



**Prepared Statement by Dr. James Hyman  
President, Society for Industrial and Applied Mathematics  
Before the  
Subcommittee on VA, HUD, and Independent Agencies  
Committee on Appropriations  
House of Representatives  
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Mr. Chairman and Members of the Subcommittee -- my name is Mac Hyman, and I am a mathematician and group leader at the Los Alamos National Laboratory. For the past fifteen months, I have served as the President of the Society for Industrial and Applied Mathematics (SIAM), and it is in that capacity that I come to you today to testify on the subject of the National Science Foundation's FY 2005 budget.

SIAM is an organization of about 10,000 scientists from academia, industry, and government laboratories, all of whom share a common interest in applied mathematics and computational science and engineering.

SIAM appreciates this opportunity to share its concerns with this Committee and takes note of this Committee's long standing consistent support for research and education. On behalf of the members of SIAM, I want to thank this Subcommittee for all that it has done to help this Nation create the finest research enterprise in the world.

As this Subcommittee begins to consider the fiscal year 2005 appropriations bill, we recognize you are facing some of the most difficult budget constraints in recent memory. Nevertheless, it is essential for the health of the economy and for this Nation's national security that we continue to have a robust science and engineering research enterprise. The programs at NSF are an integral part of that enterprise and we urge you to do all that you can to support this enterprise in the face of today's budgetary austerity.

SIAM urges the Congress to provide the maximum support possible for the NSF consistent with the spirit evidenced in the National Science Foundation Authorization Act of 2002. We feel strongly that such an investment is needed to develop the intellectual capital, maintain and strengthen a strong scientific infrastructure, and develop the mathematical and scientific workforce needed to sustain economic improvements and national security through world class research and vigorous education and training programs.

In particular, we are here today to draw the Subcommittee's attention to the applied mathematical sciences and computational science and engineering programs supported primarily by the Foundation's Mathematics and Physical Sciences (MPS) Directorate and the Computer and Information Science and Engineering (CISE) Directorate. Both directorates have programs that promote important collaborations between mathematicians, computer scientists, and scientists in many cutting-edge, interdisciplinary areas.

MPS is an essential supporter of a wide range of disciplines, including physics, chemistry, astronomy, materials research, and mathematics. CISE sponsors research in computational science as well as cyberinfrastructure. Federal support for the fields supported by MPS and CISE has lagged in comparison to federal support for the life sciences in recent years. Consistent with the October 2002 report of the President's Council of Advisors on Science and Technology (PCAST), *Assessing the US R&D Investment*, SIAM believes it is important to America's scientific future that this disparity be alleviated and we urge the Congress to increase funding for the physical, computational, and engineering sciences. Since MPS and CISE are among the leading sponsors of these disciplines, any attempt to achieve this sort of balance must incorporate these directorates.

The leadership that Congress has shown with respect to the mathematical sciences as a priority area within NSF in recent years has already begun to achieve results and generate much needed excitement in the field. According to NSF data, the average core mathematics research grant has increased in size and duration. While still well below the NSF average, these increases are providing significant evidence to U.S. mathematics students that a career in the mathematical sciences is an exciting choice. The investment has allowed for the establishment of three new national mathematical sciences institutes, with a heavy focus on interdisciplinary research. These institutes are located in California, Ohio, and North Carolina. Through the VIGRE program (Grants for Vertical Integration of Research and Education in the Mathematical Sciences), increases have been achieved in the number of U.S. undergraduates majoring in mathematics, participating in graduate-level research projects, and continuing on to do graduate work in the mathematical sciences.

The increased support mathematics has received as a priority area from this subcommittee has just begun to attract more U.S. students into this field -- a major policy objective of a 1998 National Academy of Sciences report. Leveling the funding at this time will almost certainly send a negative message to students who are considering a career in applied mathematics and computational science and engineering.

