

**THE NATIONAL ACADEMIES
DIVISION OF ENGINEERING AND PHYSICAL SCIENCES
BOARD ON MATHEMATICAL SCIENCES AND THEIR APPLICATIONS**

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**CORE SUPPORT OF THE
BOARD ON MATHEMATICAL SCIENCES AND THEIR APPLICATIONS**

SUMMARY

The National Academies' Board on Mathematical Sciences and their Applications (BMSA) is a primary interface between the research enterprise and federal agencies that rely on the mathematical sciences. The Board provides objective and authoritative advice on how best to apply the tools of mathematics, statistics, operations research, financial engineering, computational modeling, computational science, information analysis, and decision analysis to practical problems of national importance. In so doing, the Board strengthens the policy-making process and increases the visibility of, and appreciation for, the mathematical sciences while also identifying growth areas for the discipline.

The Board consists of 18 pro bono experts from a broad range of quantitative fields, with experience in academia, industry, and national laboratories. Current activities include:

- A recent workshop on Enterprise Risk Management, which provided a forum for the exchange of perspectives among a wide range of public and private-sector experts in risk management; this workshop was a unique and stimulating gathering of risk managers from the IRS and other agencies with which the mathematical sciences community has had little previous contact;
- A study to recommend a far-reaching mathematical sciences research program for the Department of Energy that will support its new initiatives and directions in computational biology;
- Workshops in preparation for the National Security Agency on Visualization of Uncertain Information and on Statistics on Networks;
- A study for the Department of Defense on how decision makers can combine inputs from quantitative physics-based models and semi-quantitative simulations to best inform high-stakes strategic decisions;
- A study for the Environmental Protection Agency (in conjunction with another unit of The National Academies) on how best to incorporate and validate the results of computational models into their regulatory process; and

- A study for the Air Force Office of Scientific Research to recommend a basic research program to support Air Force information science and technology goals.

Other activities under development include studies to identify best practices in computational modeling and to outline research directions for handling massive amounts of data.

The BMSA plays a unique role of advising the federal government and policy community how to make best use of the mathematical sciences. It does this by involving leading mathematical scientists in workshops and studies that help federal decision-makers address their technical challenges. Some of these decision-makers are found in agencies that fund mathematical sciences research, but most do not have strong existing ties to the mathematical sciences research community. Thus, through its execution of this function, the BMSA also demonstrates very clearly the value that the mathematical sciences provide, while also identifying fruitful research opportunities that strengthen the mathematical sciences community. Its position as part of the National Academies (which include the National Research Council, National Academy of Sciences, National Academy of Engineering, and Institute of Medicine) enables the BMSA to also build links between the mathematical sciences and other fields of science, engineering, and medicine.

More information about the Board may be found at www7.nationalacademies.org/bms.

INTRODUCTION

The mathematical sciences, like other fields of science, require strong internal cohesion, robust connections with other fields of sciences and engineering, and broad appreciation for, and support of, their contributions. The BMSA addresses these needs. It contributes to internal cohesion of the discipline by bringing together leaders of mathematics, statistics, operations research, and other mathematical fields for a broad range of interactions at its biennial meetings and other functions. The Board is the only such broad-based and high-level committee that meets on a regular basis. Through its position within the National Academies, the Board also strengthens connections between the mathematical sciences and other fields, because it has ready access to the leaders in all fields of science, engineering, education, and medicine. This allows the Board to convene workshops and studies that are truly cross-disciplinary. And the Board's position within the National Academies gives it access to leaders in federal agencies and public policy, who tend to accept the Board's inputs as more authoritative and objective than would be the inputs of a group convened by, for example, agency staff or a professional society.

The Board has one standing committee, the Committee on Applied and Theoretical Statistics (CATS), which has analogous goals but is focused on the statistical sciences.

RECENT AND CURRENT ACTIVITIES

The Board has recently issued proceedings from two workshops, ran a major workshop on enterprise risk that many participants saw as the first step in building a broad community focused on that topic, launched two major studies (one on mathematical research in support of computational biology and the other on combining models and simulations for strategic decision-

making), and is partnering with the NRC's Board on Environmental Studies and Toxicology on another major study.

