Has Math Funding Hit the Deficit Wall?: The NSF Fiscal Year 2005 Budget Request

This article is the 32nd in a series of annual reports outlining the president's request to Congress for the budget of the National Science Foundation. Last year's report appeared in the June/July 2003 issue of the *Notices*, pages 687–9.

The process of building a budget for the federal government for fiscal year 2005 began in February this year, when the Bush administration sent its budget request to Congress. The request includes the administration's outline for what it believes the government should spend on basic research. Hemmed in by a ballooning deficit and mounting war costs, the fiscal 2005 budget is shaping up to be quite stringent as far as funding for basic research is concerned. In particular, the budget for the National Science Foundation (NSF) would rise just 3 percent under the terms of the request.

This bleak outlook for research funding was one of the main issues discussed at the AMS Committee on Science Policy Forum, held April 1–3, 2004, in Washington, DC. The annual CSP Forum is a venue for presentations by governmental representatives about the status of research funding. In recent years, mathematics department chairs from around the country have been invited to take part in the forum, and this year seventeen attended. Also present were several members of the AMS Council, in town for their meeting being held the same weekend. Altogether, about fifty people came to the forum. The variety of viewpoints and the lively discussions made for a meeting that was, in the words of AMS vice president Vaughan Jones of the University of California at Berkeley, "fascinating."

Pressures on the Budget

The administration's request is the first step in the process of appropriating a budget for the federal government. Congress will spend the summer debating and reworking the budget, with the aim of enacting appropriations bills by the start of fiscal year 2005 on October 1, 2004. Often there are delays in passing the bills. Indeed, the fiscal 2004 appropriations were passed almost four months late, and at the time of the CSP Forum the NSF's Division of Mathematical Sciences (DMS) did not yet have official budget numbers for 2004. Predictions of delays for fiscal 2005 were already being made at the CSP Forum. The November presidential election increases the likelihood of delays.

Basic research does not fare well in the 2005 request. One of the speakers at the CSP Forum was Michael Stephens, who is on the staff of the House Appropriations Subcommittee on Veterans Affairs, Housing and Urban Development, and Independent Agencies; this is the subcommittee that has the final say on the budget of the National Science Foundation. Stephens summed up the overall mood: "Reality check: It's very bleak." To understand some of the reasons for the pessimism, one need only look at recent news headlines about mounting bills for the war in Iraq and the fight against terrorism. Perhaps even more worrisome is the escalating federal deficit. Stephens said that in his twenty-eight years working for Congress he has seen only two other periods where deficit problems loomed as large. One was 1981–82, the era of Gramm-Rudman austerity, when the deficit was around $50 billion and many government programs were cut by as much as 20 percent. The other period was 1995–96, when Republicans who had recently taken control of the House of Representatives enacted deep cuts to address a $290 billion deficit. Now the deficit stands at $521 billion. The psychology of thinking about governmental spending, Stephens noted, is dominated by this figure.

"It is a hugely constrained system for funding," he said.

Another factor ratcheting up the pressure on the research budget is the increase in earmarking, also known as "pork barrel" funding. An earmark is an appropriation for a specific project awarded to a specific institution without any competitive process. Many colleges and universities receive such earmarked funding by lobbying members of Congress. According to the *Chronicle of Higher Education*, which tracks pork barrel funding directed to academia, Congress awarded a total of $2 billion in pork barrel grants, a 10 percent increase over the previous year. Since 1996, funding devoted to such earmarks has increased by a factor of six. The rise in earmarking reflects the squeeze on federal funds: As the budget tightens, more institutions are willing to use lobbying and political muscle to get money.

In his presentation before the CSP, James H. Turner Jr. called the increase in earmarking "an absolutely unprecedented change and a new way of doing business." Turner is the Chief Democratic Counsel for the Committee on Science of the House of Representatives and has worked as a congressional staffer for more than twenty-five years.[1] "We have to watch out for the impact on peer review" that may come from the increase in earmarking, he said. He also pointed out that earmarked grants would not exist if colleges and universities did not accept them. While "there has been an explosion of earmarking," Stephens said, the NSF has been largely free of it. Stephens made a distinction between congressional additions to the NSF budget, which are sometimes referred to as earmarks, and true earmarks, which completely circumvent peer review. For example, Congress

[1] *An interview with Turner appears in this issue of the* Notices.

