NATIONAL ACADEMY OF ENGINEERING

Technological Leadership in the Nation's Service

2002 Annual Report

Promoting the technological welfare of the nation by marshalling the knowledge and insights of eminent members of the engineering profession.

NATIONAL ACADEMY OF ENGINEERING
OF THE NATIONAL ACADEMIES

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This report was printed in June 2003

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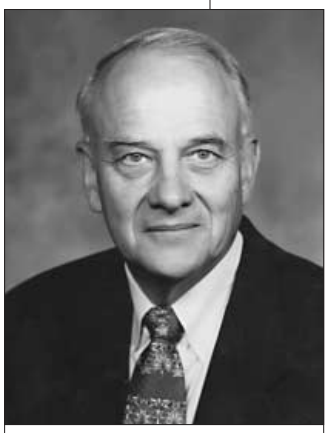
At Home and Abroad



Wm. A. Wulf
PRESIDENT

As you know, the National Academies are chartered by Congress with two missions: (1) to honor creative and innovative engineers and scientists who have impacted the world through their achievements; and (2) to serve the nation by providing authoritative, unbiased advice on technical issues. During 2002, the National Academy of Engineering (NAE) expanded its commitment to these missions "at home and abroad." Our work for the nation continued unabated, but it also became increasingly apparent that we must become active participants in the global community. Whether the issues are economic, environmental, or technological, they must be addressed in a global context; we cannot serve the nation well unless we also participate in the global arena.

At home, we have accomplished many things, but perhaps none more important than our work on counterterrorism in the wake of September 11. In June, in collaboration with the rest of the National Academies, we published *Making the Nation Safer*, which details the role of engineering and science in countering terrorism. We are also actively engaged in about eighty other activities related to counterterrorism. In addition to our traditional studies, we have established new ways to help the government in a timely fashion—including, for example, establishing links between officials responsible for countering specific threats and researchers with expertise in technologies that might apply to those threats.

Another important event was the creation of the Center for the Advancement of Scholarship on Engineering Education (CASEE)—a new and critical component of our initiative to strengthen the engineering workforce. CASEE is dedicated to fostering a climate of continuous improvement in engineering education through the promotion and support of rigorous research on all aspects of the engineering education system. CASEE will strive to make engineering education more relevant to the needs of employers, graduate schools, graduates, and society at large. This new endeavor will strengthen our commitment to engineering education in the years to come.

In January, the Technological Literacy Program released *Technically Speaking: Why All Americans Need to Know More About Technology*, which makes a case for a more technically literate public. Although our society is critically dependent on technology, there is a general lack of understanding of the nature of technology. Absent this understanding, the public is ill equipped to participate in meaningful public policy discussions, many of which hinge on technological issues. This report assesses the situation and recommends steps to remedy it.

In 2002, we also instituted the Reunion Program, which encourages spouses of deceased NAE members to remain in contact with us and to continue to participate in NAE activities. Over the years, our members and their spouses forge strong relationships through their involvement with NAE. We strongly believe NAE is more than just an organization; it's a family.

Abroad, the German-American Frontiers of Engineering (GAFOE) and the Japan-America Frontiers of Engineering (JAFOE) programs continued to promote international understanding among young engineers from the participating countries. The GAFOE Symposium focused on tools for biomedical engineering, new trends in urban engineering, and intelligent transportation systems. The JAFOE program was centered on synthesis and applications of nanomaterials, pervasive computing, and sustainable manufacturing. But beyond these technical discussions, both symposia provided a forum for building a network of future leaders in engineering that spans academic disciplines and industries, as well as national boundaries.

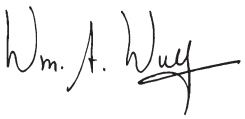
NAE, in conjunction with the National Academy of Sciences (NAS) and the Institute of Medicine (IOM), signed an agreement with the Russian Academy of Sciences to collaborate on technical meetings and workshops, seminars and conferences, and joint studies and research projects on a broad array of issues, such as arms control, the security and disposition of fissile materials, ethnic tensions in multiethnic countries, and the prevention of terrorism. This bilateral agreement recognizes the many contributions of international cooperation to the achievement of research, economic, and national security goals; the agreement is a testament to our commitment to promoting international collaboration and learning.

