready to accept the idea, Daly believes.

The range of income in Herman Daly's stationary state neatly brackets the average income in Herman Kahn's ever expanding economy. The world at present is home to 4 billion people with an average annual income of \$1,250. In 200 years, Kahn foresees, it will house 15 billion people with an average income of \$20,000. "Two hundred years from now, mankind is going to be almost everywhere in control of the forces of nature, and almost everywhere rich."

In this Kahn-do world, needless to say, "It will always be possible, through substitutes, redesign, or the adoption of alternative processes, to continue economic activities." Internal evidence suggests that Kahn's prepared paper was originally composed as an upbeat celebration of the bicentennial, which might explain why the fears of the anti-growthers are dismissed as "largely illusory or susceptible to relatively accessible solutions." The serene confidence of this position was somewhat blemished by Kahn's afterthought that, just in case of widespread calamity on earth, "a concerted international effort to create extra-terrestrial self-sustaining life platforms would probably be warranted."

The basic premises of *Limits to Growth* were not reexamined at the conference, but a strange recension on the theme was

offered by Rome-Clubber Jay W. Forrester of MIT. Forrester's computer simulations laid the basis for those conducted by the Meadows team. He now believes that debate about the physical limits to growth is counterproductive, in part because it "invites the rejoinder that technology can circumvent such limits." The dangers of social limits may be a better card for anti-growthers to play, because "rising population density and use of resources is surely at the root of many social stresses." *Limits to Growth* treated the world as a single oyster, but Forrester has discovered that since "only nations have effective political processes," the problems of growth must be solved on a national basis.

Among the more practical offerings at the conference was that by John Todd of the New Alchemy Institute at Woods Hole, Massachusetts (*Science*, 28 February 1975). Todd believes that living systems, powered by sun and wind, will come to replace today's hardware and fuel-consuming systems, and will transform society in doing so. It was perhaps an omission that no one at the conference tried to specify the conditions under which conceptions like Todd's will be relevant.

For those who hadn't spotted the silver lining, Iranian ambassador-at-large Jahan-gir Amuzegar rehearsed the beneficial effects of the rise in oil prices—the encouragement of energy conservation, industrial efficiency, and environmental sanity. Amuzegar castigated the "needlessly wasteful lifestyles" of the affluent industrial world but said, in effect, that growth was great as long as the Third World could share in it.

Iran's view of growth was put in even more graphic terms by Firuz Vakil, head of the government's planning bureau. In Teheran, he said, people who can now afford to own a car "get more of a kick sitting in a traffic jam than in having clean air. Those countries who have achieved a certain standard of living must take the lead in preserving the environment and such concerns, because others are very busy improving their children's teeth. There is a fallacy in the conception that developing countries can avoid the mistakes of the developed countries, because in a world in which they have to do things quickly, quality suffers."

This down-to-earth note was one that was struck perhaps too seldom. *Limits to Growth '75* made a good beginning, but its successor should probably give more time to hard analysis of stationary state economics, and less to the mushy visions of semiprofessional futurologists, if the Mitchell conferences are to become a forum for serious discussion.

—NICHOLAS WADE

Image Reconstruction (I): Computerized X-ray Scanners

Medical science tends to advance incrementally, and full-fledged breakthroughs are rare. The discovery of the x-ray by Wilhelm Conrad Roentgen in 1895 and the subsequent development of the science of radiography is one notable example. In the last 3 years, a new x-ray device known as the CAT-scanner (for computerized axial tomography) has been appearing in an increasing number of hospitals and clinics. On the basis of their experience so far, many radiologists are saying that these computerized x-ray scanners are the greatest advance in diagnostic medicine since Roentgen's discovery, while others are only somewhat less effusive in their praise. CAT-scanners have had an indisputably marked effect on the way radiologists and surgeons diagnose their patients, but it is still too soon to evaluate what the overall contribution of the scanners to the quality of health care will be.

The enthusiasm for CAT-scanners derives from their superior ability to detect abnormalities (lesions) in the brain as compared with such conventional neuroradiological techniques as standard skull x-radiography (roentgenography), angiography, pneumoencephalography, and radionuclide scanning. Radiologists also cite the relatively noninvasive character of the scanners and their potential for reducing the cost of health care for patients who otherwise would be hospitalized.