Table 1: National Science Foundation (Millions of Dollars)

	2001 Actual	Change	2002 Actual	Change	2003 Actual	Change	2004 Plan	Change	2005 Request
(1) Mathematical Sciences Research Support	$ 121.4	24.8%	$ 151.5	18.0%	$ 178.8	12.1%	$ 200.4	0.9%	$ 202.2
(2) Other Research Support (Note a)	3370.2	6.2%	3579.8	13.3%	4054.7	3.7%	4205.9	6.1%	4463.3
(3) Education and Human Resources (Note b)	795.4	8.9%	866.1	7.9%	934.9	0.4%	939.0	-17.9%	771.4
(4) Salaries and Expenses (Note c)	172.9	2.1%	176.6	13.8%	201.0	15.7%	232.5	32.5%	308.1
(5) Totals	$4459.9	7.0%	$4774.1	12.5%	$5369.3	3.9%	$5577.8	3.0%	$5745.0
(6) (1) as a % of the sum of (1) and (2)	3.48%		4.06%		4.22%		4.55%		4.33%
(7) (1) as a % of (5)	2.72%		3.17%		3.33%		3.59%		3.52%

Tables prepared by Notices *staff.*
Note a: Support for research and related activities in areas other than the mathematical sciences. Includes scientific research facilities and instrumentation. **Note b:** Support for education in all fields, including the mathematical sciences. **Note c:** Administrative expenses of operating the NSF, including the National Science Board and the Office of the Inspector General.

Table 2: Directorate for Mathematical and Physical Sciences (Millions of Dollars)

	2001 Actual	% of Total	2002 Actual	% of Total	2003 Actual	% of Total	2004 Plan	% of Total	2005 Request	% of Total
(1) Mathematical Sciences	$121.4	14.2%	$151.5	16.5%	$178.8	17.2%	$ 200.4	18.4%	$ 202.2	18.1%
(2) Astronomical Sciences	148.7	17.4%	166.0	18.0%	187.1	18.0%	196.5	18.0%	204.4	18.3%
(3) Physics	187.5	22.0%	195.9	21.3%	224.5	21.6%	$ 227.7	20.9%	235.8	21.1%
(4) Chemistry	154.3	18.1%	162.8	17.7%	181.6	17.4%	185.2	17.0%	188.9	16.9%
(5) Materials Research	209.7	24.5%	219.4	23.8%	241.4	23.2%	250.9	23.0%	253.2	22.7%
(6) Office of Multidisciplinary Activities	32.4	3.8%	24.8	2.7%	27.3	2.6%	30.8	2.8%	31.0	2.8%
(7) Totals	$854.1	100.0%	$920.4	100.0%	$1040.7	100.0%	$1091.5	100.0%	$1115.5	100.0

may direct the NSF to launch a program of grants to two-year colleges, but the grants would still be awarded through a peer-review process.

According to an analysis by the American Association for the Advancement of Science (AAAS), total federal research and development funding would rise 4.3 percent under the terms of the budget request. That increase is concentrated in weapons development, homeland security, and the National Institutes of Health (NIH). Cuts are proposed in basic research at the Department of Defense, the Department of Energy, the U.S. Geological Survey, and other agencies. In this context, the 3.0 percent increase for the NSF looks like a relative bright spot. Still, a question that must have been on the minds of many CSP members was, Whatever happened to the plan to double the NSF budget over five years—a plan authorized by Congress in late 2002? Carrying out this plan would have meant double-digit increases for the NSF until 2007.

AMS president David Eisenbud posed this question to David Trinkle, a staff specialist in the Office of Management and Budget who made a presentation before the CSP. Trinkle's reply may be summed up in the familiar Washington refrain: an authorization is not an appropriation. Authorizations express support for spending plans; appropriations provide the dollars. The bill authorizing the doubling had widespread support. "The president signed it," Trinkle said. "We took it as a potential plan forward. Meanwhile, the economy tanked and wars came up. There is still a lot of good will toward the NSF, but it's hard to see how the doubling can happen." A similar drive to double the budget of the NIH was successful; its budget went from $14 billion in 1998 to a requested level of $29 billion this year. The NIH benefited from budget surpluses following 1998. For the NSF, the timing was less fortunate. As Stephens put it, "The NSF advocacy hit its stride when the money dried up."

Mathematical Sciences Priority Area

The NSF has committed itself to emphasizing five "priority areas", one of them being the mathematical sciences. The other four are Biocomplexity in the Environment, Human and Social Dynamics, Nanoscale Science and Engineering, and Workforce for the 21st Century. Except for Nanoscale Science and Engineering, which would get a substantial increase of 20.3 percent for a total of $305.1 million, funding for the other priority areas would be flat under the terms of the budget request. In particular, the mathematical sciences priority area would get essentially no increase. Stephens said that, in his personal view, it makes little sense to declare all five areas to be priority areas and then give one a large increase and leave the others flat. Nevertheless, he observed, "This is an indication of the difficult choices people are making."