As noted above, this portfolio of activities was consciously developed in part to build bridges between the mathematical sciences and a range of federal agencies that, while they rely on sophisticated mathematical sciences, do not themselves have strong ties into the mathematical sciences research community. Such agencies have a great need for the objective and authoritative guidance about mathematical methods that the Board provides. The Board's success in reaching many audiences is evidenced by the fact that the recent activities described in this section have been sponsored by both research agencies—DOE, NSF, National Security Agency, Office of Naval Research, Air Force Office of Scientific Research, Army Research Office, Defense Advanced Research Projects Agency—and agencies that sponsor little mathematical sciences research—IRS, EPA, and the Defense Modeling and Simulation Office. In addition, many of the Board's activities involve participants from fields or organizations that have little regular interaction with the mathematical sciences community; for instance, the enterprise risk workshop described below drew participants from the following 21 federal agencies:

- Bureau of the Census
- Department of Energy
- Department of Labor
- Department of Treasury
- Economic Research Service
- EPA
- Federal Aviation Administration
- Federal Reserve Bank of Boston
- Federal Reserve Bank of New York
- Food and Drug Administration
- IRS
- NASA
- National Science Foundation
- Navy Medical Command
- Nuclear Regulatory Commission
- Office of the Comptroller of the Currency
- Office of the Secretary of Defense
- Postal Rate Commission
- Securities and Exchange Commission
- U.S. Coast Guard
- Veterans Administration

Most of the participants from those agencies have had little previous interaction with the mathematical sciences research community, and so this workshop helped them understand that mathematical scientists share their interests and contribute useful insights and capabilities.

At the same time, the Board continues to advise the research enterprise directly. Examples of that role include a recent CATS workshop on the analysis of massive streams of data (which brought together a wide variety of researchers working on disparate but analogous challenges); the ongoing BMSA study to develop a mathematical sciences research agenda that supports DOE's computational biology goals; and studies in the conceptual stage that will identify best

practices in computational science and mathematical methods for data-intensive science, such as exemplified by astronomy's "virtual observatory."

Recent Workshops

The workshop proceedings mentioned above are:

1. *Mathematical Sciences' Role in Homeland Security* (National Academy Press, Washington, D.C., 2004), proceedings of an April 2002 workshop of the same name. This proceedings, the Board's first that is entirely in electronic form (on CD-ROM), includes videos, transcripts, presentation materials, speaker biographies, and other information from the subject workshop. It is useful for any mathematical scientist who wishes to learn how his or her field can contribute to homeland security or who wishes to demonstrate that link to others.
2. *Special Issue on Statistical Analysis of Massive Data Streams*, Journal of Computational and Graphical Statistics, vol. 12 (December 2003). This special issue consists of 11 articles that document a December 2002 CATS workshop on statistical analysis of massive data streams.
3. *Statistical Analysis of Massive Data Streams: Proceedings of a Workshop* (National Academy Press, Washington, D.C., in preparation), captures the presentation materials and summary discussions of the December 2002 CATS workshop.

The workshop on Mathematical Sciences' Role in Homeland Security demonstrated to a diverse audience the wide array of important contributions being made by the mathematical sciences, while also identifying numerous outstanding research challenges. A large fraction of the speakers and audience were closely involved in national security, and key non-mathematical leaders were involved in the program. As a result, the profile of the mathematical sciences community was raised in important ways. This workshop was profiled in Business Week online, April 30, 2002 (http://www.businessweek.com/technology/content/apr2002/tc20020430_3678.htm). The 80 participants included leaders in the mathematical sciences, computer security, epidemiology and public health, intelligence, and defense, including 9 members of the National Academy of Sciences, one member of the National Academy of Engineering, and one member of the Institute of Medicine. The workshop also attracted the Senior Advisor to the Director of the CDC, a Technical Director of the National Imagery and Mapping Agency, the Chief Scientist of the Air Force, the head of mathematics research at the National Security Agency, and the Vice Chairman of the Critical Infrastructure Board of the Department of Homeland Security. This range of highly-positioned participants again demonstrates the Board's ability to reach and influence leaders in a variety of technical fields. As part of the follow-on to that workshop, the Board is planning a meeting with key people in the Science and Technology arm of the Department of Homeland Security.

