crats, empowered to among other things help coordinate US research activities with those of other countries. I propose that we establish Technology Extension Centers, similar to those used for many years by agriculture, to help with the wide dissemination and effective use of the new technology we develop. They would channel Federally supported R&D monies to the private sector and provide technical assistance to new and smaller businesses.

I believe, in addition, that we should make the 25% R&D tax credit permanent, eliminate the capital gains tax for long-term investment in smaller businesses, and broaden the Investment Tax Credit to cover new investment in education and training of industrial R&D personnel. We should also reexamine our patent and copyright laws to ensure that new kinds of "intellectual property" such as computer software are appropriately treated, and clarify antitrust laws to encourage joint R&D ventures by creating legal zones in which companies can engage in legitimate cooperative activities without risk of adverse antitrust action.

Lastly, I support broadened cooperation with our allies on large projects requiring the combined skills and resources of more than one country. The cooperative projects undertaken by NASA are a good example of this type of work. However, we should take care to preserve America's competitiveness in basic and applied research in those areas where we and our allies are vying for shares in the international marketplace.

■ *Each year many worthy scientific projects are abandoned or deferred for lack of funds. Each such instance represents a technological risk for the United States. Yet some projects continue to be funded by direct congressional action, avoiding the process of peer review. How can the Federal government ensure that the advice of our leading experts is considered in establishing priorities for the most essential and promising scientific projects?*

The Economic Competitiveness Council should be empowered to engage in ongoing technology assessment, soliciting the advice and recommendations of experts in and out of the government to set priorities in funding, and aiding coordination and cooperation between business, labor, education and private research centers, and the Federal government. It should work closely with the Congressional Office of Technology Assessment to assist Congress and the Executive Branch in arriving at unified priorities for the nation. We also need to ensure that our university personnel have adequate time for research and rapid access to information, without which they cannot contribute effectively to this effort.

■ *The economic and military security of the United States is dependent on our continued technological superiority. In an effort to deny US advances to our adversaries, restrictions have been imposed on scientific communication that threaten the very system that has given us our lead. What actions would your administration take to ensure a proper balance between the need for secrecy and the openness essential to the health of science?*

As mentioned in my answer to the first question, I believe that the restrictions on scientific discussions should be reduced to only that level absolutely necessary to safeguard national security. I realize that this distinction is often unclear, but I feel we must foster the openness all scientists need to work effectively. I strongly oppose the type of wide-sweeping gag rule which the Reagan Administration recently tried to establish.

■ *More than a year ago the National Commission on Excellence in Education issued its sober report, "A Nation at Risk: The Imperative for Educational Reform." The report places particular stress on the urgent need for reform in math and science education. What should be the role of the Federal government in ensuring that the vital needs of the nation for scientific and technical manpower are met?*

Excellence in science begins with a trained mind. To be effective, that training must begin in the early years of education, and it must continue to the most advanced level. For that reason, I have offered a comprehensive program to upgrade instruction in science, mathematics and technology. This program includes:

Establishing a new Fund for Excellence, which would make $4.5 billion in added resources available each year to local school districts to use to address their most pressing primary and secondary education needs. These funds could be used for such purposes as upgrading instructional materials, developing new computer literacy courses, raising teacher salaries to attract first rate personnel, and training teachers to use new technology in the classroom. I have proposed investing an additional $1 billion each year to enhance the quality and attractiveness of elementary and secondary education as a career, especially in critical areas such as mathematics and the sciences.

At the college level, we need to ensure access for all capable students, and we must provide special opportunities for talented students in science and math. We should increase Pell grants for low and moderate-income students, expand the Guaranteed Loan Program, enlarge summer research opportunities through internships and funding for summer research projects and enhance campus-based aid programs. We must also help colleges and universities obtain the best possible equipment on which to train students.

At the graduate level, we should create new national Advanced Study Awards for outstanding students in science, mathematics and other areas, provide funds for institutions hosting Advanced Study Award winners to support their research, and institute competitively awarded block training grants, modelled after the current US Public Health Service grants, to pay for student stipends and the costs of equipment and laboratory materials.

Few but telling changes in science budget

The government's new year began 1 October with funds for science research relatively unmarred by the budget bashing that Congress sometimes inflicts. Before departing Washington for his party's convention in August, President Reagan signed all three science spending bills for fiscal 1985. He also signed the Education and Economic Security Act that had been in a state of high entropy for more than a year after the House passed a similar version, but without the perverse "equal access" provision that the Senate added to allow student religious groups to meet in public schools before and after classes. Of all the appropriations bills involving science, only the Defense Department's remained bogged down, largely in election-year political and philosophical differences.