In 2002, we decided to regularize the practice of holding "regional" meetings with our foreign associates. We chose Germany and Japan for the first two meetings of what now will be a regular series. We expect this series will strengthen the bonds between NAE and our foreign associates and help us achieve our mission abroad.

In pursuit of our honorific mission, we elected 74 new members and seven foreign associates. We also honored two engineers who have made their mark on engineering history. The Charles Stark Draper Prize was awarded to Robert Langer of MIT for the development of alternate methods of drug delivery. The inaugural Bernard M. Gordon Prize for innovation in engineering and technology education was awarded to Eli Fromm of Drexel University for his development of the E4 Program and its extension into the Gateway Engineering Education Coalition. Both men typify the changing face of engineering that seeks to impact our world. We take pleasure in applauding their achievement.

In 2002, we also moved into our new home, the National Academies' Keck Building at 500 Fifth St. N.W. The NAE Program Office joined the program offices of the NRC and IOM in the new facility. We are excited about the possibilities this new facility allows for more efficient and effective collaboration, and we encourage everyone to visit the building (and to enjoy the impressive commissioned artwork in the lobby).

The 2002 Annual Report reflects our growth at home and abroad and our dedication to providing proactive, authoritative, unbiased advice in all technological matters that affect us today and will affect us well into the future. We recognize that our work is made possible by our extraordinary community of members, foreign associates, volunteers, and staff. This community gives NAE its drive to provide excellent engineering leadership in a rapidly changing world and the desire to carry on this legacy for years to come.



Wm. A. Wulf
NAE President

In Service to the Nation

Every day our nation is faced with questions that involve engineering and technology. How can we protect our critical physical and information infrastructures from terrorism? What role should citizens play in the deployment of new technologies and the regulatory processes that may govern their deployment? How can we meet the growing need for a diversified engineering workforce? How can we promote accurate and timely reporting about engineering and technology? As we strive to advance technologically in our global community, these questions are becoming more urgent and more complex.

The National Academy of Engineering is a unique organization of the world's most accomplished engineers dedicated to providing authoritative engineering information for the benefit of our nation and the world. NAE has more than 2,000 peer-elected members and foreign associates, approximately 47 percent from academia, 46 percent from industry, and 7 percent from nonprofit institutions and government organizations. Since 1964, NAE has provided independent, objective advice to the nation, not only by fulfilling government requests, but also by sponsoring activities in cooperation with foundations, private industry, and state and local governments. NAE members represent a wide array of fields, including bioengineering, computer science and engineering, and aerospace, civil, industrial, and mechanical engineering; they volunteer their time to serve on research and study committees, plan and execute symposia, and participate in government, university, industry research roundtable discussions. The NAE endeavors to promote communication and collaboration in the United States and abroad to solve technological problems that affect our society and our world, assess the technological needs of the nation and sponsor programs to meet those needs, advise Congress and the nation on matters pertinent to engineering, and recognize outstanding contributions by national and international members of the engineering community.

Mission Statement

To promote the technological welfare of the nation by marshalling the knowledge and insights of eminent members of the engineering profession.

PROGRAM REPORTS

Engineering Education

The Committee on Engineering Education (CEE), a standing committee of the National Academy of Engineering Office of the President, is composed of thought leaders and experts from the business, academic, and public sectors who have demonstrated their commitment to the advancement of engineering education. The current CEE chairperson is Stephen W. Director (NAE), Robert J. Vlasic Dean of Engineering at the University of Michigan. The mission of CEE is to provide guidance and advice to policy makers, administrators, employers, and other stakeholders in the engineering education enterprise to ensure quality, diversity, and quantity in engineering education. To carry out its charge, CEE

- identifies significant issues in engineering education and collects the information necessary for their detailed examination
- organizes studies and develops long-term strategies for the future of engineering education in the context of changing national and global circumstances, technologies, and societal and industrial needs
- recommends specific policies for implementing these strategies to appropriate national and state government agencies and academic administrations
- provides for an ongoing assessment of the impact of its activities on engineering education

In 2002, CEE sponsored three activities (described below), and reports for two of these activities will be released in 2003. This year will also mark the launch of Phase II of the Engineer of 2020 project. The committee has also identified additional activities to support the general program goals. A summary of future projects is available on the CEE web page <*www.nae.edu/education*>.