The workshop on Statistical Analysis of Massive Data Streams was a very successful gathering of over 80 experts addressing the subject in the domains of high-energy physics, atmospheric modeling and remote sensing, intelligence, and communications networks. This workshop provided the first opportunity for many of the participants to share their insights and perspectives, pulling together a widely dispersed network of people working on analogous issues while demonstrating that the statistics community is a common link. CATS is planning a follow-on workshop on Visualizing Uncertain Data, which will be similarly multidisciplinary and is intended

to spark a renewed interest in the subject of how best to present complex information with uncertainties.

In January 2004, the Board gathered over 170 participants for a broad workshop on Enterprise Risk Management, which is an emerging discipline for managing in a coherent fashion the entire spectrum of risks that affect a large organization composed of units and programs. This discipline has proven valuable in banking, nuclear power, and some heavy industries, and the workshop provided an opportunity for federal agencies to learn about and adapt the best practices of the private sector. As noted above, representatives of 21 federal agencies participated. Mathematical scientists on the program included Pat Brockett, Univ. of Texas at Austin, Claude Greengard of IBM, Chuck Lucas of AIG (a member of the BMSA), John Nolan of American University, and Shaun Wang, SCOR Group. Enterprise Risk Management is an example of a field that is widely perceived as mathematical by those in the business world, is built on a substrate of mathematical tools, and presents some true mathematical research challenges. Yet, without the efforts of BMSA to link its practitioners with mathematical scientists, this discipline would likely be developed by the business community without the healthy involvement of the broader mathematical sciences community. This would represent two missed opportunities: the opportunity for the mathematical sciences community to become more connected with the business community, and the opportunity for risk management practitioners to have ready access to advances in the mathematical sciences of usefulness in managing risk.

Current Studies

The Board has nearly completed a major study for the DOE to identify the mathematical sciences research that DOE should support in order to complement its ongoing research in computational biology. This study has the potential for sparking a major change in DOE's extramural mathematical sciences research program, and more generally, it will be a roadmap for computational biology research done everywhere. Computational biology suffers from a dramatic shortage of researchers with appropriate backgrounds, math phobia on the part of some bioscientists (greatly decreasing in number in recent years), and large differences of opinion about which quantitative research should be given top priority. The study will address the last of these issues, and it also will help address the shortage of researchers by explaining to mathematical scientists how they or their students can contribute. The study committee consists of eminent mathematical scientists and biologists, including four members of the NAS and one member of the National Academy of Engineering. A well-attended session at the 2005 Joint Mathematics Meetings, organized by the Board, gave a hint of the areas of computational biology covered by the study. BMSA core funding supported the development of study plans, creation of a funding proposal, and preliminary work to identify the members of the study committee, while a separate contract from DOE supports the actual execution of the study. The study's report will be released in the early spring of 2005.

The Board has also begun a major study for the Defense Modeling and Simulation (M&S) Office that will recommend how to compose the outputs of physics-based models and semi-quantitative human-in-the-loop simulations to properly inform major strategic decision-making. The study is being chaired by Sallie Keller-McNulty of Los Alamos National Laboratory. At present, there does not exist a good methodology for putting these models and simulations on commensurate bases, and so it is very difficult for decision-makers to assess how a force's effectiveness is

affected by choices of equipment (often well-defined via high-fidelity models) and choices of staffing, training, and doctrine (usually evaluated via semi-quantitative simulations and test exercises). Information that is key to military decision-makers includes assessments of (a) what the models and simulations do and do not credibly imply about the situation being represented and of (b) estimates of the consequences of various decisions given the environment and information at hand. The study will also identify research and development tasks required to overcome shortfalls with respect to these topics.