Few significant changes were made in the administration's budget presented last February to advance basic science and military research, amounting to an overall 14% increase, to a grand total of $53.1 billion (PHYSICS TODAY, April, page 55). Congress approved one of the President's own pet projects, NASA's proposed space station. While it acknowledged support for the project by the aerospace industry and the prospect of an "on-orbit facility for undertaking biological, commercial, science, applications and payload operations on a routine basis," Congress also admitted in its final compromise bill that the space station

had its critics—for instance, the Space Science Board of the National Research Council, which advised NASA last year it could see no scientific reason for a manned space station during the next 20 years, but since then, after a conference at Woods Hole on Cape Cod this summer, concluded that some science could be done on board. Despite vocal opposition in some scientific circles to another of the President's favorite projects, DOD's Strategic Defense Initiative, it seemed clear that Congress would go along with it. The President, who had first revealed SDI during a televised speech in March 1983, often called its development "a moral obligation." "Some call this Star Wars," he told the American Legion convention in Salt Lake City in September. "I call it prudent policy and common sense."

Pass the fat. Congress, for its part, provided some preferences of its own, as it usually does to demonstrate to the agencies and public that it is responsible for the care and feeding of science, education and many other constituencies. Among its more public-spirited actions, it increased support for science and mathematics education, university space science programs, advanced scientific computing and postgraduate research fellowships. It also ignored outraged cries of "pork-barrel" tactics from leaders of the academic and scientific communities in adding funds for new science buildings at four campuses: Catholic University in Washington, D.C., will get another $9 million on top of the $5 million last year to continue building its Vitreous State Laboratory; Columbia will receive $3 million more for its National Center for Chemical Research, which got $5 million in fiscal 1984; $7 million will go to a new supercomputer center at Florida State University, located in the Congressional district of Representative Don Fuqua, chairman of the House Science and Technology Committee, even though a supercomputer center already exists at the University of Georgia, some 250 miles away; and $2.3 million will be handed to the University of Oregon for a science and technology building. While none of these items was in the administration's budget request and none was submitted to peer review of any sort, funds for them will come from one source: Basic Energy

VLBA: A Congressman's victory over NSF project

In 1982, the National Research Council's Astronomy Survey Committee recommended as its top priority for ground-based astronomy the construction of an array of ten 25-meter radiotelescopes widely spread from Hawaii across the US to Puerto Rico. Known as the Very Long Baseline Array, it would operate as a single instrument, with each antenna directly controlled from a main operation center in Socorro, New Mexico. The committee, under the chairmanship of George B. Field of the Harvard-Smithsonian Center for Astrophysics, figured that VLBA would cost about $50 million. For that price, said the Field Report, VLBA would surpass all existing or planned radiotelescopes in resolution, sensitivity, speed, image quality, polarization capacity and frequency coverage, providing images at ultrahigh angular resolution of such distant objects as quasars and galactic nuclei, as well as the Milky Way. In addition to providing an extremely accurate fix on the position of the objects, it would make possible the observation of the fine detail of their internal structure and dynamics. Not content with its astronomical capabilities, the committee went on to observe that VLBA would be applied to other important problems—notably, assisting the navigation of interplanetary spacecraft, making possible tests of Einstein's general theory of relativity and, over a period of years, providing repeated measurements of movements of the Earth's tectonic plates as small as 1 cm per year.

The Field Report was eagerly accepted by the National Science Foundation, which had commissioned the survey along with NASA. NSF, in fact, was so enthusiastic, it put VLBA in its budget for fiscal 1985, seeking $15 million for the National Radio Astronomy Observatory to begin building the array that year. By this year, however, the estimated cost of the entire project had risen, because of inflationary effects, to around $61 million.

Rising costs. Members of Congress also were concerned about rising costs. If all the recommendations in the Field Report were carried out, some claimed on Capitol Hill, the cost would run to much more than the $1.9 billion the committee had reckoned when it totted up the sum in 1980 dollars. In June 1983, the House Committee on Appropriations directed its staff to review the implications of the Field Report for both NSF and NASA. The result was a critical 46-page report in which the House staff argued against supporting several proposed astronomy projects during the rest of the decade, especially because new facilities, such as the National Optical Astronomy Observatories and the Space Telescope, would certainly require more funding. Some US astronomy facilities, claimed the staff report, suffer from computer analysis problems or duplicate existing and planned centers, including those at Mauna Kea, Hawaii, and Cerro Tololo, Chile, where US and foreign countries support instruments side by side.

