FUNDING GLOOM: MOOD OF FOREBODING PERVADES FORUM AT SCIENCE ACADEMY

Academic scientists in the US are beset by a paradox. Scientific journals and professional meetings are crammed with reports of exciting ideas and notable discoveries. Not since the influx of scientists fleeing Europe before World War II have so many come from abroad to study and do research. Yet the number of American graduate students in the physical sciences and in engineering continues to fall. And although Federal funding for academic research has never been greater—much more than the amount allocated in Western Europe and Japan combined—professors are frustrated and angered by the increasing difficulties of obtaining research grants to support their graduate students and to buy expensive new equipment to keep pace with developments in their fields.

This unsettling situation has been the subject of many conferences and colloquiums by scientific societies in recent years. The topic was discussed again in a mood of somber foreboding on 7 January in the auditorium of the National Academy of Sciences, where the central figure was Leon Lederman, director emeritus of Fermilab and now a physics professor at the University of Chicago. A Nobel Prize winner, Lederman is attaining additional celebrity as the messianic organizer of a project to inculcate Chicago's 17 000 public school teachers with the ability to teach science and math. This month, he also becomes the 143rd president of the American Association for the Advancement of Science, a position that catapults him into a pulpit to deliver sermons on science policy issues.

As president-elect of the AAAS last summer, Lederman convinced the staff to conduct an informal opinion poll of the heads of physics, chemistry and biology departments at the 50 universities that receive the most research grants. They and some of their faculty colleagues were asked to comment on their experiences in obtaining funds and how those efforts affected their own work, attitudes and plans. The poll also sought to determine the opinions and outlook of their students. By late fall, nearly 250 academic researchers responded.

The results of the survey appear in a 19-page report bearing the title of "Science: The End of the Frontier?" a wordplay on "Science: The Endless Frontier," the 1945 report by Vannevar Bush that stimulated government support of basic science and inspired the creation of the National Science Foundation. As the principal author of the new report, Lederman summarized the findings at the academy meeting before an audience of some 350, who included leaders of science organizations, officials of government agencies, staffers from Capitol Hill and reporters for science publications. He characterized the report as "a cry of alarm about the state of academic science." It is indeed a depressing and sometimes desperate portrait of academic science in the decade of the 1990s.

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Lederman: 'Cry of alarm for science.'

The responses, Lederman writes in the preface, "confirmed my expectations of trouble, but with a depth of despair and discouragement that I have not experienced in my 40 years in science." Although he admits to being moved by the expressions of poignancy and passion, "my concern is not for the unhappiness of my colleagues in science, much as I love and value them," he laments. "My concern is for the future of science in the US and for the profound cultural and economic benefits that science brings."

Lederman's jeremiad speaks of an academic research community apprehensive about "flagging morale, diminishing expectations and constricting horizons." The margins of the report are studded with brief excerpts from some of the letters. The statements leave an impression of talented students deterred from becoming scientists, of scientific careers cut off just as they are about to flower and of scientific creativity unrealized. One of the quotes is from a University of Michigan physics professor, who wrote: "I am dismayed by the great difficulties that so many of [the young faculty] encounter in obtaining grants. These are highly qualified young scientists, yet they are in much more dire straits, in the early stages of their careers, with regard to research funding than were their predecessors." A physicist occupying an endowed chair at Caltech says his financial future is secure, but "every time you write a proposal for a renewal of your grant, you are playing Russian roulette with people's lives. You soon find that your chief responsibility is no longer to do science at all; it is to feed your graduate students' children."

The purpose of the survey is twofold, according to Lederman. It is intended to sensitize scientists to the perils of academic life and to enlighten heads of government agencies and members of Congress about the plight of scientists. Lederman is the first to admit that the report can be faulted on several grounds. It is based on personal experiences. Anecdotal data send opinion researchers and survey statisticians up the wall. The report also leaves the impression of being self-serving. Lederman himself points out in the preface that some colleagues question whether issuing

the report brings science "down to the level of 'just another interest group.' "

Scientists are probably divided into two "gangs" about the report, Lederman told the academy audience. "Gang one says: There are finite resources, so science must make hard choices and not behave like special pleaders. . . . Gang two says: Science has always been one of the best investments the government can make." Lederman believes the year 1968 "was the peak year of what we call the Golden Age" of Federal funding, "when any competent scientist could get funded, with persistence." His choice of 1968 is an anachronism because that was the year the New York Academy of Sciences held a meeting on "The Crisis Facing American Science" at which it released its "Preliminary Report on the Effects of Decreased Federal Support of Scientific Research and Education."

Woes of funding research

As he sees it, observes Lederman, neither the Administration nor Congress believes that science is now adequately funded; both would like to appropriate more if budgets weren't squeezed so tight. Lederman says academic scientists have two choices in dealing with the current funding woes: They can adopt the position that the government's financial problems, which are aggravated by a budget deficit that is likely to amount to $300 billion this year, even before the Persian Gulf war and the savings and loan bailout are taken into account, make it necessary for them to tighten their belts, or they can argue that hard times are exactly when support for research and education should be strengthened.