In the diagnosis of numerous abnormalities of the brain, radiologists at the Mayo Clinic have reported an overall error rate with CAT-scanning of 4 percent on 12,000 scans over a little more than 2 years, for example (1). Disorders visualized included brain atrophy, degeneration of the brain, hydrocephalus, cysts, tumors of the brain and the eye, infarcts (dead areas of the brain due to loss of blood supply), and hemorrhage (Fig. 1). In addition, they find that CAT-scanning is applicable to all of the above-mentioned categories of abnormalities, whereas the other methods are each limited to certain ones only.

In conventional x-radiography, the image obtained on a film after a diverging x-ray beam passes through the subject is a projection or shadow of everything standing between the x-ray source and the film. Thus, the image may contain many overlapping organs and tissues which are difficult to separate. In addition, whereas an observer can easily distinguish between air, soft tissue, and bone in an x-ray photograph, the same viewer cannot easily see the few percent difference in the attenuation of x-rays by normal and diseased tis-

sue, even when overlapping images are not a complicating factor.

The method embodied in computerized x-ray scanners to overcome these difficulties is a specific example of a general mathematical technique called reconstruction of images from projections. In principle, if x-ray photographs are made of a person's head at an infinite number of angles, it is mathematically possible to reconstruct a full three-dimensional image of the skull and its contents from these projections. Such reconstructions can be made from a finite number of projections, but the reconstructed image is no longer exact.

A number of researchers have made reconstructions of two-dimensional cross sections normal to an axis of rotation of an object (transverse axial tomography) from x-ray photographs taken at equal angular intervals around the axis. This procedure overcomes the problem of overlapping, but the cumulative x-ray dose to a patient would be excessive. In addition, scattering of x-rays by parts of the patient's body would cause a loss of contrast, as it does in conventional x-ray radiography. The use of an electronic detector in place of the x-ray film together with a collimated, narrow x-ray beam and computer processing solves these problems.

Since the detector records only a small region at a time, in order to duplicate the

area recorded in an x-ray photograph, the x-ray source and the detector must scan the region to be imaged. In the first generation scanners, the x-ray source and the detector scan together normal to the axis of rotation of the object, and thus generate a series of parallel x-ray beams in the plane of the cross section to be reconstructed. Only x-ray photons not scattered out of the beam are detected. Readings of the attenuated x-ray beam during the scan are stored in a minicomputer. At the end of a scan, the frame that holds the x-ray source and the detector rotates 1 degree, and another scan begins.

The computer completes the reconstructed image of the cross section either after or as the data from 180 or more scans accumulates, depending upon which of several possible algorithms it uses (2). The image consists of a rectangular array of elements, each of which represents an area of the cross section about 1.5 millimeters on a side. A cathode-ray tube or television screen displays the image. The cross section is not mathematically thin; its thickness is determined by the thickness of the x-ray beam and is 8 or 13 millimeters.

In the simplest algorithm, the brightness of each element represents the sum of the total attenuations of each x-ray beam that passes through the element. The method used by scanner manufacturers involves modifying the projections, so that this line summation gives a closer approximation to the true attenuation in each element.

With computerized x-ray scanners, differences of absorption as small as 0.5 percent can be distinguished, because the entire range of attenuations need not be displayed simultaneously, as on film. By selecting a small range of attenuations to be displayed in the reconstruction, the viewer can easily pick out small changes that would be missed in a normal x-ray photograph. The spatial resolution of the image, however, is not as good as that of an x-ray photograph, being limited by the size of the picture elements. The accumulated radiation dose from a CAT-scanner is comparable to that from a series of skull x-rays. A set of three or four x-rays imparts a dose of 2 to 4 rads, as does a series of three or four sets of scans that constitutes a CAT examination. (In actual machines, two detectors are used, so two cross sections are obtained simultaneously. Thus, a typical examination results in six or eight cross sections.)

