Mathematical Sciences in the FY 1998 Budget

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Summary

- In FY 1998 federal support for the mathematical sciences would grow by 5.3%, to an estimated $191.6 million. Adjusted for inflation, that would be an increase of 2.6% above the FY 1997 level, but would amount to a 1.5% decrease from the FY 1996 level.
- The National Science Foundation's Division of Mathematical Sciences would spend $97.0 million in FY 1998, a potential increase of 4.1% over the FY 1997 level.
- Combined support from the five mathematical sciences programs at the Department of Defense would grow by an estimated 8.6%, to $73.6 million, in FY 1998. However, the estimated combined budget for FY 1997 is 12.3% below the FY 1996 level.
- The Department of Energy's support for the mathematical sciences would be flat in FY 1998. In real terms, the program's funding has been shrinking steadily since FY 1994.

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Introduction

The federal government maintains seven dedicated programs in the mathematical sciences at three agencies: the Departments of Defense (DOD) and Energy (DOE) and the National Science Foundation (NSF). These programs support research and related activities carried out primarily at academic institutions.

The NSF provides about half of total federal support for the field and the only significant investment in fundamental research to expand the intellectual frontiers throughout the field. Thus it plays a key role in ensuring the vitality of the mathematical sciences and makes itself available as a resource for progress in science, technology, and industry.

The DOD maintains five mathematical sciences programs that together account for just under 40% of the federal budget for research in the field. These programs fund activities based on their potential to contribute to the missions of the DOD research agencies and the technology thrusts established at the highest levels of the department. Here the mathematical sciences are increasingly regarded as a problem-solving technology that can reduce costs in the development and deployment of hardware and software.

The Department of Energy also maintains a small dedicated program, and other federal agencies support research in the mathematical sci-

ences, mostly applied mathematics and statistics, to enable progress in fields related to their missions. These agencies include the Department of Transportation, EPA, NASA, NIH, and NIST. It is difficult to estimate the scope and extent of this research without detailed after-the-fact reporting from these agencies because they do not have dedicated mathematical sciences programs. Much of this research is carried out in agency R&D centers, although they make some grants to university-based mathematical scientists.

Trends in Federal Support for the Mathematical Sciences

In FY 1998 aggregate spending by the seven mathematical sciences programs would total an estimated $191.6 million, a potential increase of $9.6 million or 5.3% above the estimated FY 1997 level. This would amount to a 2.6% increase after adjusting for inflation. However, because aggregate support in FY 1997 would decline below the FY 1996 level by an estimated 4.0% in real terms, FY 1998 support would be 1.5% less than it was in FY 1996.

FY 1997 spending cuts at the Department of Defense are primarily responsible for this outcome. In FY 1998 combined DOD support for the mathematical sciences would increase by 5.8% in real terms above the FY 1997 estimate, but that estimate is 14.4% below the FY 1996 spending level. The mathematical program at the Office of Naval Research, for instance, would lose more than 20% of its FY 1996 budget. None of the five mathematical sciences programs at DOD would spend more in FY 1998 than they did in FY 1996, after adjusting for inflation.

The Department of Energy's level of support for the mathematical sciences has been declining steadily in real terms since FY 1994, and the program's university component has been shrinking since FY 1991. In fact, the proposed FY 1998 budget for this component would be roughly the same, in real terms, as spending levels in the mid-1980s. At its peak in the late 1980s and early 1990s, DOE's support for university-based mathematical activities was approximately 1/10th the size of NSF's support for similar activities; in FY 1998 DOE funding would amount to about 1/20th of NSF's. These trends are clearly a reflection of the overall downsizing at the Department of Energy, although some areas of DOE-supported science and technology have fared better.

FY 1998 Agency Budget Proposals

The tables on page 829 show the budgets of the seven federal mathematical sciences programs for FY 1995–1998 in current dollars and constant 1992 dollars. These programs provide support for a variety of research and related activities, including individual and group awards, institutes and centers, equipment, and education and human resources development. Following is information on each program and its FY 1998 budget proposal/estimate.