The Engineer of 2020

Phase I of the Engineer of 2020 project involved bringing together engineering education stakeholders, including current and emerging thought/opinion leaders, leaders from different disciplines, and selected individuals with different perspectives. The group was chaired by Wayne Clough (NAE), president of Georgia Institute of Technology. Phase I was sponsored by the National Science Foundation, NEC Foundation of America, Honeywell Foundation, SBC Foundation, and NAE.

The highlight of Phase I activities was a visioning and scenario-development workshop designed to generate far-reaching visions of engineering and society in 2020. The workshop featured video and live presentations by Philip M. Condit (NAE), CEO of Boeing; Bran Ferren, founder of Applied Minds, Inc.; and Shirley Ann Jackson (NAE), president of Rensselaer Polytechnic Institute. Peter Schwartz of Global Business Network was the workshop facilitator. The workshop discussions were

complemented by a survey of the 600 alumni of the NAE Frontiers of Engineering program and interviews with focus groups of engineering faculty and students.

The written reports will identify a range of challenges and opportunities that could define the nature of engineering in 2020 and include visions of engineers and the engineering profession in 2020. The project findings will support and encourage strategic planning for educators considering changes in the structure, content, and delivery of engineering education.

Engineering Education Retreat

In January 2002, NAE hosted a two-day retreat for 28 leaders from academia, industry, and government to discuss the establishment of a center for scholarship on engineering education at NAE and to provide guidance on structuring and carrying out the activities of the NAE center. The retreat attendees were especially concerned about the growing gap between the skills of typical U.S. engineering graduates and the skills required for high-tech industries, which include technical skills, creativity, an interdisciplinary perspective, teamwork, and a global orientation. The NAE center would develop a program to identify necessary changes, provide a rationale for making those changes, and promulgate those changes on a national scale. Following the retreat, a proposal was developed for the establishment of the Center for the Advancement of Scholarship on Engineering Education (CASEE). A brief summary of the workshop discussions is available at <*www.nae.edu/education*>.

Workshop on Information Technology-Based Educational Materials

Although electronically enabled techniques to support administrative, repository, and dissemination functions in engineering education have become common, information technology (IT)-enabled learning materials continue to be used sporadically in "islands of innovation." Many developers and users of IT-based materials claim they have many benefits, including increased efficiency, adaptability, and student engagement. However, the promise of IT-based education is far from a reality. Relatively isolated pockets of activity have impeded progress toward the creation of truly robust IT-based instructional materials.

To address these concerns, NAE hosted the Workshop on Information Technology-Based Educational Materials in Engineering Education in November 2002. The workshop brought together 30 experts in education and technology to develop a basis for a national strategy to support the development and use of IT-based educational materials in engineering and related disciplines. Workshop participants, drawn from academia and government, had expertise in computer sciences, engineering, social sciences, and network administration. The group identified the critical elements of a national strategy and proposed some initial activities to maintain the momentum of the initial meeting. A report summarizing the workshop discussions and findings will be available in summer 2003 at <*www.nae.edu/education*>. The workshop was sponsored by the Kavli Foundation & Institute and the National Academy of Engineering Fund.

Center for the Advancement of Scholarship on Engineering Education

The Center for the Advancement of Scholarship on Engineering Education (CASEE) was established in October 2002 to promote more efficient and effective engineering education. The goal of the new center is to make engineering education more relevant to the needs of employers, graduate schools, graduates themselves, and society at large. CASEE's goals will be achieved by the collaborative efforts of representatives of diverse elements in the engineering community. NAE hopes that its prestige and expertise will encourage engineering faculty to embrace opportunities for significant improvements in engineering education.