In the preface of the report Lederman shows sympathy with the government's dilemma. "Since the mid-1980s, in the face of enormous pressures on the budget, the Federal investment in basic research has grown significantly—faster, in fact, than nearly any other area of nondefense spending," he writes. Nonetheless, since the 1970s, the cost of academic research has been rising faster than the consumer price index because of the complexity and sophistication of modern laboratory apparatus, the new environmental and other regulatory requirements, and the proportion of dollars taken from grants to pay the indirect overhead charges at universities.

Lederman suggests a few courses of action: One is to double the current funding for basic research, which approaches $10 billion in 1991, in the next two or three years. Lederman makes the case that Federal spending for science research last year was only 20% more than it was in 1968, when adjusted for inflation. In the years intervening, the number of scientists with PhDs has more than doubled. Another idea is to place the funding increments for science "off the budget," possibly in the kind of trust fund that already exists for social security or highway construction. "If it is true, as economists say, that science pays, then establish a 'Scientific Investment Trust Fund' by taxing high-technology products," says Lederman. In the meanwhile, he proposes that a national commission consisting of representatives of the executive and legislative branches of government and the industrial, financial and academic communities should be formed to examine the problems of basic research.

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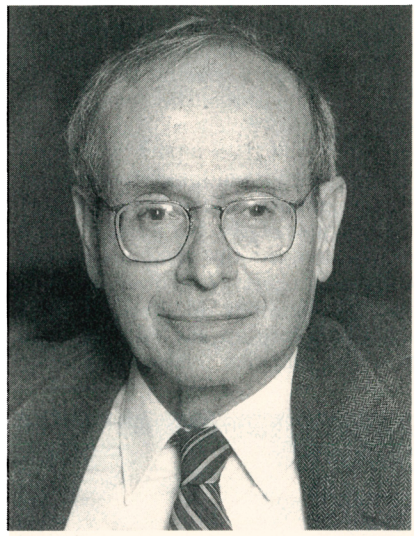

Press: 'No blank check for science.'

In a statement reacting to Lederman's report, D. Allan Bromley, President Bush's science adviser and director of the Office of Science and Technology Policy, said it "raises important issues that deserve, and are receiving, serious consideration. . . . The anecdotal evidence that Lederman has compiled emphasizes the fact that the number of [science and engineering] investigators and the total of their requests for Federal support for their research have grown more rapidly during the past decade than has the available funding. The pain and concern expressed by the research community are very real."

Bromley recounted that government support for academic research increased from $5 billion in 1968 (in 1988 dollar value) to about $8 billion in 1988 and that funds for R&D at the nation's colleges and universities equal 0.27% of the GNP—"an all-time high." Bromley's numbers, says Lederman, are based on the inflation formula the White House Office of Management and Budget applies to the consumer price index, but OMB uses a different inflation factor for calculating laboratory research costs.

It seems that America's academic scientists are paying a price for their success in the 1950s and 1960s in turning on the best and brightest to research. In this connection, Bromley was quoted recently in Daniel Greenberg's newsletter *Science and Government Report* as saying, somewhat insensitively, "You would have thought that the nation's brightest folks [presumably meaning scientists] would have been able to realize that this disparity between output of scientists and obligation of funds couldn't continue indefinitely." He also stated in the interview that scientists do not have "a divine right" to a grant.

Human side of 'dry data'

Frank Press, president of the National Academy of Sciences, thanked Lederman at the academy meeting for putting "a human dimension on these dry data" about the dearth of grants for academic research and defended the doubling of Federal support for basic science. Press, in fact, had called for doubling the research budget in his 1988 address to the academy (PHYSICS TODAY, June 1988, page 49). A similar recommendation came from Bromley himself in 1986, in a report he wrote for President Reagan's White House Science Council.

Lederman's report, said Press, "accurately portrays the state of affairs and the morale of the academic scientific community. However, no nation can write a blank check for science. . . . If the number of scientists has doubled in 20 years and spending has not kept pace, why should the taxpayers come to the rescue? Who says that science should be a top priority?" Press, who was President Carter's science adviser, entered a note of realism into the debate. "Science is competing for funds with the homeless, with social programs, and these all occur in the same budget function as support for science agencies." These matters cannot be ignored, he said, "and all of us must be prepared with convincing evidence rather than hortatory responses." He wound up his remarks by predicting that money for science and education would increase in the next few years but "would not necessarily be wisely spent. So I believe the scientific community should participate in steering these new resources in directions that . . . will ensure the greatest

creativity for our working scientists of the next generation."

Another speaker, Al Gore Jr, the Tennessee Democrat who heads the Senate's science research subcommittee, also noted that science confronts many social priorities in the Federal budget. Science funding was not at the top of the agenda of any member of Congress, he observed. "The way the country as a whole responds to the appeal for scientific research includes their demands for education and economic competitiveness." Despite his words of warning, Gore, along with Senator Pete Domenici, a New Mexico Republican, and Representative George Brown Jr, a California Democrat and chairman of the House science committee, sent copies of Lederman's report to their colleagues.

