The Limits to Growth: Hard Sell for a Computer View of Doomsday

If the melodrama that unfolded last week around a little book called *The Limits to Growth** is any indication, the dismal science of economics may have as much potential for great theater as the original heart transplant.

The premise of this cliff-hanger is even more spine-chilling than the swapping of human hearts: Can civilization save itself from smothering in its own malignant growth? Was Malthus right all along? There's less time to ponder such questions than you might think.

Featured in the cast of *Limits to Growth* are an earnest young systems analyst, his biophysicist wife, their computer, and a gaggle of youthful colleagues at M.I.T. There's also a globe-trotting industrialist-cum environmentalist named Aurelio Peccei and his enigmatic Club of Rome, plus a galaxy of inadvertent supporting stars caught by the TV cameras in cameo appearances. Not the least of them is the Secretary of Health, Education, and Welfare, Elliot L. Richardson.

As in all good drama, the plot is less complex than the cast. Dennis L. Meadows, the young systems analyst, his wife Donella, and their friends have plugged into the computer a mathematical model of world growth trends which famed M.I.T. computer expert Jay W. Forrester is said to have conceived during an inspirational plane trip from Switzerland to New York one hot July day in 1970. Forrester's young disciples—backed by Peccei's elite Club of Rome and $250,000 from the Volkswagen Foundation—have refined the model and used it to generate a passel of spaghetti-like graphs that convey an urgent and alarming message: Unless current world trends in population growth and industrial output are checked, and unless pollution is severely curbed, civilization faces a catastrophic collapse within 100 years and perhaps within 50.

Never mind that hardly a reputable economist can be found who thinks these projections amount to more than a fascinating exercise in model-making. Never mind that not a shred of this has yet been exposed to critical review in a scientific journal. There's not enough time to fiddle with stodgy publications and their interminable lead times. And anyway the economists are only grimacing from sour grapes, what with the very foundation of their profession—the assumption of inevitable growth—threatened by a band of computer-wielding upstarts. The amenities of science aside, the world must be alerted, authorities must act.

Does Meadows get his message across? You bet he does. It's all done with a readable little book for laymen that may very well prove as popular as Linus Pauling's recent treatise on vitamin C.

As the book explains, the model used in the study consists of five global variables—pollution, population, food production, industrialization, and consumption of nonrenewable resources. About 100 causal relationships among the variables were then defined—the relation, for example, between pollution and life expectancy—and described by individual equations. Numerous computer runs of this model suggest to the authors that, if global economy is allowed to run its course, civilization may be expected to collapse in a miasma of disease and starvation within a century. On the brighter side, however, the model suggests to Meadows and his group that collapse can be averted by increasing the doubling time of population and industrial growth to something on the order of 1000 years—in short, the world must switch to a steady-state economy. Implied here is an "optimal" though not necessarily Utopian civilization with an average gross national product per capita of $1800—about half that of the United States, about equal to that of Europe, and three times the average GNP of the less-developed nations.

The book concedes that its model is crude, in the sense that it ignores national distinctions and nearly all social factors; but the point is made that it's still preferable to the "mental" models of global trends now used by policy-makers. The authors go on to say that:

> In spite of the preliminary state of our work, we believe it is important to publish the model and our findings now. Decisions are being made every day, in every part of the world that will affect the physical, economic, and social conditions of the world system for decades to come. These decisions cannot wait for perfect models and total understanding. . . . Furthermore, the basic behavior modes we have already observed in this model appear to be so fundamental and general that we do not expect our broad conclusions to be substantially altered by further revision.

The model deals essentially with economics, and thus, understandably, most of the public criticism of the book has come from economists. Their opinions of it are largely intuitive for the simple reason that the book reveals none of the assumptions and equations that are the meat of the model.

Remarks of Allen Kneese, a noted economist at Resources for the Future, in Washington, D.C., seem fairly typical of this intuitive chariness:

> I really don't see what value this model has for the real world. How can you define meaningful relationships with such a high level of aggregation? . . . And the idea that economists are just treating this like sour grapes is total rubbish. Exponential growth and the limits of resources are thoroughly embodied in economic literature. This kind of model has been discussed more or less continuously since Malthus. Either they're ignoring the history and work of their precursors or they're doing a snow job or both. . . .

Kneese and others have found a few factual errors in the book, which may or may not reflect on the model's veracity. And some critics suggest that Meadows and his group biased their model toward "collapse" by assuming that new technologies and resources grow at linear rates while everything else grows exponentially.