The BMSA is collaborating with the NRC's Board on Environmental Studies and Toxicology on a study titled "Models for Environmental Decision Making: Principles and Criteria." BMSA staff will be involved at a low level to ensure that appropriate mathematical scientists are included on the committee and that mathematical perspectives are included in the study. As such, this study provides an important opportunity for the mathematical sciences community to demonstrate its value in analyzing issues regarding the proper use of computational models. The study is not intended to assess the quality of EPA's models—the normal incentives within the research community tend to encourage steady improvements in the models and algorithms—but rather to provide EPA with guidance on the appropriate use and interpretation of computational results. That guidance will delve into issues such as how to adequately peer review and validate complex models, how to quantify model uncertainties and convey them to policymakers, and, more generally, how to determine when computational modeling is an appropriate and justifiable underpinning to regulations. The study will begin with a major workshop, March 18-19, 2004.

In a related activity, funded by the National Academies, the Board co-sponsored with the National Academy of Engineering an April 2003 workshop on the interface between mathematical modelers and decision-makers. That workshop—which was meant to explore a wide range of issues so as to identify some that were amenable for future exploration in depth—drew a very diverse group of engineers, statisticians, defense modelers, environmental scientists, economists, and policymakers. Bill Oberkamp of Sandia National Laboratories brought valuable DOE perspectives to the table.

Direct Interactions with Federal Agencies

The BMSA and CATS have direct interactions with representatives of federal agencies, primarily in conjunction with their semi-annual meetings. Discussions include mathematical challenges facing various agencies or communities. Because the Board and CATS members collectively have a rich set of ties to professional societies, leading institutions, and other committees, these meetings present unique opportunities for collecting and disseminating ideas. The meetings are well organized and well attended. Representatives of funding agencies, academia, industry, the professional societies, and the professional communities are routinely invited to attend. Most BMSA and CATS meetings are held in Washington, D.C.

A recent example of a valuable discussion sponsored by the Board was a session at the November 2003 BMSA meeting that dealt with the challenges of data overload and the need for new modeling and analysis methods. The goal of the session was to understand the range of fields affected by data overload, the scale of the challenge, and most importantly to effect actions that the mathematical sciences community should take to help. The following experts spoke to the Board and some half dozen federal representatives:

- Rob Lipshutz, Affymetrix, Inc., *Data from the new generation of gene chips.*
- Alex Szalay, Johns Hopkins University, *Data-intensive astronomy.*
- David Harris, National Security Agency (NSA), *Data overload at NSA.*
- Vince Stanford, National Institute for Standards and Technology (NIST), *Data generated by “pervasive computing,” sensor arrays, and “smart spaces.”*
- Mike Lesk, Rutgers Univ., *Digital libraries.*

This session led to a study proposal that is under development. The proposed study, which will be directed to federal agencies that are challenged by dramatic increases in the amount of incoming data, will recommend directions for those agencies to follow so as to be able to process and use the increased amount of data. At the same time, this study is expected to stimulate relevant research in the mathematical sciences community and position that community as an important contributor in the development of data-intensive fields.

More recently, at its meeting of November 2004, the Board held a session devoted to the frontiers of computational modeling. This was led by Board members Phil Colella of Lawrence Berkeley National Laboratory and C. David Levermore, formerly of Lawrence Livermore National Laboratory. Speakers included David Nelson of the federal ITRD office.

Topics of particular interest to the DOE have also been explored at CATS meetings. On November 5, 2001, CATS held discussions with a variety of agency representatives on the role of statisticians in homeland security and in environmental modeling. The former topic was expanded through a BMSA workshop in April 2002, and the latter fed into the study on EPA models in which the BMSA is participating. At its meeting of December 2002, CATS held a discussion with Salman Habib of Los Alamos National Laboratory and Matt Goodman of Telcordia about the statistical challenges in quantum computing. Based on that session, CATS may frame a study that would accelerate statisticians’ contributions to quantum computing, and perhaps to other emerging areas that rely on quantum effects.