The mathematical sciences priority area is now in its second year. One of its biggest proponents was former NSF director Rita Colwell, who abruptly left the Foundation in February; her term was supposed to have ended in August. In the fiscal 2005 request, its funding would rise by just $20,000, from $89.09 million to $89.11 million; the increase would be for joint projects with the Office of Polar Programs. While this increase may seem small, it should be noted that, when the priority area was established in 2003, the NSF projected it would spend only $86 million on it by 2005. Of the $89.11 million for the priority area, $67.39 million would be in the DMS budget, the same amount as in fiscal 2004. The remaining $21.72 million would be spread around the foundation to support interdisciplinary projects involving the mathematical sciences. The DMS has clearly benefited from the priority area: its budget has grown 65 percent since 2001, when the division first started receiving big increases in anticipation of the establishment of the priority area. Under the fiscal 2005 request, the DMS budget would rise from an estimated $200.41 million in fiscal 2004 to $202.25 million, an increase of 0.9 percent.

Still, there appeared to be no disagreement with the general message that the mathematical sciences are underfunded compared to other areas.

In a presentation before the CSP, acting executive officer Deborah Lockhart described some of the things the division has done with the new money gained with its recent increases. The VIGRE program (Vertical Integration of Research and Education) has been a major emphasis, and last year the DMS added two companion programs, Research Training Grants (RTGs) and Mentoring through Critical Transition Points (MCTP). The RTGs are similar to VIGRE grants in that they are "vertically integrated", involving undergraduates, graduate students, postdocs, and faculty. But the RTGs involve smaller groups and have a more focused research agenda than do the VIGRE projects. In addition, they do not require activities that cut across an entire mathematics department, as VIGRE projects generally do. The RTGs differ from the similarly named Focus Research Groups (FRGs), which need not involve vertically integrated activities. While FRGs do often contain substantial support for graduate students and postdocs, the focus of an FRG proposal must be research focused on a well

identified problem. RTGs, by contrast, are intended to support workforce activities within a strong research group, and the substantial majority of the funds must be in student and postdoc stipends. The MCTP program supports projects to facilitate transitions an individual must make along the path to becoming a mathematician. These transitions might be from a bachelor's degree program to a doctoral program, or even from high school to college. The first round of RTGs and MCTP grants will be announced this summer; awards will run about $500,000 per year for one to five years.

VIGRE, the RTGs, and the MCTP program together come under the rubric of Enhancing the Mathematical Sciences Workforce for the 21st Century (EMSW21). The 2005 budget request calls for a $2.0 million increase for EMSW21, for a total of $27.78 million, through reorientation of $1.50 million from the Faculty Early Career Development (CAREER) program and $500,000 from postdoctoral fellowship activities. Another DMS program slated for an increase under the terms of the request is the mathematical sciences research institutes, of which there are now five. Total funding for the institutes would climb $1.5 million, to $16.6 million, "to address the growing interface with other disciplines," the request states.

DMS director William Rundell was traveling abroad and could not attend the CSP Forum. In an interview, he noted that the contraints on the budget mean that new initiatives are unikely to be launched in fiscal year 2005. "We have to look at the best things we are doing and do them at full power," he remarked. "Less interesting things may be phased out. But we will protect the disciplinary core at all costs. We are not going to reduce the single-investigator program… The pieces that are important to us will not be cut." In particular, he said that although there will be belt-tightening in 2005, he does not foresee a reduction in the number of investigators supported by the DMS.

Upping Grant Size

Lockhart also said that the DMS has in recent years devoted funds to increasing grant size and duration. In doing so, the DMS is abiding by an NSF-wide policy set some years ago by the National Science Board, the NSF's governing body. Indeed, the fiscal 2005 request explicitly states that one of the goals for the mathematical sciences priority area is to "[b]ring support for researchers in the mathematical sciences to a level competitive with other sciences and recognize mathematicians and statisticians as full partners in research, by increasing award size and duration." Within the DMS, the increase in award size has primarily gone toward adding more graduate students and postdocs to the top-rated awards.

The issue of bringing support for researchers in the mathematical sciences to a level comparable with those in other areas was one of the topics of a discussion during the CSP Forum. But the way the issue was framed in the CSP was in terms of numbers of researchers supported, not size and duration of awards. During the discussion, CSP chair Jane Hawkins of the University of North Carolina, Chapel Hill, displayed a graph of NSF data entitled "Percentage of Full-Time Academics Receiving Federal Research Support". According to this graph, for example, 50.4 percent of researchers

Table 3: Compilation of NSF Budget, 1999–2005 (Millions of Dollars)