With the progress we have made, it is more important than ever to remember that applied mathematics and computational science and engineering bring together the power of advanced computers, along with mathematical models, algorithms, and visualizations to provide insight into challenging problems in nearly all fields of science and engineering. Research in these areas makes possible simulation-based decision-making used in virtual prototyping for design and manufacture of new products.

Applied mathematics and computational science and engineering also play a key role in providing tools to analyze problems that would be too expensive, dangerous, or even impossible, to study by direct experimentation alone. Most recently, simulations were used to reconstruct a scenario disaster analysis to explain the Columbia Shuttle disaster. In the area of homeland security, DHS is asking very difficult questions that will require new mathematical underpinnings. The sequencing of the human genome and its impact

on our lives will someday owe as much to advances in the mathematical analysis of these massive data sets as it will to advances in sequencing technology.

In my own research, I have used mathematical models to estimate and predict the impact of control measures on the spread of HIV, SARS, influenza, and a hypothetical bioterrorist smallpox attack. Mathematical models based on the underlying transmission mechanisms of these diseases have helped the medical and scientific communities understand and anticipate the spread epidemics and evaluate the potential effectiveness of different approaches for bringing the epidemic under control.

Applied mathematics and computational science and engineering allow the development of software and other tools that enable researchers to take advantage of the power of today's and tomorrow's most advanced computers. Advances in algorithmic efficiency rival advances in hardware architecture. In a recent report to the Department of Energy, entitled, "A Science-Based Case for Large-Scale Simulation" concluded that advances in algorithmic research rival the well-known Moore's Law advances in hardware:

The choice of appropriate mathematical tools can make or break a simulation code. For example, over a four-decade period of our brief simulation era, algorithms alone have brought a speed increase of a factor of more than a million to computing the electrostatic potential induced by a charge distribution, typical of a computational kernel found in a wide variety of problems in the sciences. The improvement resulting from this algorithmic speedup is comparable to that resulting from the hardware speedup due to Moore's Law.

The example regarding electrostatic potential is most certainly the rule rather than the exception. Moreover, recent studies on high-end computing (HEC) efforts point out that investments in computational science and engineering into software and algorithms result in productivity increases when using some of the most advanced and complicated high performance computers. High-end computers have a certain raw speed (measured in peak performance) but when applied to real problems, very sophisticated mathematical algorithms are needed to achieve the full potential. New and more exotic architectures will require even more sophisticated computational tools in order to achieve their potential. High-end computing needs major contributions from mathematical and computational techniques to address this performance gap.

SIAM believes that NSF - largely through its Mathematical and Physical Sciences and Computational and Information Science and Engineering directorates - is working to elevate the priority for computational science and engineering. SIAM understands the difficulties of promoting high-end research in mathematics and computing alongside the important needs of building bigger and faster computers. Nevertheless, SIAM believes computational science and engineering represent a vital underpinning with respect to future advances in such fields as nanotechnology, genomics, materials fabrication, and meteorology. We urge the Subcommittee to support and further encourage NSF's efforts to elevate its focus on computational science and engineering as well as maintain mathematics as a priority area within the NSF research portfolio.

Computational science and engineering flourishes best in an interdisciplinary team environment. The NSF-wide Information Technologies Research program was one successful example that brought computing and information research to bear on a wide range of scientific problems. SIAM would urge the Subcommittee to encourage NSF to continue to invest in interdisciplinary teams attacking important areas of computational science and engineering.

In summary, there is a clear need in the applied mathematical and computational science and engineering communities for growth in federal funding. These are exciting times for these communities as they engage in teams with scientists in diverse fields in an effort to solve some of the great challenges facing the scientific community today.

SIAM is grateful for the support this Subcommittee has provided to the Foundation in the past, and while you face an extraordinarily constrained budget environment today, we hope you will continue to invest in this Nation's future through your support of the National Science Foundation.

Thank you for this opportunity to testify today. I would be happy to answer any questions the Subcommittee may have.