FUTURE DIRECTIONS

Three examples of mathematical topics that challenge federal agencies are financial engineering, risk analysis, and large-scale computational modeling. Financial practices and instruments have developed very rapidly in recent years, and they are mathematically sophisticated. Because the federal agencies that regulate these practices and instruments must stay on top of continuing innovations in financial engineering without, in most cases, significant research staffs of their own, they could benefit from BMSA advice on matters such as how to update regulations to oversee new instruments and how to incorporate advanced financial techniques into their own operations. On the topic financial and management risk, the Board seeks to become a primary source of advice on such risks, which also opens up opportunities for links between the mathematical sciences community and a large number of non-research agencies. The Board’s

very successful January 2004 workshop on enterprise risk management gives the Board a foothold in this area, and it should also create opportunities in the area of financial engineering. Finally, on the topic of large-scale computational modeling, there is a need for more authoritative advice on the proper use, interpretation, and validation of complex computational modeling, because computing power has increased so rapidly in recent years and become so pervasive. Advice may be needed, for instance, on methods for validating large-scale computations, for presenting results in ways that are most useful and responsible for informing policymakers, on legal, ethical, and professional issues associated with the incorporation of virtual results into decision-making, and on how best to educate students and workers in the appropriate use of computational models. The Board's current studies on EPA models (with the Board on Environmental Studies and Toxicology) and on linking defense models and simulations provide important steps toward developing this program area. Based on this foundation, the Board is beginning talks with the Federal Reserve Bank of New York on a possible major conference on modeling of systemic risk in the financial sector, which would involve expertise from the national laboratories and other institutions with skill in very complex computational modeling.

At the same time that it builds its connections and relevance to those who rely on the mathematical sciences, it is essential that the Board maintains its connections to, and credibility with, the mainstream mathematical sciences research community. That community must learn from the Board's studies and provide the follow-through research. They won't be positioned to do so—for their own good and the nation's—unless they are truly connected with the Board. The Board is addressing this by ensuring that prominent, mainstream mathematical scientists are well represented among its members and are involved in its activities. It is working more closely with the professional societies (e.g., AMS, MAA, SIAM, ASA, INFORMS) to strengthen its ties with the broad mathematical sciences community, and it is raising its profile via an improved Web site and occasional articles about its activities in professional publications. Finally, it is improving its coordination with the NSF-funded mathematical sciences research institutes, which have a complementary role to play in exploring new opportunities for the discipline.

CONCLUSION

The Board on Mathematical Sciences and Their Applications is the only forum where core and applied mathematicians, probabilists, operations researchers, statisticians, scientific computing experts, computer scientists, and members of other mathematically-intensive fields come together to address intellectual and infrastructural issues that affect the broad mathematical sciences community and its relationship to federal agencies. The Board and CATS undertake activities that build cohesion within the discipline, strengthen its ties to other fields of science and engineering, and demonstrate the value of the mathematical sciences to research and non-research agencies of the federal government, and strengthen the role of the mathematical sciences in attacking the problems of our time. The latter function helps to identify areas in which the mathematical sciences can grow and to improve the appreciation for, and visibility of, the mathematical sciences.

PUBLIC INFORMATION ABOUT THE PROJECT

The NRC will post on its web site (<http://www.nas.edu>) a brief description of the project, as well as committee appointments with short biographies of the members, meeting notices, and other pertinent information, to afford the public greater knowledge of our activities, and an opportunity to make comments. The web site will also include an ongoing record of compliance to the requirements of Section 15 of the Federal Advisory Committee Act of 1997, and a certification of compliance when the study is completed.