National Science Foundation (NSF): The NSF Division of Mathematical Sciences (DMS), part of the Mathematical and Physical Sciences Directorate (MPS), invests in the development of mathematical and statistical ideas and techniques, supports their interaction with other scientific and engineering disciplines, and encourages their diffusion into the technology base. Its portfolio includes grants for individual investigators and small groups, research institutes and centers, shared computing equipment, postdoctoral fellowships, research conferences, and undergraduate programs such as curriculum development.

DMS would spend $97.0 million in FY 1998, a 4.1% increase over the FY 1997 level. The spending proposal includes $74.0 million for research project support, a 1.5% increase, and $23.0 million for infrastructure support, a 13.3% increase. With these funds DMS would continue participation in a variety of interagency, NSF-wide, and MPS-wide activities, including the NSF's initiative in Knowledge and Distributed Intelligence. The increment for infrastructure support would be used in part to establish a new graduate student traineeship program.

The MPS Office of Multidisciplinary Activities (OMA) encourages meritorious projects that bridge gaps between or transcend the MPS disciplines. The distribution of OMA's budget among the MPS disciplines cannot be determined in advance, but a rough estimate of the portion of its requested FY 1998 budget that might be used to support mathematical activities in multidisciplinary areas is included in the table.

Air Force Office of Scientific Research (AFOSR): The Mathematics and Geosciences Directorate of AFOSR provides funds for research and related activities in the mathematical sciences in support of the Air Force mission. Research areas include optimization, signal processing, probability and statistics, computational mathematics, and dynamics and control. The FY 1998 budget estimate for mathematical activities would remain the same as its FY 1997 estimate, $17.1 million.

Army Research Office (ARO): The ARO mathematical sciences program focuses on the mathematics of materials science, high-performance computing, stochastic methods in image analysis, mathematical and computational issues in intelligent manufacturing, and other areas of interest to the Army. The program supports several centers and institutes that fall under the Uni-

FEDERAL SUPPORT FOR THE MATHEMATICAL SCIENCES

FY 1995-1998, in millions, current dollars

	actual FY 95	actual FY 96	estimate FY 97	budget request FY 98	percent change FY 97-98
National Science Foundation	87.69	91.70	98.22	102.00	3.8%
DMS	85.29	87.70	93.22	97.00	4.1%
Other MPS	2.40	4.00	5.00	5.00	0.0%
Department of Defense	77.40	77.30	67.80	73.60	8.5%
AFOSR	17.50	16.70	17.10	17.10	0.0%
ARO	15.00	15.00	13.00	15.00	15.4%
DARPA	21.00	22.90	19.50	22.40	14.8%
NSA	2.50	2.50	2.10	2.10	0.0%
ONR	21.40	20.20	16.10	17.00	5.6%
Department of Energy	15.70	16.00	16.00	16.00	0.0%
University Support	6.20	5.50	5.00	5.00	0.0%
National Laboratories	9.50	10.50	11.00	11.00	0.0%
TOTAL, All Agencies	180.79	185.00	182.02	191.60	5.3%

FEDERAL SUPPORT FOR THE MATHEMATICAL SCIENCES

FY 1995-1998, in millions, constant 1992 dollars

	actual FY 95	actual FY 96	estimate FY 97	budget request FY 98	percent change FY 97-98
National Science Foundation	81.48	83.44	87.20	88.26	1.2%
DMS	79.25	79.80	82.76	83.93	1.4%
Other MPS	2.23	3.64	4.44	4.33	-2.5%
Department of Defense	71.92	70.34	60.19	63.68	5.8%
AFOSR	16.26	15.20	15.18	14.80	-2.5%
ARO	13.94	13.65	11.54	12.98	12.5%
DARPA	19.51	20.84	17.31	19.38	12.0%
NSA	2.32	2.27	1.86	1.82	-2.5%
ONR	19.88	18.38	14.29	14.71	2.9%
Department of Energy	14.59	14.56	14.20	13.84	-2.5%
University Support	5.76	5.00	4.44	4.33	-2.5%
National Laboratories	8.83	9.55	9.77	9.52	-2.5%
TOTAL, All Agencies	167.99	168.33	161.59	165.79	2.6%

Note: The FY 1998 budgets for DOD's mathematical programs are estimates based on DOD's overall budget request for basic research.

versity Research Initiative (URI). For instance, in FY 1996 the program began support for a center on intelligent systems at the University of California, Berkeley, and Stanford University. In FY 1997 the program will begin support for a collaboration among Harvard University, the University of Maryland, and Boston University on the design and control of smart structures.