A careful evaluation of the efficacy of CAT-scanners in detecting and differentiating lesions as compared with other

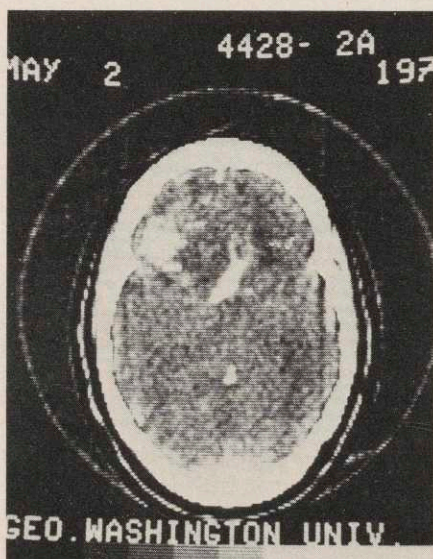


Fig. 1. Reconstruction of the head of a patient with a calcified glioma (tumor of the connective tissue that supports the brain cells) of the left frontal lobe. The view is from the top of the head down toward the body. The calcified areas are white, as is the skull. The light circle outside the skull is the water bag. The dark ring just inside the skull is an artifact. [Source: George Washington University Hospital]

To Prof Forrester 10/24/75

COURANT
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OCT 5 1975

New
England
Newsclip

Waste Held Threat to Resources

NEW YORK (UPI) — Man must end his wasteful ways in this century or face a total collapse of the world's food and energy resources early in the next.

This is not a statement by a streetcorner prophet of doom of the "beware the end is nigh" variety, but the conclusions of a prestigious team of scientific researchers.

Three years ago a research team from the Massachusetts Institute of Technology directed by Professor Dennis L. Meadows released a report, titled "Limits to Growth," which said a sustained growth in population, the use of raw materials and energy by governments and industry would lead to worldwide collapse early in the 21st century.

Three million copies of the report sold in 34 languages and sparked controversy around the world.

Next month Prof. Meadows will direct an international conference at The Woodlands, near Houston, Tex., which will examine the problems of moving away from policies of growth.

The MIT report, sponsored by the Club of Rome, a group of about 100 international businessmen and scholars whose aim is to examine long-range problems facing mankind, made two general conclusions:

— Global growth trends in population, material consumption and energy use can not be supported even for another century.

— Man's ingenuity and the earth's resources are sufficient to support the current population at stable levels of material consumption, if there is a deliberate attempt to alter current growth trends.

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BILLIONS OF BARRELS OF OIL MAY BE WAITING UNDER ICEBERG ALLEY.

WE'RE MOVING MOUNTAINS TO GET IT.

Mountainous icebergs, as tall as 20-story buildings and two city blocks wide, break away from glaciers in the Arctic and stampede down the coast of Labrador. Anyone with a drill rig bobbing in their path puts 30 to 50 million dollars on the line.

But we're there, with our partners. We follow the icebergs for miles on radar. We plot their drift, pray for good winds and favorable currents, and if necessary, tow them with tugboats till we're sure they'll pass out of range. Then we drill.

Our exploration program has just begun in Iceberg Alley. Canadian surveys estimate a possible 21-billion barrel potential. Although these estimates have a high degree of uncertainty, we feel the potential justifies the risk—or we wouldn't be there.

We didn't set out to move mountains in the beginning. But the days of cheap and easy oil are gone.

Almost everywhere we look—Labrador, the Arctic, the North Sea—it's move mountains, or do without the oil.

So where the potential is great and profitable, we do what we have to do.

You'll be hearing from us.

FOLLOW THE SUN 

Sun Oil Company, St. Davids, Pennsylvania

The hard job of saving Lake Erie

Phosphorus is causing it to choke on its own regenerated pollution

Swimmers and sunbathers who crowded Cleveland's Edgewater Park beach along Lake Erie's southern shore this summer often insisted that the lake seemed cleaner than it has for years. But a Great Lakes Regional Assessment study released this week by the National Commission on Water Quality gives a more dismal picture. In fact, experts say the relatively shallow lake—210 ft. at its deepest point—has aged 15,000 years in the 200 years since white men first settled on its shores, and the aging process has barely slowed. As Raymond Kudukis, Cleve-

mer. The decomposition consumes all the dissolved oxygen in the lake's hypolimnion, or cool lower stratum. This condition, known as anoxia, lasts until the entire lake cools in autumn. The anoxia, in turn, causes a chemical reaction that pumps up more phosphorus from the bottom sediments, which stimulates the growth of more algae. The result is a nightmarish phenomenon in which the lake chokes on its own regenerated pollution.

