that universities, industry and the national labs jointly initiate generic R&D projects and encourages them to exchange their scientists and engineers. The report also encourages universities to bring their curriculums up to date for both undergraduates and graduates and to provide state-of-the-art instruments in their labs. Finally, it unabashedly argues for Federal agencies to ramp up their materials R&D budgets by $1.25 billion more than their current expenditures over the next five years. The report admits that while funding will be high, "we believe this increased level of support will be required if the US is to remain competitive with the rest of the world."

Huber informed the physicists in Cincinnati that OSTP is "paying a good deal of attention" to the report and would be sure to include data and views from industry as well as the academic community in preparing its initiative. While the details still need to be worked out, the proposed initiative is likely to be similar in style to those the Bush Administration put forward in the 1992 budget request last February for high-performance computing and communications, for global climate change research and for science and engineering education (PHYSICS TODAY, April, page 79). Like those, the materials initiative would be spread across all the relevant agencies and coordinated by an interagency body called the Federal Coordinating Council on Science, Engineering and Technology (known familiarly as FCCSET—pronounced "fix it").

OSTP and the White House Office of Management and Budget have already asked a FCCSET panel to prepare an inventory of all Federal activities in materials, including the current spending levels for each agency, to identify overlaps and opportunities for collaboration. A report will be circulated to all the agencies for comment this summer. Bromley expects OMB to shape up a dollar request by the end of the year for Bush's approval as a full-fledged Presidential initiative.

—IRWIN GOODWIN

NSF'S NEW $50 MILLION EQUIPMENT PROGRAM TO AUGMENT RETOOLING ACADEMIC SCIENCE

The "instrumentation gap" persists in academic physics and astronomy. Failure to replace aging scientific instruments with new, state-of-the-art apparatus in physics and astronomy departments and to modernize deteriorating and often dilapidated physics laboratories threatens to drag faculty research and graduate education in American universities down from their preeminent heights. Physics and astronomy department chairmen informed the National Science Foundation in 1986 that as much as 35% of their research equipment could be considered obsolete. Now an NSF report of a follow-up survey of the departments in 55 universities and colleges statistically selected to represent 174 of the largest institutions, each spending more than $3 million annually on science and engineering R&D, reveals that 46% of the instruments used in 1989 were considered inadequate, an increase of 12% since the last survey, three years earlier.

Even in the 20 largest universities, which house a high proportion of the nation's total instrumentation inventory, 20% of the department heads complained that their current equipment is generally so poor that faculty investigators cannot do important research in their specialties. Only 9% of the department chairmen rate their equipment as excellent—a drop of 2% since the last survey. Outside the top 20 institutions, 52% of the department heads in physics and astronomy described their current instrumentation as inadequate.

Worse yet, the NSF report, "Academic Research Equipment and Equipment Needs: 1989," released on 21 May, shows that for physics and astronomy departments that are not within the big 20 research universities, the sources of funding for new equipment have begun to dry up. Indeed, these academic administrators characterize the quantity and quality of their research instruments as in decline. This situation, says the report, is in contrast with that in chemistry departments, which boast of widespread improvements in equipment at both large and small research universities.

The report notes that there has been a "pronounced upward shift" to big-ticket instrument systems in physics and astronomy to enable researchers to perform experiments they can't do now. It argues that physics and astronomy are worse off than other scientific disciplines because the research relies on more specialized and more sophisticated instruments.

A 'continuing investment'

Testifying before committees of Congress on NSF's budget, Walter E. Massey, the agency's new director, emphasized the need to modernize the academic infrastructure as "a continuing investment" in education and research. Massey observed that universities have deferred maintaining and purchasing capital equipment for classrooms and labs for nearly two decades because operating costs have risen rapidly while Federal support of research infrastructure has fallen.

His laments have been endorsed by the Association of American Universities and the National Association of State Universities and Land-Grant Colleges, which are admittedly not entirely objective in appraising the subject. Their report, "University Research Facilities: A National Problem Requiring a National Response," urges the Federal government to support competitive matching grants for institutions that need to upgrade their research equipment and laboratories. Similar pleas had come before in the White House Science Council's 1986 report "A New Partnership," which claimed it would take $1 billion per year for a decade to deal with "the inadequacy and decay of the physical plant and the obsolescence of the equipment pool" at US universities.

One of the authors of the White House report was D. Allan Bromley, then director of the A. W. Wright Nuclear Structure Laboratory at Yale University. Bromley and the chairman of the panel that produced the report, David Packard, cofounder of Hewlett–Packard and a former deputy secretary of the Defense Department, warned that the accumulated shortfall in the capital base for university research could wreck the engine of American science, thereby weakening the nation's economy and security.

"One conclusion is clear," said the Packard–Bromley report. "Our universities simply cannot respond to society's expectations for them or discharge their national responsibilities in research and education without substantially increased support."

In 1989, when Bromley became President Bush's science adviser and director of the White House Office of Science and Technology Policy, he vowed to improve the situation. His first opportunity came last year, in

formulating NSF's budget request for fiscal 1992. The result was a $50 million Presidential initiative to award peer-approved grants ranging from $100 000 to $2 million for instrumentation for science and engineering research at all academic levels.