FEDERAL ADVISORY COMMITTEE ACT

The Academy has developed interim policies and procedures to implement the Federal Advisory Committee Act, 5 U.S.C. § 1 et seq. (FACA), as amended by the Federal Advisory Committee Act Amendments of 1997, H.R. 2977, signed into law on December 17, 1997 (FACA Amendments). The FACA Amendments exempted the Academy from most of the requirements of FACA, but added a new Section 15 that includes certain requirements regarding public access and conflicts of interest that are applicable to agreements under which the Academy, using a committee, provides advice or recommendations to a federal agency. In accordance with Section 15 of FACA, the Academy shall deliver along with its final report to the National Science Foundation a certification by the responsible staff officer that the policies and procedures of the National Academy of Sciences that implement Section 15 of FACA have been complied with in connection with the performance of the grant.

APPENDIX A

Convening Activities

The Board's convening activities have included numerous workshops and an annual colloquium for heads of mathematics and statistics departments. Most of the Board's other convening activities are workshops that illuminate new research opportunities or draw attention to interfaces that are under-exploited. Following are the topics and dates of symposia that the Board has organized or overseen:

- * *Workshop on Statistics on Networks*, planned for September 2005
- * *Workshop on Visualization of Uncertain Information*, March 3-4, 2005
- * *Enterprise Risk Management*, Jan. 14-15, 2004.
- * *Statistical Methods for the Analysis of Massive Streams of Data*, Dec. 13-14, 2002.
- * *Mathematical Sciences' Role in Homeland Security*, April 26-27, 2002.
- * *The Interface of Three Areas of Biomedical Science with the Mathematical Sciences*, April 26-28, 2001.
- * *The Interface of Three Areas of Computer Science with the Mathematical Sciences*, April 28-29, 2000.
- * *Statistical Approaches for the Evaluation of Complex Computer Models*, December 3-4, 1999.
- * *Record Linkage Workshop*, March 20-21, 1997.
- * *Actions for the Mathematical Sciences*, May 17-19, 1996.
- * *Statistical Challenges and Possible Approaches in the Analysis of Massive Data Sets*, July 7-8, 1995.
- * *Earth Shaking Analyses: Mathematical Sciences in Seismology*, June 1, 1995.
- * *Large-Scale Structures in Acoustics and Electromagnetics*, September 26-27, 1994.
- * *Motion, Control, and Geometry*, April 12, 1994.
- * *Transportation and the Mathematical Sciences: The Changing Interaction*, May 13, 1993.
- * *Clinical Trials and Statistics*, December 1, 1992.
- * *Mathematics in Support of Industry*, October 25, 1991.
- * *Mathematical Sciences, Technology, and Economic Competitiveness*, May 7, 1991.
- * *The Future of Statistical Software*, February 22, 1991.
- * *Partial Differential Equations*, May 9, 1990.
- * *Statistics: A Guide to Assessing Societal Risk*, November 29, 1989.
- * *Number Theory*, May 4, 1989.
- * *Nonlinear Mathematics, Chaos, and Fractals*, April 28, 1988.
- * *Statistics in Science, Industry, and Public Policy*, April 9, 1987.
- * *Mathematics, the Unifying Thread in Science*, May 12, 1986.

Reports of the Board and its Committees

The publications listed here are consensus reports created by committees of experts and issued as official reports of the National Academies. They can be grouped roughly into two categories: those that identify directions in which the field can grow, and those that assess federal programs or the health of the field generally. The publications that identify research directions serve to advise younger mathematical scientists on emerging topics of importance, so that they can position

themselves to exploit those opportunities. In some cases, such reports have helped federal program officers establish new directions of funding for mathematical scientists. Most publications are available gratis on the Web so as to make them available to anyone who needs the information.

Mathematics for 21st Century Biology, 2005

Statistical Methods for the Analysis of Massive Streams of Data: Proceedings of a Workshop, CATS, 2004.

Mathematical Sciences' Role in Homeland Security: Proceedings of a Workshop, BMSA, 2004.

Making Sense of Complexity: Summary of a Workshop on Dynamical Modeling of Complex Biomedical Systems, BMSA, 2002.