CASEE's initial focus is on extending the research base on teaching and learning in engineering disciplines and translating research results into practice in classrooms, internship sites, and workplaces. The primary vectors for knowledge generation and transition will be senior and postdoctoral fellows. Senior fellows will be recognized opinion leaders, drawn from the ranks of industry, government, and academia, who can catalyze advancements nationally, as well as in their own organizations. Postdoctoral fellows will be recent doctoral recipients in engineering disciplines who wish to receive specialized training in educational scholarship under the mentorship of a senior fellow or other campus-based engineering educator. Postdoctoral fellows will take the lead in improving the effectiveness of the next generation of engineering faculty.

CASEE will also develop a network of research community affiliates to leverage the research results. Research community affiliates will be campus-based education research centers that are pursuing projects to improve the quality of engineering education. Implementation network affiliates will be academic and industrial entities willing to serve as test beds for experiments and pilot projects in innovative approaches to engineering education.

CASEE's reach will extend beyond fellows and affiliates to the rank and file of the almost 350 colleges of engineering. The center will host or endorse national and regional workshops to disseminate research findings. Information sharing will also be facilitated via a monthly newsletter offering in-depth case studies of proven innovations and summaries of relevant research findings. We will also sponsor an electronic portal linking existing journals focused on education research in engineering and science disciplines. Additional information is available on the CASEE website at <*www.nae.edu/CASEE*>.

Technological Literacy

The NAE Technological Literacy Program is investigating how Americans can become better prepared to navigate our highly technology-dependent society. What do citizens—adults and children—need to understand about technology? What

role should citizens play in deciding which technologies are developed and for what purposes? What kinds of changes in formal and informal education and in public policies would equip citizens to participate more meaningfully in this process?

The program began in 1997 with an NAE-funded exploratory workshop. The first major activity was a joint effort between NAE and the National Research Council (NRC) to advise an outside organization, the International Technology Education Association, during the development of content standards for K-12 technology education. In 1999, with funding from the National Science Foundation (NSF) and Battelle Memorial Institute, NAE and the NRC Center for Education launched an in-depth study of technological literacy overseen by the Committee on Technological Literacy.

In late 2001, the committee finished a consensus report, *Technically Speaking: Why All Americans Need to Know More About Technology*. The report was publicly released at a national symposium held at the National Academies Building in January 2002. William Hansen, deputy secretary of the U.S. Department of Education, gave the keynote address. Other speakers at the event, which attracted some 200 people from around the country, included Carl Kohrt, CEO of Battelle, Alan Friedman, director of the New York Hall of Science, and Rep. Rush Holt (D-N.J.).

Also at the symposium, the committee launched a website as an online companion to the report <*www.nae.edu/techlit*>. The site includes a web-friendly version of the document, an interactive quiz on technological literacy, and an extensive list of online and traditional resources for teachers, parents, policy makers, and others interested in learning more about technology and technological literacy. Throughout 2002, committee members and staff took part in a variety of outreach activities, including briefing staff on Capitol Hill and speaking at professional meetings to disseminate the key ideas of the report.

In spring 2002, NAE received new funding from NSF for a follow-on project to develop approaches for assessing technological literacy in three distinct populations: students, teachers, and the public at large. The lack of reliable information is a major impediment to determining the effectiveness of interventions intended to boost technological understanding. Elsa M. Garmire (NAE), Dartmouth College, chairs the 16-member Committee on Assessing Technological Literacy. The committee's first meeting was held in early 2003. The project is being carried out in collaboration with the NRC Board on Testing and Assessment.

Public Understanding of Engineering

The Public Understanding of Engineering Program (PUE) has two primary goals: (1) to help the public understand the relationship between engineering and society and appreciate the importance of engineering to their quality of life; and (2) to increase the amount and improve the accuracy of information about engineering in the mass media.

Committee on Public Awareness of Engineering

At the end of the year, NAE published *Raising Public Awareness of Engineering*, a report based on a national survey of organizations involved in activities to improve public understanding of engineering (PUE). Stephen D. Bechtel, Jr., (NAE) chaired the committee that oversaw the project. The survey inventoried PUE programs by some 240 professional societies, universities, foundations, science museums, television producers, industries, and other organizations. Some of the findings are listed below:

- Respondent organizations spend an estimated $400 million annually on PUE activities, but survey data suggest that they have had little impact on a national scale.