—IRWIN GOODWIN

CONGRESS HEAPS FUNDS ON EPSCOR FOR RESEARCH IN 'HAVE-NOT' STATES

EPSCOR is the acronym for a little-known program within the National Science Foundation that has recently come in for well-deserved mimicry around Washington. The program, bearing the full name of Experimental Program to Stimulate Competitive Research, operates on a small budget, amounting to $11 million in fiscal 1991, to "leverage" support for science and engineering in 16 states and Puerto Rico. It was created in 1979 in response to Congressional criticism that NSF was not fulfilling a requirement of its original act to strengthen scientific research throughout the country and to avoid undue concentration of such research. The purpose of EPSCOR is to improve research in states that have historically fared poorly in their efforts to attain Federal funding. Many in Congress argue that NSF peer reviews for awarding R&D grants are nothing more than an elitist "good old boy" system that rewards the "haves" and ignores the "have-nots." Senator Ted Stevens, the Alaska Republican who is vice chairman of the board of Congress's Office of Technology Assessment, complains that NSF "neglects the possibility of excellence from smaller universities and states."

Congress expects to see more of EPSCOR in fiscal 1991 and in the years following. The program was featured in seven conference reports or appropriations bills last year. House and Senate conferees for the energy and water development appropriations bill called on the Department of Energy to devote "not less than $2 million . . . for EPSCOR planning grants and $2 million for Graduate Traineeship EPSCOR funding." The Department of Defense, the Environmental Protection Agency and the Department of Agriculture are also directed to introduce EPSCOR programs. NASA decided to get a jump on Congress: Program solicitation for its own version of EPSCOR, known as Capability Enhancement grants, went out last October, and awards will be made early this year.

While the traditional method Congress uses to spread the wealth is to ladle out funds from the "pork barrel," this does not assure that money reaches the states that need help the most. Scientists and educators disapprove of the practice because it bypasses the peer-review process. In a 1989 study of academic pork, James Savage, of the president's office of the University of California system, found that between fiscal 1980 and 1989, "NSF's top ten research states received more than a third of all earmarks. Rather than creating geographical equity, earmarking helps the rich states get richer."

Formula for self improvement

EPSCOR, by contrast, acts as an affirmative action program to reward those states that almost always receive the smallest Federal research support. Proponents of the program claim the EPSCOR formula provides incentives for researchers in poorer states to pull themselves up by their own bootstraps.

So it is not surprising that EPSCOR has many friends in Congress. Among the program's influential champions are the chairmen of the appropriations committees in each house, Senator Robert Byrd of West Virginia and Representative Jamie Whitten of Mississippi. Both are from EPSCOR states. While President Bush's budget request for 1991 left the EPSCOR program in NSF at the 1990 level of $9.8 million, Congress, largely through the persistence of Senator Bob Kerrey, a Nebraska Democrat, boosted its allocation to $11 million. With the additional funds, NSF will be able to bring two more states into the program. The most likely additions: Kerrey's own state of Nebraska and neighboring Kansas.

States do not apply to participate in EPSCOR; they are chosen by NSF. The procedure begins with a pool of states that have ranked below a certain level of research grants for a number of years. The states in this pool are rated by their Federal and NSF research support in three ways: total grants for all research, totals per academic scientist or engineer, and totals per capita. The lowest-scoring states become eligible to compete against one another for EPSCOR grants. The current EPSCOR states are Alabama, Arkansas, Idaho, Kentucky, Louisiana, Maine, Mississippi, Montana, Nevada, North Dakota, Oklahoma, South Carolina, South Dakota, Vermont, West Virginia and Wyoming. NSF officials also included Puerto Rico in the program.

Once the foundation puts out its program solicitation, an *ad hoc* statewide EPSCOR committee in each eligible state, in collaboration with participating public and private academic institutions, responds with a two-part proposal. In the first part, the state explains its long-term strategy for improving research support at universities and indicates how much money it is willing to put up to match NSF's contribution. By demanding matching funds, NSF has coaxed some $110 million from states, institutions and private donors in the first eight years of the program.

EPSCOR states have developed a variety of initiatives for state support: Over the past decade Montana's MONTS program (Montanans On a New Trac for Science) has provided close to $400 000 a year to fund almost 250 investigators. The Oklahoma Center for Science and Technology, an organization representing the state, universities and industry, annually funds $17 million worth of research, equipment grants, endowed chairs and state centers of excellence. The Wyoming Science, Technology and Energy Authority, helps the state legislature develop a research agenda for the state. In Arkansas, North Dakota and South Dakota, EPSCOR led to the creation of new funding agencies to support research.

The second section of the EPSCOR proposal contains requests to fund individual research projects. This part of the proposal goes through the customary NSF merit review process and those projects that do not meet the review standards are eliminated. "Reviewers judge the proposal in relation to the most excellent research in the field," says Joseph Danek, EPSCOR's former program director, who now directs the NSF Office of Experimental Programs. The number of awards granted depends on the quality of the proposals and the availability of funds.