The project that led to the book was the brainchild of the Club of Rome, a 4-year-old organization of 75 prominent scientists, businessmen and politicians that bears an uncanny resemblance to Jules Verne's fictional Gun Club of Baltimore. In the present case, the Roman group's sole enterprise is only a little less grandiose than the 19th century Gun Club's plan to send a man to the moon. At the instigation of Peccei, an executive of both Fiat and Olivetti, the Club of Rome began in 1968 what it

* *The Limits to Growth*, a report for the Club of Rome's Project on the Predicament of Mankind, by Donella H. Meadows, Dennis L. Meadows, Jørgen Randers, and William W. Behrens III (Potomac) Associates-Universe Books, New York, 1972), $6.50; paperback edition, $2.75.

calls The Project on the Predicament of Mankind. As an afterword in *Limits to Growth* explains, "The project was not intended to be a piece of futurology. It was intended to be, and is, an analysis of current trends, of their influence on each other, and of their possible outcomes." Club members say that their organization represents no particular ideology and merely wants to bring mankind's predicament to the attention of those in a position to avert global calamity.

Carroll Wilson, a member of the club and a professor of management at M.I.T., says that after several months of talent-scouting the club settled on Jay Forrester as the best man for the job. He committed himself tentatively to the project after a club meeting in Bern on 29 June 1970, "that momentous date when it all began," Wilson says. Forrester had the project roughed out in his mind within a day or so. A 2-week meeting at Cambridge, Massachusetts, followed later that summer, and after that it was left to Meadows and his group to produce a report during the next 18 months. Meanwhile, Eduard Pestel, a director of the Volkswagen Foundation and also a member of the Club of Rome, convinced his foundation to grant a quick quarter-million for the project.

The resulting book was actually written by Meadows' wife Donella. Encouraged by Peccei and Wilson, she and her husband signed over the rights to it late last year to a little-known public policy think tank in Washington called Potomac Associates. Then the hoopla began.

Fully cognizant that, to borrow a phrase from a press release, an "intellectual bombshell" had fallen into its lap, to say nothing of a potential best-seller, Potomac Associates president William Watts passed a copy of it along to Benjamin H. Read, director of the Woodrow Wilson International Center for Scholars in Washington. Read quickly agreed to organize a symposium on the book, and the Xerox Corporation promised its financial support of the meeting.

Then came the publicity. To spread the word, Potomac Associates hired Calvin Kytle Associates, an energetic local public relations firm. Kytle churned out some zingy press releases and background material, embargoed it all for Sunday 27 February, and promptly struck a PR man's idea of gold. The *New York Times*, the Washington *Post*, the Boston *Globe*, and others picked up the story and splashed

DBS: Officials Confused over Powers

A notable state of confusion prevailing over federal authority to regulate biological products such as vaccines has finally been resolved. The point at issue is no less central than the government's authority to require that biological products be of proven effectiveness. Attorneys in the Department of Health, Education, and Welfare have now discovered that the department was entrusted by Congress with such authority 10 years ago but neglected to delegate it to the relevant regulatory agency, the Division of Biologics Standards (DBS).

This bureaucratic oversight was first noticed by James S. Turner, a public interest attorney who has been investigating the DBS following his representation of DBS scientist J. Anthony Morris in a Civil Service grievance procedure held last year (*Science*, 25 February and 3 March 1972). Officials of DBS, Turner noted in a legal memorandum shown to Senator Abraham Ribicoff (D–Conn.), believed they possessed authority to require safety, purity, and potency in the products they licensed, but not effectiveness. But authority to require effectiveness, Turner argued, was granted by Congress in the 1962 amendments (Kefauver amendments) to the federal Food, Drug, and Cosmetic Act.

"DBS apparently believes that it has no legal authority to test vaccines for effectiveness," Senator Ribicoff repeated to the floor of the Senate on 15 October last year. "If this legal interpretation is correct, Congress should act to give the Division the duty to do so; if the interpretation is incorrect, the Division should begin to fulfill its responsibilities."

In a memorandum of 23 November, Wilmot R. Hastings, general counsel of HEW, advised the Secretary that in his opinion the Department had indeed been invested with the authority to regulate biological products for effectiveness by the 1962 amendments to the act, but had never "formally delegated" such authority to the DBS. Following Hastings' discovery, this omission was remedied last month by official order.