Armed with the report, Representative Edward P. Boland of Massachusetts, chairman of the House Appropriations subcommittee that oversees NSF, attacked the VLBA. As Boland saw it, astronomy was going to get a substantial sum for the space telescope and its institute at Johns Hopkins University through NASA and NSF was in the midst of reorganizing and coordinating three independent national astronomy centers that the Field committee had urged. What's more, the Field Report had assumed that NSF would construct a 25-meter millimeter-wave radiotelescope as part of an "essential" program to support basic astronomy research that was estimated to require a $95 million increase in expenditures over a decade. It turns out that NSF dropped the plan about the time the Field Report came out because the 25-meter telescope was overtaken by more technologically advanced radiotelescopes. Anyway, claimed Boland, it is more important that NSF put more money into science education than into VLBA.

Successful case. Boland and his Appropriations committee aide, Richard N. Malow, succeeded in making this case in the House report on NSF. "For too long the funding of science education programs has received a disproportionately small share of the Foundation's budget," it said. "The 1985 request for science education represents only 5% of the total requested for the Foundation—and that level is down from approximately 5.7% in fiscal year 1984. In fact, it is important to point out that the total amount requested and appropriated for science education for the past ten years is less than $625 million. During roughly the same period, NASA and NSF astronomy projects either completed or currently underway have totaled $2.9 billion. In addition, astronomy projects planned for the NSF and NASA as new starts for the balance of the 1980s are estimated to cost approximately $2.25 billion. These projects include an advanced x-ray astrophysics facility, a shuttle infrared telescope facility, a solar dynamic observatory, the very long baseline array, the new national technology optical telescope, a large deployable reflector and a solar optical telescope.

"The committee, therefore, does not believe that the astrophysical or astronomy sciences have been underfunded. It does believe, however, that science education, which is vital to ensuring the future science capability of this nation, must receive an appropriate share of the Foundation's budget. In that context, the committee directs the Foundation to seek a 1986 fiscal year appropriation request that will reflect a commitment to a sustained level of funding of at least 8.5% of the total Foundation budget."

Boland convinced his colleagues in Congress that $6 million of the $15 million requested for VLBA in fiscal 1985 could be safely cut so that the funds could be applied to science and math education at NSF. What's more, even the remaining $9 million for VLBA could not be spent until next 1 April. Boland was not so successful, however, in persuading Senate members to go along with the House provision that NSF will allocate at least 8.5 % of its budget in fiscal 1986 to science education. The Senate-House Conference Committee expressed its concern "about the precedent such 'linkages' would have on the respective constitutional responsibilities of the legislative and executive branches of government. Indeed, it was only with the fast footwork of two senators, Pete V. Domenici of New Mexico, where VLBA would be headquartered, and Jake Garn of Utah that the administration's project was saved from zero budgeting this year and the April spending compromise worked out. —IG

Sciences in the Department of Energy.

What Congress giveth, it sometimes also taketh away. Accordingly it made some major cuts in science projects—most severely and in Byzantine ways, the planned Continuous Electron Beam Accelerator Facility, now known as CEBAF, to be built with DOE funds by the Southeastern University Research Association at Newport News, Virginia, and the Very Long Baseline Array radiotelescope that the National Science Foundation put forward (see box).

Among the important budget changes in the three principal science agencies:

NSF budget. The Foundation is funded at the requested level of $1.5 billion. Of this, $1.3 billion is for research and related activities, though some $900 million goes strictly to science studies. Congress rearranged some priorities—doubling the $20 million originally asked for supercomputing at universities, thus opening the way for more academic research, new machines and national computer centers, rather than simply facilitating the use of existing machines or enlarging computer networks, as NSF had once planned. The House–Senate conference on the final version of the NSF bill made a point of insisting that the agency should not establish any computer center without competitive, impartial peer reviews of the proposals—apparently in reaction to less high-minded handling of the supercomputer center at Florida State by DOE.