	1999 Actual	2000 Actual	2001 Actual	2002 Actual	2003 Actual	2004 Plan	2005 Request	1999–2003 Change	1999–2005 Change
(1) Mathematical Sciences Research Support	$ 100.7	$ 106.0	$ 121.4	$ 151.5	$ 178.8	$ 200.4	$ 202.2	77.6%	100.8%
Constant Dollars	*60.4*	*61.6*	*68.5*	*84.2*	*97.2*			*60.9%*	
(2) Other Research Support (Note a)	2777.6	2978.9	3370.2	3579.8	4054.7	4205.9	4463.3	46.0%	60.7%
Constant Dollars	*1667.2*	*1729.9*	*1903.0*	*1989.9*	*2203.6*			*32.2%*	
(3) Education and Human Resources (Note b)	662.5	683.6	795.4	866.1	934.9	939.0	771.4	41.1%	16.4%
Constant Dollars	*397.7*	*397.0*	*449.1*	*481.4*	*508.1*			*27.8%*	
(4) Salaries and Expenses (Note c)	149.5	154.9	172.9	176.6	201.0	232.5	308.1	34.4%	106.1%
Constant Dollars	*89.7*	*89.9*	*97.6*	*98.2*	*109.2*			*21.7%*	
(5) Totals	$3690.3	$3923.4	$4459.9	$4774.1	$5369.3	$5577.8	$5745.0	45.5%	55.7%
Constant Dollars	*2215.1*	*2278.4*	*2518.3*	*2653.8*	*2918.1*			*31.7%*	

Current dollars are converted to constant dollars using the Consumer Price Index (based on prices during 1982–1984).

For Notes a, b, and c, see Table 1.

in the physical sciences and 52.9 percent in computer science receive federal support. Mathematics, with 28.3 percent, had the lowest proportion of the six areas on the graph. Some were skeptical about the numbers, asking "What is the denominator?" in the percentage calculations. Still, there appeared to be no disagreement with the general message that the mathematical sciences are underfunded compared to other areas.

However, there did not seem to be a consensus that grants in the mathematical sciences need to be bigger. AMS Council member John McCarthy of Washington University in St. Louis said that, in the short term, the mathematical sciences are being hurt by the drive to increase award size. He said it seemed that the DMS funded only about a third of proposals. When he participated in a DMS proposal-reviewing panel, there was a large group of people doing good research who were turned down. "Mathematics is different from lab sciences", he said after the CSP meeting. "We don't need large grants to buy equipment. At current funding levels, it would be better if we had more, smaller grants." Jonathan Wahl of the University of North Carolina, Chapel Hill, said that mathematicians just starting their careers might need full summer support and that senior mathematicians, with higher salaries, can frequently make do with less, especially if the outcome is that many more people receive funds for travel and other activities that facilitate research. With NSF grants, he noted, mathematicians either get a large amount of funds, or they get nothing. He suggested that the awarding of DMS grants should reflect less this kind of "all-or-nothing" model.

Samuel M. Rankin III, director of the AMS Washington office, suggested that it would be a losing strategy for mathematicians to volunteer to take smaller grants. Indeed, past efforts to limit the size of DMS grants in order to fund more mathematicians have usually failed. One reason is that arguments to simply spread the money more thinly and more widely have little resonance within the upper echelons of the NSF. In addition, the success rate for proposals made to the DMS is comparatively high, averaging 37 percent over the past ten years. Without more "proposal pressure" in the mathematical sciences, arguments to increase the number of grants given by the DMS are unlikely to be persuasive.

One controversial point in the 2005 request that kept coming up during the CSP Forum but that is not directly related to mathematics research, is the fate of the Math and Science Partnerships (MSP) program at the NSF, which was begun with a budget of $160 million in 2002. This program aims to establish partnerships between school districts and institutions of higher education to strengthen K–12 mathematics and science education. The fiscal 2005 budget request proposes phasing out MSP and shifting the funds to the Department of Education (DoEd) to start a program focused on high school mathematics. One reason for the controversy is that the existing MSP grants were awarded through the NSF's competitive process of peer review. The DoEd, by contrast, traditionally awards funds to states on a formula basis. The intention is that the DoEd program would be competitive, but, as Rankin pointed out, Congress would have to pass a new law for that to happen. The proposed shift of the MSP funds to DoEd has been criticized by many, including influential members of Congress. The National Science Board has also publicly voiced its opposition.

From the start the administration's 2005 budget request for the NSF was seen as inadequate by strong supporters of science in the House and the Senate. By the time of the CSP Forum, many of these supporters had made their views known to the appropriations committees, urging that increases for the NSF be made a high priority in spite of the severe budget constraints. "We have come a long, long way in the past five to ten years in the visibility of science and technology on Capitol Hill," Turner told the CSP. The scientific community, including the AMS, he said, has pulled together to advocate increased funding for all of science, rather than each discipline arguing for its own pot of money. But equally important, he noted, is the need for constituents to speak directly to their representatives about the need for strong support for science. In the current budget climate, "you have to be talking to your members," he said. "Because if you are not talking to them, there is someone who is who wants your money."

—Allyn Jackson

The NSF fiscal year 2005 budget request may be found on the web at `http://www.nsf.gov/bfa/bud/start.htm`.