How did this 10-year misunderstanding come about? As far as concerns the Secretary's office, it seems that in between the coming and going of secretaries, the efficacy of vaccines was a matter sufficiently trivial to get overlooked. Officials in the DBS were concerned about the problem, but believed that the 1962 amendments did not apply to biological products, in part because of a regulation drawn up by the Food and Drug Administration excluding biologics from a section of the federal Food, Drug, and Cosmetic Act. (Turner's comment on this position: "During investigation into the subject of biologics efficacy, some attempt might be made to discover how widespread the notion is that an Act of Congress can be nullified by a regulatory agency's announced regulation.")

Each year since 1964, the DBS has included in its legislative proposals a request that the division be given the authority to require effectiveness, a request that HEW officials have repeatedly ignored. Nevertheless, the DBS believes it has, in practice, ensured efficacy in all products licensed since 1962 by requesting manufacturers to provide efficacy data on a voluntary basis when applying for permission to test out a new biological product.

The new authority delegated to the DBS will primarily affect products licensed before 1962. These include rickettsial vaccines and many of the bacterial vaccines, for which proof of efficacy has never been demonstrated. All of these vaccines were believed to be effective at the time of licensing, DBS officials say, but some may not meet today's more stringent standards.

If the DBS has ensured efficacy in practice, at least for products licensed since 1962, what difference has the lack of formal authority made? Turner contends that the division has not moved as vigorously as possible in ensuring the efficacy of such vaccines as influenza and that, with formal authority to require efficacy, the DBS would have had to be more active in improving and developing this and other vaccines.—N.W.

it in their Sunday editions. Most reported some criticism of the Meadows' work, but not all did. Later in the week for instance, syndicated columnist Claire Sterling wrote from Rome that the study, soon to be available to the eyes of Everyman, contained "shattering insights" to catastrophe waiting in the wings, no question about it.

A flood of phone calls Monday morning made it plain to the Woodrow Wilson people that their sedate invitation-only affair was now an Event of major proportions. After all, who could turn away ambassadors, industrialists, high government officials, congressmen, and a flock of distinguished scientists practically pounding on the door?

Thursday morning, the day of the symposium, the first copies of *The Limits to Growth* hit the bookstands.

Women's Lib and NIH Advisory Committees—Progress?

In the course of the last year, the National Institutes of Health (NIH) has come under heavy fire from feminists for discriminating against women in the appointment of scientists to its advisory committees. As a result, on 29 September 1971, Elliot L. Richardson, Secretary of the Department of Health, Education, and Welfare, issued a memo ordering that one-third of those nominated or appointed to the committees should henceforth be women (*Science*, 15 October 1971). Since then, NIH officials maintain that they have been trying to comply. But problems have arisen.

First, NIH slowed the entire nominating process for the 500-odd upcoming vacancies for 2½ months, allegedly in order to wait for a group of women scientists to submit a list of candidates for the post. Second, the effort among women's groups to compile a roster of candidates has hit some internal snags. Third, there is now the possibility that the whole question of committee appointments may be tied up by feminists in court.

NIH deputy director John F. Sherman says that NIH stopped inviting scientists to fill the upcoming 500-odd vacancies from 15 November 1971 until 1 February 1972 because NIH wanted to obtain lists of qualified women scientists who might be eligible to fill the jobs. One-fourth of the 2000 prestigious advisory jobs become vacant automatically each July. In the meantime, Sherman says, NIH continued to invite scientists to join committees that had vacancies left over from last year. Acceptances, he says, have come in precisely at the rate specified in the Richardson memo. In January, 8 women were among the 23 scientists who agreed to fill prior vacancies, and, in February, 15 women were among the 45 scientists who accepted other vacancies. Sherman says that the number of women serving on the committees has risen from 73 in July 1971 to 197 at present.

But there now seem to be problems concerning the way in which NIH should go about filling the majority of committee vacancies, that is, those available 1 July. At present, it appears that a list of 1000 women's names, with as many as 21 candidates for a single specific committee vacancy, is being withheld from NIH on the grounds that NIH officials tinkered with the number of committee vacancies and failed to keep an alleged promise to pay the clerical costs of compiling the list. For their part, NIH officials say that the number of vacancies, originally stated at 500 but subsequently found to be 413, was first only estimated. They also insist that there never was a clear agreement that NIH would pay clerical costs. In the meantime, since 1 February NIH has started to fill vacancies from its own roster of qualified women, which numbers only 450. This roster is being compiled in the Division of Research Grants.