Science and engineering education receives $87 million, including $6.3 million more for graduate fellowships, bringing the total for such fellowships to $27.3 million. The HUD/Independent Agencies Appropriations Act, signed by President Reagan on 18 July, requires that the increased appropriations be used to restore the number of new fellows to the 1984 level of 600, while at the same time increasing the annual stipend to $11 000 and tuition allowances to $6000. At the urging of Congress, Edward A. Knapp sent written assurance before leaving the top job at NSF that no fewer than 13 000 research grants would be awarded in fiscal 1985. Other add-ons are $5 million for university research instrumentation and $1 million for the Experimental Program to Stimulate Competitive Research, which is designed to increase the capability of scientists and engineers in states and institutions that have not achieved much success in competing for NSF grants.

To make up for the add-ons, the act requires that NSF make "unspecified general reductions" of about $43.5 million. None of the reductions can come from behavioral and social sciences, which Congress considers "untouchable" after the severe cuts inflicted by the Carter and Reagan administrations. Consequently, a 3% reduction is being made in the budget increases of all other NSF directorates. Another target was VLBA, which received a $6 million cut from NSF's request for $15 million.

NASA budget. R&D funding for NASA is $2.4 billion—a sizable part of the total authorization of $7.5 billion, which is $35 million more than the administration's proposed budget. The space station is authorized at the requested level of $150 million, though $57 million of this is deferred until 1 April, while the agency performs "complementary" studies required by the House and Senate for various options to a permanently inhabited facility. The House expressed concern that budget cutbacks may not permit the full development of the station, so that alternatives to permanent manning need to be explored. The Senate asked NASA to study how to reduce the use of robots on the space station.

Largely through intense lobbying by the space science community, NASA gets $10 million more than the administration had intended for research and analysis—some $7 million going to planetary R&A. This is a modest response to the frequent criticism that NASA has promoted new projects at the expense of budgets needed to analyze data piling up from existing projects. Under this change, planetary R&A receives $61.5 million—a 3.4% increase over fiscal 1984—and physics and astronomy R&A about $39.9 million, for an increase of 10.5% over the previous year. In addition, $7 million is earmarked for university research instrumentation—a line item that was missing entirely from the agency's budget request. To accommodate such add-ons, the appropriations act requires NASA to make similar "unspecified general reductions," as was the case with NSF. At NASA, those reductions amount to 37.5 million from its total budget.

The NASA Authorization Act also calls on the President to establish a 15-member National Commission on Space, which would issue a report a year from now on the nation's long-range needs for the peaceful use of outer space, including exploration and use. The commission will be instructed to consider the current space program as well as future scientific, economic, social, environmental and foreign policy requirements and the best ways to achieve those. In addition, it will seek to determine the likelihood that the government and commercial interests can meet the civilian space needs of the nation.

DOE budget. As usual, Congress added funds for R&D dealing with solar and renewable energy, as well as environmental research relating to energy, such as acid rain effects and nuclear waste disposal. Thus, solar energy went up from the administration's request for $163.6 million to $179.4 million for fiscal 1985. In one field, magnetic fusion, Congress made some unkind cuts, reducing the program from $483.1 million to $440 million. "I was both suprised and disappointed by the action in Congress," says Alvin W. Trivelpiece, DOE's Director of Energy Research. "There are several versions about why this happened. It's my opinion that some members of Congress came to the conclusion that the fusion program has not adjusted to the realities of the current abundance of energy supplies and the current level of budget deficits. I was told 'Congress wants to get DOE's attention.' Well, Congress certainly got it."

One setback to the DOE program is the refusal by Congress to appropriate $2 million in construction funds for the electron accelarator for SURA (PHYSICS TODAY, September, page 55). Congress provided $3.5 million for R&D and for preliminary engineering work during the year, but insisted that DOE would have to submit a five-year plan for nuclear physics that examines the possibility of dropping the project. —IG

House group begins science policy study

For Congressmen between political conventions and anxious about their own reelection, it was a promising beginning. Of the 18 self-appointed members of a task force to study the making of US science policy, all but one gathered in a Rayburn Building hearing room on 2 August and agreed to initiate the project soon after the new 99th Congress assembles in January. Explaining the study to his colleagues, Representative Don Fuqua (D–Fla.), chairman of the House Committee on Science and Technology and organizer of the bipartisan task force, observed that Federal support of basic and applied scientific research now totals $18 billion per year and that it is time to examine the principles and procedures of Congress in its program oversight and budget authorization functions.

Fuqua expresses concern that science and policy may not serve the same ends. Don K. Price of Harvard once characterized the difference in his book, *The Scientific Estate*, observing that pure science concerns knowledge and truth while politics deals with