- Most PUE programs are meant to inspire young people to pursue careers in engineering by conveying messages indicating that math and science are fun.

- Most PUE efforts are small in scale and limited in duration and thus lack critical mass.

- Although the sponsors of most PUE efforts feel they are successful, few collect data on the long-term outcomes of their programs; thus it is very difficult to identify best practices.

The committee recommended that a series of steps be taken to leverage the resources already being invested. Organizations engaged in PUE should be encouraged to continue their efforts, and, at the same time, the engineering community should consider launching a nationally coordinated public relations and public affairs initiative. The committee also suggested that a blue-ribbon council be established—comprised of representatives from the engineering, education, and policy communities—to develop an action plan for improving education in math, science, engineering, and technology. Based on these recommendations and other input, NAE is planning follow-on work to the PUE survey in 2003.

Media Relations

NAE developed a curriculum for a series of regional workshops/seminars on engineering to help reporters cover developments in engineering more effectively, as well as to incorporate engineering angles into their coverage of breaking news. We hope that this added dimension will add depth and originality to these stories. NAE brought together seven engineers and six journalists, including representatives of the Foundation for American Communications (FACS), to develop the workshop format and content. Each "backgrounder" workshop/seminar will brief journalists on general aspects of engineering, including risk assessment, and will explore the engineering aspects of a current news topic. NAE will conduct several of these sessions in 2003 in cooperation with FACS.

One of the benefits of these workshop/seminars is the establishment of contacts with journalists. In 2002, NAE continued to cultivate these relationships by working closely with reporters to produce coverage of NAE events, as well as to assist them in covering breaking news stories. The number of times NAE was mentioned in the news increased by more than 71 percent in 2002 compared with the previous year (see Figures 1 and 2). By working closely with national and large local media outlets, NAE was given more coverage in 2002 in markets with audiences of more than 500,000. Through print, broadcast, and electronic media, the number of potential human "impressions" increased by more than 24.5 million—up to 33.2 million.

NAE is mobilizing its resources to provide accurate information quickly and efficiently to the media, and thus to the public—particularly in the event of a terrorist incident. To prepare for a time of crisis, an appeal was made to NAE members to share their expertise with the media. The names and information pertaining to volunteers who responded are being added to a database of contacts we can access quickly should the need arise.

NAE has also begun planning a first-of-its-kind war game scenario exercise that will focus on the effectiveness of the media in informing the public about potentially lifesaving scientific and technological matters in the event of a major terrorist crisis. As 2002 came to a close, efforts were still being made to secure funding for this project.

Great Achievements in Engineering

In 2002, NAE began production on *Greatest Engineering Achievements of the 20th Century*, a large-scale, graphically rich coffee table volume that will have 20 chapters, one for each of the 20 greatest achievements identified by an NAE committee. Each achievement was identified by its significance in terms of its impact on the quality of life during the 20th century. The chapters will all include: text about the history and impact of that achievement on quality of life; photographs; a detailed graphic timeline; and an original "how things work" illustration. Each chapter will also include a "perspectives" piece with either personal observations or recollections by an NAE member or anecdotes about that achievement. The book will be published in time for the October 2003 NAE Annual Meeting.

The NAE members who will be writing "perspectives" include William A. Anders, Stephen D. Bechtel, Jr., E. Linn Draper, Jr., George M.C. Fisher, Samuel C. Florman, William H. Gates III, Mary L. Good, Wilson Greatbatch, Shirley A. Jackson, Donald L. Johnson, Robert E. Kahn, Kent Kresa, Robert W. Lucky, Gordon E. Moore, Donald E. Petersen, Lee R. Raymond, Donald E. Ross, Ian M. Ross, Roland W. Schmitt, and Charles H. Townes. Neil A. Armstrong (NAE) will write the foreword, and Sir Arthur Clarke (NAE) will write the afterword. For additional information, please visit our website <*www.nae.edu*>.

