

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 Naisbitt, 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 illusionary 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