Sherman says that, until a short time ago, NIH was under the impression that a group of women scientists, who had met with officials and who had as spokeswoman Julia T. Apter of Rush Medical College, Chicago, would supply NIH with a roster of qualified women to fill specific vacancies by 1 February. He says NIH has not received the list. Apter is declining to comment on its existence and its present whereabouts.

However, other women's groups that have helped, since November, in putting together the Apter list say that it contains over 1000 names matched to specific NIH committee vacancies, and in some cases proposes as many as 21 women candidates for a single specific vacancy. They say that Apter decided to withhold the list from NIH until she had been reimbursed for $1435 in clerical expenses. Apter's lawyer, Sylvia Roberts, says that there never was a firm agreement about turning a list over to NIH, and that the work of finding qualified women is NIH's job anyway.

However, sources in other women's professional groups appear to advocate a more moderate path. Their view is, it seems, that despite the money dispute, the list should be given to NIH to facilitate the process of adding women to the committees. One informed source who agreed to be quoted is Judith Pool, senior scientist at Stanford University Medical Center, and co-president of the Association of Women in Science (AWIS). AWIS itself is preparing a roster of 4500 women scientists based on *American Men and Women of Science* (formerly *American Men of Science*). AWIS helped to compile the Apter file. Pool agrees that finding qualified scientists is really NIH's job, not that of feminists. "But since we had made a head start on it and we offered to share the work with NIH, I for one would have been willing to overlook the fact that NIH was having its work done for it. . . . I wouldn't have tried to punish NIH by withholding the list because we would be punishing ourselves."

However, another move, apparently contemplated by Apter, could tie the whole matter of NIH committee appointments in court. AWIS and other women's professional groups have signed a statement circulated by Apter suggesting a court case based on Executive Order 11478, which prohibits employment discrimination by federal agencies. In accompanying correspondence, Apter said, " . . . It is obvious that NIH could have found these women had it made the effort. . . . Our legal action will seek to raise the participation of women on these advisory bodies from its present 2 percent to 50 percent and shall be invoking the provisions of Executive Order 11478. . . ."—DEBORAH SHAPLEY

Now the drama took a turn toward the dull side. What might have been a scene of climactic confrontation between authors and critics was in fact quite a genteel affair, well out of the Huxley-Wilberforce league.

Perhaps it was the immense respectability of the setting—the Great Hall of the Smithsonian Institution's Victorian gothic castle, a room of baronial proportions decorated with tall Romanesque columns and glowering busts of Joseph Henry, Samuel Pierpont Langley, and the like. Perhaps the television cameras and klieg lights strung about the place had a moderating effect on some of the stronger feeling evident in private conversations among the audience of 250 or so. Or it may just have been the fact that nobody knew any more about the Meadows study than what *The Limits to Growth* told them, which wasn't much. And a good many apparently hadn't had a chance to read even that.

In any event, talk during the morning half of the symposium stuck to the study's implications for social policy, with hardly a question of its veracity.

For the benefit of those who hadn't yet seen the book Dennis Meadows summarized it, patiently explaining what exponential growth was, as opposed to the linear kind. He showed himself to be pleasant and reserved, even a little uncomfortable with the commotion that had been engineered around him. He insisted that he was not "antitechnology"—"but as long as we rely solely on technology for alleviating short-term problems we are heading for trouble"—nor do he and his group think of themselves as prophets of doom. He said this is because they are optimistic that society can make the necessary adjustments toward a steady-state economy.

Questions and answers followed: Senator Claiborne Pell, Democrat from Rhode Island, noted that, "You presume man is rational, but in our work he is emotional. How do you convert this into an action program?" Meadows replied that legislators were better equipped to answer that, but he presumed that science "can have rational inputs to man's behavior." Senator Pell then left for other business.

Indian ambassador L. K. Jha said he was concerned that, unless income were equalized between wealthy and poor nations, "poor nations would slide down to starvation" while the wealthy continued to sap their resources. Meadows said that he didn't think this would necessarily happen.

Philippe de Seynes, the United Nations undersecretary general for economic and social affairs, offered his "heartfelt congratulations" to Meadows and Peccei for their work. But, with a sidelong glance at the TV cameras, he said he was concerned about "the campaign we are facing from the mass media" and about the prospect that the study "might be put to the service of ideology." In an interview, de Seynes went on to say that important caveats in the study "do not clearly come across in the book . . . I already see these views affecting people at the UN. Some people fear that it may work to hinder their immediate goals of development."

