NIH BUDGET

A New Kind of Earmarking

As if the numbers in President Clinton's 1994 budget request for the National Institutes of Health (NIH) weren't bad enough, there's something new for biomedical researchers to complain about: Executive branch earmarking. NIH budget officer Leamon Lee told a science policy colloquium sponsored by the American Association for the Advancement of Science last week that the president has taken a page from Congress's book and for the first time is channeling some $650 million in new funding to research on specific diseases and target groups, such as women and minorities. The reason for the complaints: NIH will have less flexibility in choosing the research it funds.

This wouldn't be so bad if the rest of the agency's budget were not so Spartan. But because Clinton's request would give NIH as a whole just a $342 million (3.3%) increase, directing $650 million to specific programs means that other programs will get cut. Indeed, nine of NIH's 16 institutes are slated for reductions in the 1994 request (*Science*, 2 April, p. 24).

Although the Administration has indicated its preferences for spending in categories such as AIDS and cancer in the past, the targeting "has never been as specific as this year," says NIH budget officer Francine Little. The earmarks include $214 million in increases for tuberculosis, minority and women's health, high-performance computing (including expanding Library of Medicine databases), health care reform, vaccines and immunization, and advanced materials. Breast cancer research is slated for a $216 million rise, and NIH officials say the White House has directed them to reach a level of $1.3 billion for AIDS research, or an increase of $226 million.

NIH BUDGET, BY FUNDING MECHANISM

Selected categories (millions of dollars)	1993 Estimated	1994 Request	Percent Change
Research grants	5665	5685	0.4
Research centers	912	950	4.2
R&D contracts	699	778	11.3
Intramural research	1167	1218	4.4
Library of Medicine	105	133	27.1
Office of director	190	235	23.7
Women's health study	41	61	48.8
Minority health study	41	56	36.6
Research training	349	355	1.7
Other research*	639	712	11.4

* includes career, education, cooperative clinical research, and other grants.

Clear directions. The increases are being channeled mainly to AIDS contracts and special programs rather than research grants, reflecting the Administration's efforts to set priorities.

It's not easy to say how this targeting will play in Congress. Looked at in one way, says David Moore, the Association of American Medical Colleges' assistant vice president for governmental relations, "the Administration is responding to what Congress has been saying for a long time: 'You can't have everything, so identify some priorities.'" The problem, says Moore, is that groups backing such programs as cardiovascular, neurology, mental health, and aging research, which are "losers in this budget," will no doubt be lobbying Congress to get increases for their own programs. Such pressure raises the specter of duelling earmarks, as disease groups battle through Congress for NIH's limited funds.

Whether by Congress or the White House, says Moore, earmarking "really reduces the flexibility of the institutes, especially if they don't have an excess of funds." And even when institutes don't get their full requests, they nevertheless have to satisfy earmark language, notes Richard Fuller of the American Federation for Clinical Research, which can result in "cannibalizing" other, less politically popular research that isn't earmarked.

–Christopher Anderson

ASTRONOMY

Mirror, Mirror, Which Is the Fairest?

On the surface, Gemini project leaders appeared to have every reason to celebrate last week. At a Washington, D.C., reception, they toasted a new set of foreign contributions, from Argentina, Brazil, and Chile, that may finally make possible the $176 million twin telescopes, to be built over the next 7 years at Cerro Tololo, Chile, and Mauna Kea, Hawaii. But a dark cloud loomed over the festivities—a cloud of doubts about the design for the huge 8-meter mirrors. In recent weeks, that cloud has looked so ominous that American Astronomical Society (AAS) executive officer Peter Boyce, worried about how the doubts might affect the project's chances in Congress, took the unusual step of warning his colleagues not to air their dirty laundry in public.

Boyce's admonishment, in the *AAS Monthly Notices*, followed a report issued last month by a panel of high-ranking astronomers headed by Cornell University's James Houck. Departing from its mandate to examine the project's budget and its scientific goals, the panel took a hard swipe at the mirror design. It reported that the relatively untried thin "meniscus" mirrors chosen for the project are likely to flex in the faint air currents within the telescope dome, spoiling the razor-sharp resolution that will make these telescopes worth all those millions. To avoid "significant additional risk of failure," the panelists urged the telescope designers to adopt an alternative design—a thicker mirror made from a honeycomb of glass.

But Gemini project manager Lawrence Randall says it's too late to change course. The National Science Foundation (NSF) and foreign funding agencies have committed funding based on the earlier choice, and Corning Glass has already cast the unpolished mirror blanks. And project leaders are convinced they can make the meniscus design live up to its billing.

The controversial mirror design emerged from planners' efforts to ensure that Gemini's resolution would surpass that of any other telescope. In particular, they wanted to improve upon the design used for the only mirror of comparable size, that of the 10-meter Keck telescope on Mauna Kea, which is made up of many individual segments. To many astronomers, the obvious alternative was an innovative mirror design developed at the University of Arizona by Roger Angel, in which the mirror is backed by a strong, lightweight honeycomb of borosilicate glass. Says astronomer Donald Hall, who runs the University of Hawaii's Institute of Astronomy: "NSF and NOAO [the National Optical Astronomy Observatory] had funded the borosilicate development presumably in anticipation of using that technology."

It came as a surprise to many astronomers when Corning Glass won the bid for mirror construction last September with a dark-horse design. The company proposed a thin meniscus of glass, just 20 centimeters thick. Project scientists, with the advice of outside astronomers, chose the meniscus because it was cheaper, says Gemini director Sidney Wolff of NOAO. What's more, says Randall, Angel's university-run mirror lab couldn't agree to take on financial indemnity if something went wrong, while Corning could.