Spread of anoxia. The annual anoxia shows signs of spreading. It can occur only in deep water where there is no wave action to replenish oxygen, but the lake's unique configuration makes the process difficult to contain. Lake Erie is actually three lakes in one—a large central basin, a deeper eastern basin, and a shallower western basin.

In the last three years, the anoxia has moved from covering 2,547 sq. mi. to a full 4,246 sq. mi.—up to 70% of the putrid central basin. The condition has extended within two miles of Cleveland, and there is recent evidence of anoxia in the western basin as well. The condition is cyclical, making it difficult to measure exactly. For example, samples of water taken this week from Lake Erie show decidedly lower levels of anoxia, but experts are loath to attribute this to anything more than a temporary quirk.

Several species of valuable food fish have fallen prey to anoxia, and it is

destroying food sources of other species. It has sent foul, anoxic water gushing into Cleveland's Crown Water Filtration Plant, and the plant has been crippled by algae blooms. "The sad thing is that we've reduced the phosphorus coming into the lake, but the effect of the controls is masked by the regeneration," says Charles E. Henderdorf, director of Ohio State University's center for Lake Erie area research. "Thirty percent of the phosphorus in the central basin is the result of this process."

The social and economic impact of stopping the pollution is a central theme of this week's report by the National Commission on Water Quality. The study, which was put together by the Cleveland architectural and engi-

neering company of Dalton-Dalton-Little-Newport, is one of 11 regional water quality studies that will be presented to Congress as part of a national report on the impact of the Water Pollution Control Act amendments of 1972. The amended act proclaims a national goal of water clean enough for swimmers and fish by 1983. By July 1, 1983, industry is required to use "best available" technology to reach this goal, and the Environmental Protection Agency is now setting up guidelines for industry and municipalities to follow.

Gloomy future. The costs of meeting the 1983 standard will be considerable. The NCWQ study estimates that industry must spend some \$2 billion in Cleveland, Detroit, and Toledo alone for pollution control. Annual operating and maintenance costs could run to another \$207 million. The municipal treatment tab is even steeper: \$3.8 billion in capital expenditures and \$43 million for annual operating costs.

But these expenditures will not solve the lake's problems, experts point out. Upgrading of sewage treatment plants has significantly decreased phosphorus discharge into the lake in the last few years. But in its 1974 annual report, the International Joint Commission, which was set up to implement the objectives of the U. S.-Canadian Great Lakes Water Quality Agreement of 1972, found that phosphorus discharges from agricultural runoff were increasing significantly. Today that runoff, mostly from fertilizers, is estimated at 25 tons a day, or 40% of the total phosphorus discharges into the lake. And the study suggests that applying "best available" technology would not reverse the anoxia, or restore the lake's ability to cleanse itself, even if agricultural runoff were controlled. Only total elimination of pollutant flow into the lake would reverse the anoxia.

Over-all, the study paints a gloomy picture of Lake Erie's future. Although it looks for slow but steady improvement in the near term, it says that increased population and industrial growth could send the lake right back to its current polluted state after 2020. "We have to assume that by that time we will have new technologies or are no longer discharging into the lake," says Robert G. Rolan, Dalton's senior ecologist. "It would have taken far less pollution control and money to solve the problem in the 1950s," Rolan says. "By 1990 the situation may be irreversible." ■



Rolan Marshall

Rolan: "It would have taken far less pollution control and money to solve the problem in the 1950s."

land's director of public utilities and a member of the commission, says, "Lake Erie seems to be the national symbol of environmental degradation."

Actually, the swimmers' rosier assessment was not entirely wrong. Improved municipal treatment has brought down the level of bacterial contamination on Lake Erie's beaches. There is less evidence of oil and toxins in the lake's tributaries and harbors. But Lake Erie's biggest pollution problem remains phosphorus, and it is a problem that is far from solved.