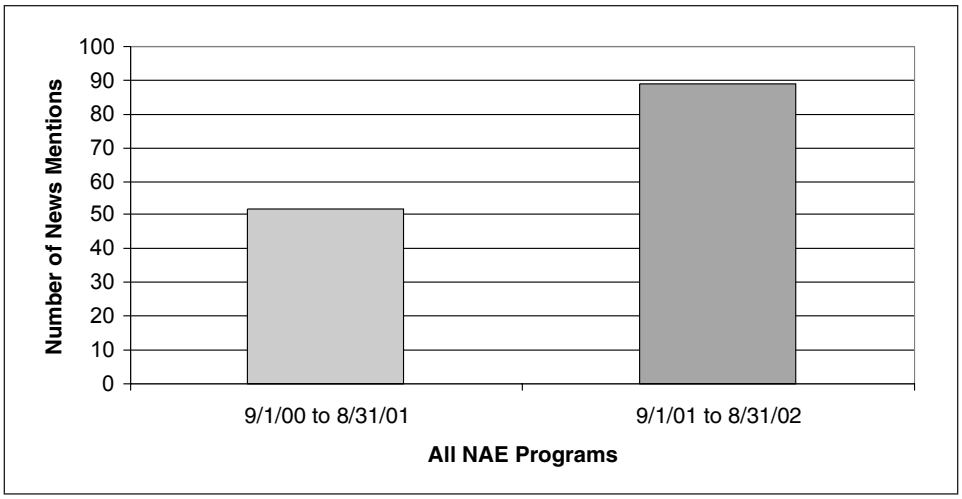


FIGURE 1 Number of times NAE programs were mentioned in news media, in the year preceding and following the hiring of an NAE senior media/public relations officer.

	9/1/00 to 8/31/01	9/1/01 to 8/31/02	Percentage Change
Total number of news mentions	52	89	71%
Mentions in outlets with a circulation of >500,000	3	17	467%
Potential impressions	8,623,979	33,195,158	285%

FIGURE 2 News mentions (by outlet size and potential impressions), in the year preceding and following the hiring of an NAE senior media/public relations officer.

Diversity in the Engineering Workforce

The goal of the Committee on Diversity in the Engineering Workforce (CDEW) is to ensure the health, vitality, and competitiveness of the national domestic engineering workforce by increasing the participation of women and underrepresented minorities. Established in late 1999 to be the primary vehicle through which NAE attempts to meet this goal, the committee brings together influential stakeholders to share knowledge, identify areas of need, design initiatives to leverage the strengths of NAE, and initiate actions to address those needs.

In July 2002, NAE published *Diversity in Engineering: Managing the Workforce of the Future*, the proceedings of a workshop held in late 2001. The report contains 15 presentations and highlights key components of successful diversity-management programs. NAE President Wm. A. Wulf, Nicholas Donofrio (NAE), vice-president of IBM; and James Padilla (NAE), vice-president of Ford Motor Company, presented the business case for diversity, and representatives of leading engineering employers discussed how they have improved the recruitment, retention, and advancement of women and underrepresented minorities in engineering

careers. Other speakers focused on mentoring, globalization, affirmative action backlash, and dealing with lawsuits. Summaries of the workshop discussions are also included in the report.

The CDEW met three times in 2002 and added new committee members in the summer, including chair Karl Pister (NAE), emeritus professor of civil and environmental engineering, University of California at Berkeley. In the fall of 2002, NAE engaged principals from two Boston-based consulting firms, Creative Realities, Inc., and Telos Partners, to help the committee identify, design, and implement novel approaches to advancing diversity in the engineering workforce that leverage the unique strengths of the National Academies over the near and long terms. Among the issues the committee expects to pursue in 2003 are the role of community colleges in advancing engineering diversity and strategies for improving the retention of women and underrepresented minorities in undergraduate engineering programs.

The *EngineerGirl!* website <*www.engineergirl.org*> remains an important component of the diversity program. The purpose of this site is to attract young girls to engineering in their middle school years when they are making important educational decisions. The site offers "fun facts," descriptions of different types of engineering careers, and information on what it takes to become an engineer. The site recently hosted an essay contest that attracted nearly 300 entries (see page 22). The "Gallery of Women Engineers" includes biographical features on women engineers from a variety of backgrounds and allows website visitors to interact with them via e-mail (moderated through NAE staff).