A rejection of that reasoning has now come from an unexpected quarter. The panel

was convened last fall at the request of NSF because project scientists hadn't yet secured a promised 50% of the funding from foreign contributors, says a House Appropriations Committee staffer. "[Congress] had extended the deadline three or four times, giving them maximum opportunity to get the contributions," he says. The panel was supposed to review the ability of the project to meet scientific goals within the budget constraints and to examine the possibility of building just one telescope for half the money.

But its conclusions focused instead on the mirror, which Houck says was seen as the project's potentially fatal flaw. "The decision [to adopt the meniscus design] traded a perceived short-term financial risk in the blank fabrication for a long-term technical risk to the telescope's performance," says the report. A safer bet, it adds, would have been the competing honeycomb design. "We conclude that it is essential that the project return to the honeycomb mirror concept," the panel says.

Panel leader Houck, along with a number of other astronomers, admits that either design carries a high risk. These mirrors must hold their shape to within 15 nanometers, he says, to achieve the promised resolution—three to four times better than the Keck's. Angel's honeycomb has its own drawbacks: Glass comprising different segments never gets mixed up as the mirror is cast, so the mirror-makers have a tough job making sure all the segments have the same heat expansion coefficient. A slight deviation would be catastrophic.

But the crucial difference, says Houck, is that a problem with Angel's design would show up early on, because early tests would detect a flaw. "It's something you would know in the shop," he says. A meniscus problem, on the other hand, probably wouldn't be apparent until the telescope was assembled on the mountain.

Randall himself agrees that the Angel design has a technical edge. He disagrees with the panel's criticism, though, because he says the project has a top-rate engineering staff that is developing a set of adjustable steel supports to make the mirrors wind-worthy.

Meanwhile, Boyce of AAS says he's worried that all the public bickering will conjure up the specter of the Hubble telescope disaster. "I have heard comparisons made to the Hubble Space Telescope problem where scientists did not ask enough questions during the process," he says in an editorial in the AAS newsletter. "The Gemini situation is different," he says, because in this case astronomers made the key choice themselves. Now that the last 10% of the needed foreign contributions have been sewn up, he and his colleagues don't want anything darkening the project's chances when Congress gets round to voting on new funding this May.

–**Faye Flam**

EDUCATION

At State Schools, Calculus Reform Goes Mainstream

It started about 10 years ago with the tool shed tinkerings of a few mathematical mechanics, moved on to a cottage industry with dozens of programs at schools around the country, and now it is beginning to enter the most challenging stage: mass production. No, it's not the latest development in computer technology, but something potentially just as important to the nation's high-tech future: a transformation in the way calculus is taught. The innovative teaching methods that characterize the calculus reform movement are taking over at some of the nation's big state universities, where the factory-style format in which calculus is commonly taught had looked a poor prospect for reform.

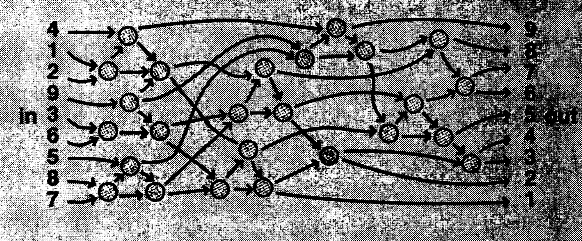
That's a major shift for the reform movement. Until recently, it had been concentrated at small colleges and elite institutions, where classes are generally smaller and resources such as classroom computers easier to come by. But calculus reform, supported by the National Science Foundation (NSF) to the tune of more than $14 million since 1988, has been gathering steam (*Science*, 28 February 1992, p. 1060), which has now helped carry the movement beyond the likes of Duke University and Harvard College to the University of Michigan, the University of Iowa, and the University of California, San Diego (UCSD). "It's almost impossible to keep up with the flurry of activity," says the University of Nebraska's James Leitzel, who heads an NSF-funded project at the Mathematical Association of America to assess the extent and impact of calculus reform efforts.

The move into the big state schools is also feeding on a new interest among academic mathematicians in teaching. Thanks in part to mounting evidence of U.S. students' poor

Turning Higher Mathematics Into Kids' Stuff

Mike Fellows could be found recently spray painting the grass at a local elementary school. Vandalism? No. Fellows, a theoretical computer scientist at the University of Victoria in Canada, was simply preparing a math lesson for a class of first-graders. Later in the day, kids could be seen stepping along Fellows' design, playing "sorting networks"—a game that was also a lesson in the workings of computing algorithms.

Fellows is in the vanguard of research mathematicians and computer scientists who are taking [illegible] the same [illegible] terest in how best to [illegible] math to young kids. [illegible] running summer [illegible] for high school [illegible] ers. Others, such as [illegible] are dealing [illegible] dren in the elementary schools. For many, the activities are a natural extension of the new concern with teaching that is pervading the mathematics community (see main text).



Of course, it doesn't take a Ph.D. to do a good job teaching long division or probability. But researchers have something crucial to offer school math classes, argues [illegible] Roitman of the University of Kansas. "We know the mathematics from the inside," [illegible] says. "It's the difference between a music critic and a musician." And recent philosophical shifts in the mathematics education community have provided an opening for researchers eager to lend their skills to school math teaching, Roitman adds.

In particular, a new set of standards developed by the National Council of Teachers of Mathematics stresses problem solving and open-ended exploration of mathematical patterns and relationships—activities that are much closer to researchers' [illegible] than the rote arithmetic traditionally taught in elementary and high schools. "When school mathematics is no longer algorithmic, that gives us an entry," Roitman says.

Fellows has used that entry to introduce children to some of the concepts of computer science. His sorting networks game, for example, demonstrates how a machine can take an unordered set of numbers and, by making a relatively small number of pairwise comparisons, put them in order. Children carrying numbered cards enter as "inputs" [illegible]