Ironically, the lake may be its own worst enemy. Phosphorus flowing into Lake Erie from industrial and municipal sewage discharges and agricultural runoff stimulates the growth of algae, which die and decompose in late sum-

Visit to a Small Planet

Is human civilization in danger of growing itself to death?

A group of cosmic thinkers called the Club of Rome raised that question three years ago and sparked a global controversy with the publication of its conclusion. Based on an elaborate computer model developed at the Massachusetts Institute of Technology, "The Limits to Growth" warned that if current trends in population and natural-resource depletion remained unchecked, the earth faced an imminent Malthusian catastrophe: a world of mines and wells run dry, of industry ground to a halt, and worse, megafamine. The resulting debate has

Houston—outside temperatures were comfortable; inside the Woodlands Inn, air-conditioning units frequently blew loud enough to drown out speakers and chilly enough to send shivers through listeners.

Debate at the Woodlands drooped under a serious case of intellectual entropy. As they have now for three years, the conferees who attend such meetings focused almost exclusively on the growth issue: would technology provide a timely bail-out, especially if the world were depleting its resources and adding to its population at exponential rates?

there permanently. The society's plan for a burgeoning population: shoot a huge colony of earthlings in a space settlement to L-5.

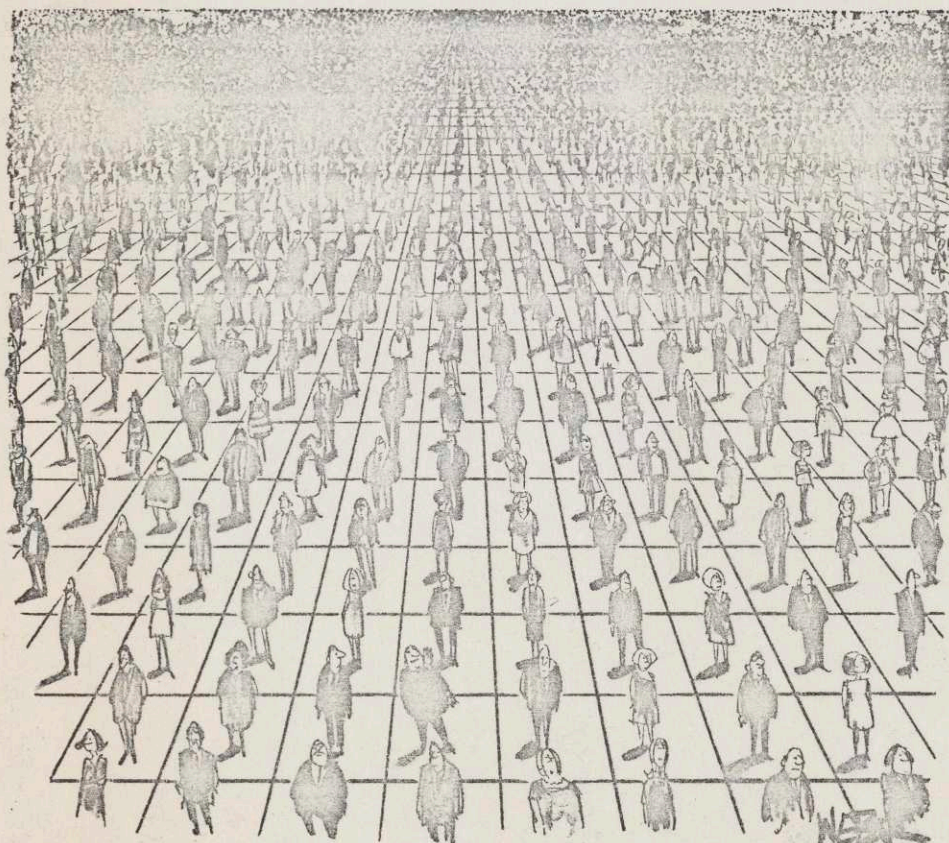
One of futurism's foremost gurus brought a familiar incantation: that growth is good for us. Herman Kahn, round-bodied director of the Hudson Institute, did concede that economic growth would slow down eventually. For now, Kahn said, a no-growth policy would only "consign the poor to indefinite poverty." On the floor, an exasperated no-growth man muttered: "How many times do you think Herman has mouthed that message?"