HEW Secretary Elliot Richardson capped the morning session with some carefully hedged praise: The study was "too thoughtful, too thorough, too significant to ignore," even if it were not entirely correct; but there was a risk that regulation of growth might lead to "destruction of our liberty and freedom."

Noontime, and the scene dissolves to stage left where an impromptu news conference surrounds Meadows and Peccei like a rugby scrum. Meadows is asked, among other things, why his group hustled out a popular book before publishing any of the study in critical journals. He doesn't seem to like the question but he answers it anyway. "Journals take so long. You're talking about delays in publication, a lead time, of 12 months on up." A reporter suggests this is an exaggeration. Meadows replies that his group has been distributing between 300 and 500 copies of mimeographed technical papers each week recently, that about 20 individual papers will be published in journals, and that a 500-page technical report, detailing the study "equation by equation" will also be published.

Later, Meadows told *Science* that the idea of bringing out a popular book with a blast of publicity was mostly Peccei's idea, not his. "This isn't our mode of doing things. We want to sink back out of sight—we're not letting TV cameras in our laboratory." Also later, in a brief conversation, M.I.T.'s Carroll Wilson defended the book's early publication, saying that "so few will read the technical report and so many will read the book that it doesn't really matter."

The afternoon session was livelier, if darker. The TV crews had packed up their cameras and lights, leaving the Great Hall in a kind of monastic gloom.

NEWS & NOTES

• **NAL ACHIEVES 200 GEV**: Great rejoicing erupted at the National Accelerator Laboratory at 2:08 p.m. on 1 March, when the Atomic Energy Commission's mammoth new particle accelerator boosted a stream of protons to 200 Gev—the highest energy ever achieved by a man-made machine. Robert R. Wilson, director of the laboratory at Batavia, Illinois, has expressed confidence that energy levels of 400 to 500 Gev will be attained within a matter of weeks. Officials expect to achieve a sustained 200-Gev beam by July, the date scheduled for completion of construction.

• **AAAS-ZNANIYE EXCHANGE**: The AAAS has reached agreement with its Russian counterpart, Znaniye, to exchange four scientist lecturers each annually for the next 3 years. The scientists will talk both to their colleagues and to the public during their 10-day visits, giving emphasis to ways of improving public understanding of science.

• **FULBRIGHT-HAYS PROGRAM OPEN**: The National Academy of Sciences will accept applications this spring for senior Fulbright-Hays awards for lecturing and research during 1973–74. Positions are available in over 75 countries for scientists who are U.S. citizens and who have either a doctorate or college teaching experience. Awards cover travel and family maintenance allowance. Application deadline is 1 July. Requests for applications may be made to Senior Fulbright-Hays Program, 2101 Constitution Ave., Washington, D.C. 20418.

• **ARMENIANS TO STUDY IN PEACH STATE**: The University of Georgia, which has an advanced program in applied mathematics, has made an unusual arrangement with Soviet Armenia to host Soviet graduate students in the fields of mathematics, statistics, physics, engineering, and computer science. The agreement grew out of a meeting between Georgia mathematics professor George Adomian and scientists he met at a meeting in Armenia last fall. Eventually, Adomian hopes there will be half a dozen Soviet graduate students continually at the university and Georgia graduate students will be able to study in Armenia and at the U.S.S.R. Academy of Sciences.

Someone scrounged fluorescent desk lamps for the panelists, and the show went on.

Critics and advocates alike now seemed a bit less bashful, and some indications emerged that even members of the Club of Rome differ on the usefulness of the Meadows model. Alexander King of Great Britain, the director of science and technology of the Organisation for Economic Cooperation and Development, said it was "clear that this is not a decision-making model," and that substantial refinements were needed. But Eduard Pestel, encouraged by the way the model's projections paralleled events between 1900 and 1970, averred that "policy decisions can now be derived from what has been worked out. There is no need to wait to start action."

Similarly, Lester Brown, an agricultural authority with the Overseas Development Council, thought the model was a "remarkable achievement." Stewart Udall, former Secretary of the Interior, dropped in to toss a few bouquets on behalf of environmentalists like himself. "You have made us respectable," he said.