A 'rapid injection'

The proposed instrumentation program, Frederick M. Bernthal, NSF's deputy director, told a House Appropriations subcommittee examining the agency's 1992 budget request, is almost certain to provide "the most rapid injection we could give to improving the academic research community." The rules of the initiative require that Federal awards, to be made competitively through the traditional peer-review process, be matched dollar for dollar by non-Federal sources, such as states, universities and private donors.

Though details of the program are still be to worked out, NSF officials assert that the awards are intended to fund the purchase, development, maintenance and operation of single instruments, multiple devices or entire systems. Under the program, researchers will be able to acquire off-the-shelf equipment as well as to develop apparatus of their own design. It excludes costly, one-of-a-kind instruments such as telescopes, supercomputers and particle accelerators. NSF holds that these are capital facilities and, as such, are to be funded in other ways.

To take on the new initiative, NSF has had to give up another program that is popular among university admiministrators, though not necessarily by researchers—namely the Academic Research Facilities Modernization program. The facilities program was the invention of Congress. When it was first broached, the White House and its Office of Management and Budget objected to it on the grounds that it was something universities ought to do for themselves, without Federal largesse. Congress authorized the program in 1988, funding it with $20 million in each of fiscal 1990 and 1991.

Most lawmakers prefer to fund new buildings, facilities and laboratories in their home states, and if need be, they use "pork barrel" methods. Demands for such appropriations, which usually originate on university campuses from top administrators, lead to Congressional "earmarking" of research budgets in particular agencies. OSTP has calculated that appropriations legislation in fiscal 1991 contained 492 earmarks, totaling $810 million, taken mainly from the departments of Agriculture, Defense, Energy and Interior and the Environmental Protection Agency.

NSF's two-year facilities modernization program is pint sized by contrast. Last January the foundation announced it was awarding a total of $39 million to 78 institutions, ranging from prominent research universities with large endowments to historically black colleges. NSF's awards will be augmented with more than $61 million put up by the institutions (including nine nonprofit research organizations and three museums) and by local and state governments in 37 different states. The largest NSF contribution is $1.9 million to improve the biological sciences building at Duke University. The smallest, $74 484, goes for modernizing a biology research lab at Winona State University in Minnesota. Only a handful of physics research facilities will be modernized under the NSF program: Among the principal recipients are Yale, with $950 000 to upgrade the space occupied by atomic, molecular and optical physics; the University of Mississippi, $889 260 for upgrading physics research facilities; Miami University in Ohio, $725 000 for repairs to a physics building; Harvey Mudd College in California, $1.05 million to renovate the Jacobs Science Center; and the University of Arkansas at Fayetteville, $500 000 for physics facilities.

Instrumentation has lacked such patronage. NSF's research directorates give grants for equipment usually costing less than $200 000. These are funded either as a component of a research proposal or directly through an equipment grant—in either case, after peer review. The research units also provide awards jointly with the directorate of Education and Human Resources to improve undergraduate laboratory instrumentation, through a program that has been operating since 1985. In fiscal 1990, undergraduate laboratory grants totaled $22 million. Physics and astronomy received 75 of the 600 awards.

During the 1980s, according to NSF data, the life sciences received the largest share of Federal funding for research equipment in higher education. The physical sciences were second. Actually, funds for academic equipment in the fields of computer science and mathematical sciences grew fastest in the 1980s, each increasing in constant 1982 dollars by a factor of about four. In terms of constant 1982 dollars, both Federal and non-Federal support of instrumentation in the physical sciences more than doubled in the decade.

The Packard–Bromley study found that support of academic instrumentation by NSF's research directorates had fallen from 11.2% in 1966 to 9% in 1982. More recently, NSF's College Science Instrumentation Program, introduced in the mid-1980s, contributed to improving undergraduate studies, with both the number and size of the grants doubling from 1988 to 1989 (see PHYSICS TODAY, April 1990, page 69), though graduate research did not benefit from the infusion of funds.

NSF's 1992 budget request for the new instrumentation program appears to be experiencing rough passage in Congress. The House Appropriations subcommittee responsible for the agency wrote a bill that would reduce the $50 million request to $33 million and, at the same time, would lop $23 million from the $23.5 million proposed for the already thrice-deferred Laser Interferometer Gravitational Wave Observatory. By proposing these changes to the House, the lawmakers were able to insert $40 million for an NSF facilities modernization program where none had been requested by the Administration.

A 'serious issue'

The White House has opposed a facilities program all along and probably expected Congress to appropriate money for it anyway, as lawmakers had done in the previous two years. Massey defended that decision on 11 April before the Senate Appropriations subcommittee that oversees NSF's budget. The absence of an NSF facilities program, he said, "should not be interpreted as meaning there's no national problem. Given the magnitude of the problem and given the scarcity of resources, the foundation believes it should concentrate its efforts on activities that will be of the most immediate and substantial benefit to the research community."

Senator Barbara Mikulski, a feisty Maryland Democrat who heads a Senate Appropriations subcommittee, agreed that upgrading research equipment was indeed "a serious issue" and stated that she would "rely on NSF to guide us." Nevertheless, she argued, one reason universities have been hiking their indirect overhead costs is to pay for modernizing their equipment and facilities. To help resolve this dilemma, Mikulski said she has asked OSTP to "develop a policy on academic facilities modernization that includes all Federal research and development agencies and a five-year funding projection of the Federal contribution to this effort."

—IRWIN GOODWIN
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