Reflecting cuts in DOD's overall support for basic research, the program's FY 1997 budget is estimated to drop to about $13.0 million, $2 million below the FY 1996 funding level. Under DOD's FY 1998 budget request, it is estimated that funding would return to its base of $15.0 million.

Defense Advanced Research Projects Agency (DARPA): The Applied and Computational Mathematics Program at DARPA supports mathematical research to facilitate the development of technologies identified by the agency as important to meeting future military needs. The program funds university and industrial researchers to solve well-defined mathematical and computational problems and work with

other DOD scientists to employ the resulting knowledge and tools in the development process.

In FY 1998 the program will focus on mathematical aspects of signal and image processing, electromagnetics, modeling and simulation of materials manufacturing processes, and optimized portable application libraries. Those last two areas are the subjects of joint DARPA-NSF initiatives.

The program's budget has been expanding in recent years, reflecting the success of more intense efforts to develop mathematical and computational methods for advancing defense technologies and reducing hardware costs. Estimated funding for the program in FY 1998 would be $22.4 million, a 14.9% increase over the estimated FY 1997 level of $19.5 million. (These figures include DARPA's support for programs under the University Research Initiative; earlier published versions of this article did not include URI monies in the DARPA budget figures.)

National Security Agency (NSA): The National Security Agency is the nation's largest employer of mathematical scientists. Its in-house research activities are highly classified. In 1984 NSA initiated a competitive grants program to support unclassified academic research in discrete mathematics, algebra, number theory, probability, statistics, and cryptology.

The program was started in response to indications that the number of U.S. citizens earning advanced degrees in the mathematical sciences was dropping at an alarming rate. Since NSA can employ only U.S. citizens, it is concerned about ensuring the long-term flow of Americans into mathematics. Although budgetary constraints have prevented support for the program from reaching the recommended level of $5.0 million, NSA continues to believe in the importance of this program. NSA also provides funds for mathematical research through programs at predominantly minority institutions and supports some contracts for directed mathematical research; spending for these activities is not included in the table.

Office of Naval Research (ONR): The Mathematical, Computer, and Information Sciences Division, part of the ONR's Information, Surveillance, and Electronics Department, supports research in the mathematical areas of applied analysis, discrete mathematics, numerical analysis, operations research, and probability and statistics in support of the naval mission. In FY 1997 ONR's support for the mathematical sciences is projected to drop by 20% from the FY 1996 level—from $20.2 million to $16.1 million—due to reductions in DOD's basic research budget. It is estimated that funding would be $17.0 million in FY 1998.

Department of Energy (DOE): The Office of Computational and Technology Research's Mathematical, Information, and Computational Sciences Division has two missions: to support a broad range of research in the mathematical, computational, and computer sciences necessary to underpin all the other sciences and to manage a network of state-of-the-art supercomputing facilities for DOE-supported researchers. Most of its funding is devoted to R&D in applied computer and computational science and technology carried out at the national laboratories. It also invests in a small mathematical sciences program, providing support to the labs and to universities for basic research and related activities in analytical, numerical, and computational methods. These mathematical tools are useful in solving complex scientific problems that hinder progress toward national energy and environmental goals.

The program would be funded at $16.0 million in FY 1998, the same amount as in FY 1997. As noted above, the investment in this program has been on a downward trend since FY 1994, resulting in a decrease in the number of mathematical scientists supported by DOE. The division's activities also contribute to the High Performance Computing and Communications program to produce the next generation of high-performance computing hardware and software.

Note: The FY 1998 budgets for DOD's mathematical programs are estimates based on DOD's overall budget request for basic research.