The real problem in today's world is not growth but the maldistribution of income between rich and poor nations. One persistent criticism of "The Limits to Growth" has been that the study tended to ignore how income is skewed, and at the Woodlands, both the program and the participants kept right on ignoring it. The only participants from Third World countries were two Iranian diplomats, and I saw practically no Asians, Indians or Africans.

The only horse sense was furnished by British economist E.F. Schumacher. For the past ten years, he has been helping to provide developing nations with intermediate technology—"something between the sickle and the harvester," he told me, for labor-intensive economies that are short of capital. In one recent project, his Intermediate Technology Development Group helped Sri Lanka find designs for small, relatively simple sugar-refining machines that would permit that nation to decentralize the sugar industry and put more people to work. In the lofty abstractions of the Woodlands, Schumacher was as reassuringly down-to-earth as a good plow.

"Multinational corporations are examples of efficient worldwide organizations," said Sicco Mansholt, former Common Market president, "and we must compare them with the clumsy ways we organize political decisions for the public interest." That was about the only thing said about the multinationals, even though they are among the most important forces shaping the real world. Corporate participation at "Limits '75" was itself limited: of the 350 people attending, a mere one-seventh represented major companies—and most of them were public-relations officers, economists or long-range planners with an eye, as one told me, "on how this stuff might affect our business."

Are there really limits to the world's growth? It is a real and troubling question; the people who gathered at the Woodlands were well-meaning and sincere in grappling with it. But in the end, Philippe de Seynes of the United Nations Institute on Trade and Development



Drawing by Weber; © 1971 The New Yorker, Inc.

'Excuse me, sir. I am prepared to make you a rather attractive offer for your square.'

become chronic, with periodic meetings of growth and no-growth partisans to argue their cases. NEWSWEEK General Editor Michael Ruby attended "Limits to Growth '75" last week and returned with the following impressions:

In an unintended way, the three conference sponsors—among them the Club of Rome itself—managed to make ironic points about natural-resource conservation. They set the meeting outside Houston, a city that ranks as one of the most energy-intensive on earth, its sprawling petrochemical complexes often spewing enough pollution into the air to turn the Texas sky a nasty gray. At the actual conference site—a posh hotel in Woodlands, a new town 25 miles from

There was only one answer: it depends. "There was room here for real progress, but unfortunately, the debate hasn't changed much in substantive content," said Jib Fowles, the young director of the University of Houston's Program in Studies of the Future. "What has changed is that the arena of the debate has enlarged."

The arena now includes not only the established stars of future-think and conservation, but an entire galaxy of no-growth groupies as well. There was, for instance, a good-size contingent from the L-5 Society. L-5 is the name for a point in space where the gravitational forces of the earth and moon balance each other, theoretically permitting a body to rest

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summed up "Limits '75" as we waited for a bus to the Houston airport. "You know," he said, "all this has become an industry now—and it's a bit difficult to determine its marginal utility."

TVA:

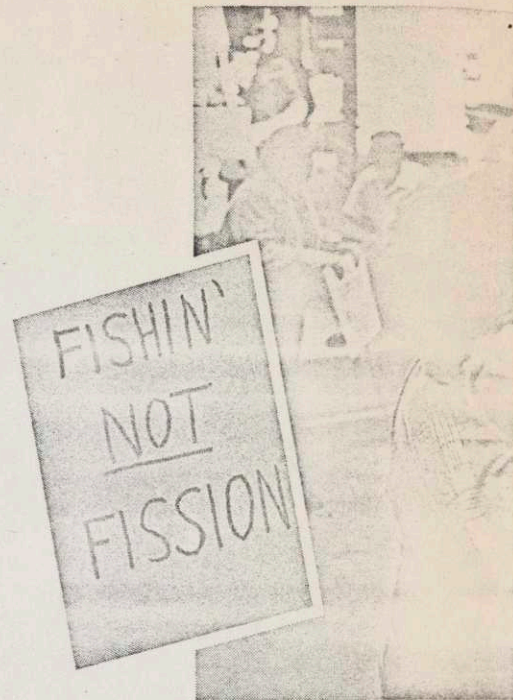
Wearing the Black Hat

In the rolling hills around the north-central Tennessee town of Hartsville (population: 2,000), old-timers still reminisce about that exciting day nearly 40 years ago "when the lights went on." Farm families who had lived by the light of kerosene lanterns took to stuffing empty light sockets with corn tassels; that, they believed, was the best available way to keep the precious new flow of electricity from escaping. And the Tennessee Valley Authority, one of the more enduring monuments to the New Deal, earned a gratitude approaching devotion as it brought electric power, jobs and freedom from floods to millions of families in an 80,000-square-mile area of seven Southeastern states (map).

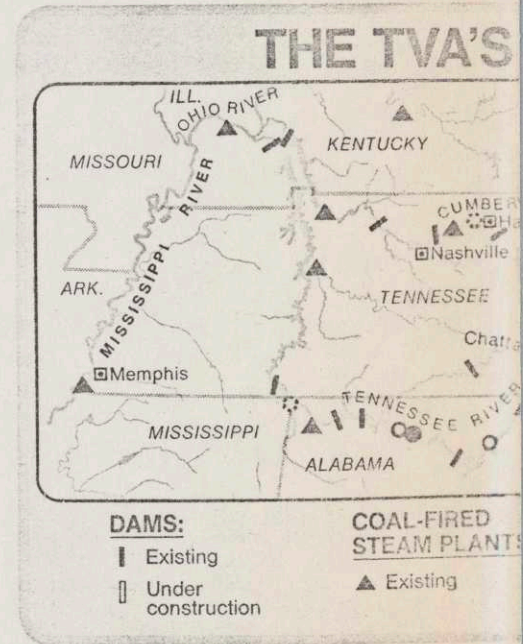
But TVA is no longer revered as a sacred icon in the area it serves; to many of its customers and most environmentalists, it is now just another greedy utility, guilty of the same pattern of unreasonable rate hikes and ecological rape as its privately owned cousins. Even though they still pay only two-thirds the national average for electricity, TVA customers complain that their bills have increased by 89 per cent since January 1974. Environmentalists charge that the TVA's growing appetite for coal and generating capacity is fouling the area's rivers and streams and either stripping or flooding the countryside. Local residents are bitterly fighting a TVA plan for a \$60 million dam and the creation of a "new town" in eastern Tennessee. And last week, a noisy public hearing erupted into fisticuffs as sleepy Hartsville debated the latest in a line of controversial TVA projects: a huge nuclear power plant to be located outside of town.

Behemoth: In many respects, TVA's troubles reflect only the authority's changing role and the changing times. It was chartered by the Federal government in 1933 with the primary mission of controlling the disastrous floods that struck nearly every spring in the Tennessee River basin. But the network of flood-control dams also generated enormous amounts of cheap power, and over the years TVA has grown into an industrial behemoth. It has assets of \$5.8 billion, employs 28,000 people and is by far the nation's largest power producer, capable of generating 110 billion kilowatt-hours. The low-cost electrical power has lured hundreds of high-volume consumers such as Alcoa and the U.S. Atomic Energy Commission to the area, creating tens of thousands of jobs.

But in some ways, TVA lost touch with its constituents. Only recently, for example, did it open its board meetings to



A tussle in Tennessee: Forty years after the



Bailiwick of a behemoth: Has TVA bee

outsiders. By its own admission, it has been lax in enforcing standards on reclaiming land stripped by coal miners, a gut issue in many Appalachian communities. "Their arteries have hardened," says an official of the Federal Appalachian Regional Commission. "Their customers have changed and they haven't."

Critics of the TVA gathered last week at the 187-year-old log farmhouse near Hartsville owned by environmentalist Faith Young and her husband, William, to argue that the proposed nuclear power plant, the fifth of seven in TVA's current construction program, is both potentially dangerous and unnecessary. Carrying