And one panelist, ABC radio commentator Edward P. Morgan, weighed in with the view that there would be negative reaction to the book, but that it would come mostly "from reactionaries and older folks." As an antidote, he suggested that "it's up to us, the news media, to mount a basic education program here." On the other hand, Antonie Knoppers, the president of Merck and Company pharmaceuticals, urged caution by the Club of Rome until the many assumptions on which the global model is built have been better verified, or at least made generally known. "The masses will look at these diagrams and believe them, but I feel it's dangerous to speak of projections 50 and 70 years ahead. If we feed the decision-makers half-baked conclusions we can do great harm."

out charge to 12,000 selected world

And finally there was Aurelio Peccei, the Club of Rome's urbane and silvery haired progenitor, explaining why he'd done it all in the first place.

For 2 years, club members had plodded quietly from Moscow to Rio, from Stockholm to Washington, seeking out political leaders and appraising them of the dangers ahead:

> Our message was received with sympathy and understanding, but no action followed. What we needed was a stronger tool of communication to move men on the planet out of their ingrained habits. This is the reason for the M.I.T. study and the book. Its conclusions are preliminary, but it is a key which permits every layman to enter the labyrinth of the fantastic problems towering over mankind.

Just to make sure everyone gets the key, the book will be printed in half a dozen languages and will be sent without change to 12,000 selected world leaders.

It's difficult to tell how this whole affair is viewed by the academic community at M.I.T.—probably the best source of perspective at this point. A few selective inquiries reveal something less than breathless excitement, however, and not just among disgruntled economists. Perhaps the most enlightened assessment of the week comes from this senior scientist at M.I.T., an acquaintance of both Forrester and Meadows, who asked not to be named:

> I happen to like Dennis Meadows. He's a nice fellow and very bright, if he doesn't go off the deep end. I find their work fascinating, but I'm not about to tell a congressman to base his career on it. . . . What they're doing is providing simple-minded answers for simple-minded people who are scared to death. And that's a dangerous thing. And there's a sense of naiveté here too. . . . it's not that *they* want publicity, or a grant, but they want to save the world. This messianic impulse is what disturbs me.

Thus ends the first but probably not the last act of a remarkably successful venture in the mass marketing of neo-Malthusian economics. In the next episode, with a little luck, some television producer might be persuaded to put aside the threadbare theme of the hero surgeon and try his hand at a pilot run featuring a brilliant team of computer experts obsessed with a passion for relevance, equipped with the world's most prodigious electronic brain, an IBM 2001. . . .

—ROBERT GILLETTE

Decline in Funding Detailed

Federal support to universities and colleges dropped by $227 million—to $3.2 billion—between fiscal years 1969 and 1970, and academic science funding bore $193 million of this cut. This debilitating downturn in science funding is chronicled in a dry compendium of facts and figures issued by the National Science Foundation [*Federal Support to Universities, Colleges and Selected Nonprofit Institutions, Fiscal Year 1970* (Government Printing Office, Washington, D.C. 20402), $1.25 a copy].

Federal support of higher education in 1970 represented the lowest level of funding since 1966 and the first decline in actual dollars since 1963. Much of the decline may be attributed to a shift in government policy from giving direct grants for construction to subsidizing interest charges on loans from nongovernmental sources. Under this policy, the Office of Education's construction grants fell $175 million in 1970. Nevertheless, the Department of Health, Education, and Welfare, of which the Office of Education is a part, remained the source of 64 percent of all federal obligations for colleges and universities in 1970. The Department of Defense (DOD) and the National Science Foundation together supplied another 20 percent of the federal total.

Academic science funding in 1970 fell by $193 million, or 8 percent, compared with a reduction of only $33 million (or 3 percent) in nonscience funding. Still, some institutions made the best of a falling market. The Massachusetts Institute of Technology became the first institution in history to receive in excess of $100 million from the federal government, cornering 17 and 20 percent, respectively, of the total allocations by DOD and NASA to academic science. The University of Cincinnati's federal support was increased by 263 percent, which raises it from 71st to 9th place in the league of federally supported institutions.

The ratio of total federal support to the number of degrees awarded (bachelor's or higher) amounted to $3,715 per degree in fiscal 1970. The regional variations of this figure ranged from high values of $24,555 and $7,447 per degree, respectively, in such underdeveloped areas as Alaska and Washington, D.C., down to a low of $1,576 per degree in Maine.—N.W.