The Interface of Three Areas of Computer Science with the Mathematical Sciences, Dianne P. O'Leary and Scott Weidman, 2000.

U.S. Research Institutes in the Mathematical Sciences, BMS, 1999.

Record Linkage Techniques—1997, BMS, 1999

Preserving Strength While Meeting Challenges, BMS, 1997.

Motion, Control, and Geometry, BMS, 1997.

Massive Data Sets, Proceedings, CATS, 1996.

Large-Scale Structures in Acoustics and Electromagnetics, BMS, 1996.

Mathematics and Physics of Emerging Biomedical Imaging, BMS, 1996.

Statistical Software Engineering, CATS, 1996.

Review of AFOSR Programs in Mathematical and Computer Sciences, BMS, 1996.

Calculating the Secrets of Life: Applications of the Mathematical Sciences in Molecular Biology, BMS, 1995.

Mathematical Challenges from Theoretical/Computational Chemistry, BMS and BCST, 1995.

Modern Interdisciplinary University Statistics Education, Proceedings, CATS, 1994.

Statistical Issues in Defense Analysis and Testing, Summary of a Workshop, CNSTAT and CATS, 1994.

Mathematical Research in Materials Science: Opportunities and Perspectives, BMS, 1993.

Transportation and the Mathematical Sciences: The Changing Interaction, BMS, 1993.

Clinical Trials and Statistics, BMS, 1993.

Statistics and Physical Oceanography, CATS, 1993.

Probability and Algorithms, CATS, 1992.

Combining Information: Statistical Issues Opportunities for Research, CATS, 1992.

Educating Mathematical Scientists: Doctoral Study and the Postdoctoral Experience in the United States, BMS, 1992 (poster "Advice to Potential Graduate Students in the Mathematical Sciences" based on Appendix B of this report is available).

Mathematical Opportunities in Nonlinear Optics, BMS, 1992.

The Future of Statistical Software, Proceedings, CATS, 1991.

Mathematical Foundations of High-Performance Computing and Communications, BMS, 1991.

Mathematical Sciences, Technology, and Economic Competitiveness, BMS, 1991.

Moving Beyond Myths: Revitalizing Undergraduate Mathematics, BMS and MSEB, 1991.

Applications of the Mathematical Sciences to Materials Science, BMS, 1991.

Spatial Statistics and Digital Image Analysis, BMS, 1991.

Statistics: A Guide to Assessing Societal Risk, Proceedings, CATS, 1991.

Actions for Renewing U.S. Mathematical Sciences Departments, BMS, 1990.

Chairing the Mathematical Sciences Department of the 1990s, Proceedings, BMS, 1990.

Number Theory, Proceedings, BMS, 1990.
The Impact of Mathematics: Nonlinear Mathematics, Chaos, and Fractals in Science, Proceedings, BMS, 1990.
Renewing U.S. Mathematics: A Plan for the 1990s ("David II"), BMS, 1990.
Selected Opportunities for Mathematical Scis. Research Related to the Navy Mission-An Update, BMS, 1990.
A Challenge of Numbers: People in the Mathematical Sciences, BMS and MSEB, 1990.
Everybody Counts: A Report to the Nation on the Future of Mathematics Education, BMS and MSEB, 1989.
Symposium on Statistics in Science, Industry, and Public Policy, Proceedings, BMS (CATS), 1989.
Mathematical Sciences: Some Research Trends, BMS, 1988.
Statistical Models and Analysis in Auditing, CATS, 1988.
Discriminant Analysis and Clustering, CATS, 1988.
Selected Opportunities or Mathematical Sciences Research Related to the Navy Mission, BMS, 1987.
Report of the Advisory Panel to the Mathematical and Information Sciences Directorate, Air Force Office of Scientific Research, BMS, 1987.
Calculus for a New Century: A Pump, Not a Filter, BMS, MSEB and MAA, 1987.
Mathematical Sciences: A Unifying and Dynamic Resource, BMS, 1986.
Computational Modeling and Mathematics Applied to the Physical Sciences, OMS, 1984.