A recent grant from the Northrop Grumman Litton Foundation provided funding for a graduate-level intern to continue development of *EngineerGirl!* Another website, *Celebration of Women in Engineering* <*www.nae.edu/cwe*>, is a resource for parents and educators.

Frontiers of Engineering

Frontiers of Engineering is a symposium series that brings together a select group of emerging engineering leaders from industry, academia, and government laboratories to discuss pioneering technical work and leading-edge research in various engineering fields and industry sectors. The goal of the symposia is to introduce outstanding engineers (ages 30 to 45) to each other and through this interaction to facilitate collaboration in engineering research, the transfer of new techniques and approaches across fields, and the establishment of contacts among the next generation of engineering leaders. The U.S. Frontiers of Engineering (FOE) Symposium, initiated in 1995, annually brings together approximately 100 engineers from across the country. Two bilateral programs—the German-American Frontiers of Engineering (GAFOE), initiated in 1998, and the Japan-America Frontiers of Engineering (JAFOE) symposia, initiated in 2000—bring together approximately

30 engineers from each country in annual meetings. NAE's partner in the GAFOE program is the Alexander von Humboldt Foundation; the Japan Science and Technology Corporation and the Engineering Academy of Japan are partners in the JAFOE symposia.

Each symposium covers topics in four areas. Examples from past symposia include: visualization for design and display; nanotechnology; advanced materials; robotics; simulation in manufacturing; energy and the environment; optics; intelligent transportation systems; MEMS; design research; and bioengineering. An organizing committee comprised of engineers in the same age group selects the topics and speakers for each of the four sessions. Following each talk, substantial time is allowed for discussion. In addition, breakout sessions, poster sessions, and other events offer ample opportunities for informal exchanges among the participants. An alumni program encourages continuing contacts among the participants.

In 2002, four symposia were held instead of the usual three. The 2001 FOE meeting, which was postponed because of the events of September 11, was held on March 1–3; about 80 percent of the originally scheduled participants attended. The topics for the symposium were: flight at the leading edge; civil systems; wireless communications; and technology and the human body. A second U.S. FOE meeting (the regularly scheduled 2002 symposium) was held September 19–21. The topics were: chemical and molecular engineering; human factors engineering; nuclear energy; and quantum information technology. Michael L. Corradini (NAE) of the University of Wisconsin chaired both symposia. On May 16–18, NAE hosted the GAFOE meeting in Washington, D.C., where participants discussed developments in sustainable energy, tools for biomedical engineering, urban engineering, and intelligent transportation systems. Sangtae Kim (NAE) of Eli Lilly Company chaired the symposium with Albert Weckenmann of the University of Erlangen-Nürnberg. The 2002 JAFOE symposium was held in Tokyo on October 24–26. Bioengineering, synthesis and applications of nanomaterials, sustainable manufacturing, and pervasive computing were the topics. Robert H. Wagoner (NAE) of Ohio State University cochaired the symposium with Hideaki Matsubara of the Japan Fine Ceramics Center.

Frontiers of Engineering: Reports on Leading Edge Engineering from the March 2002 NAE Symposium on Frontiers of Engineering was published in 2002. The volume from the September U.S. FOE meeting was issued in February 2003. The Frontiers alumni newsletter—a mechanism for alumni to keep in touch and share information about their work and current status—was published in June and December. Through a grant from IBM, six engineering graduate students were selected to attend the U.S. FOE meeting in September. A searchable database with research interests and engineering fields of all participants was added to the Frontiers website <*www.nae.edu/frontiers*>, which also includes a directory of Frontiers alumni. Regional dinners for Frontiers alumni were organized in Minneapolis, Detroit, Columbus, and Washington, D.C. Six of the papers from the U.S. FOE meetings were published in the winter issue of *The Bridge*. Finally, grants from the AvHumboldt Foundation provided support for ongoing

collaboration between participants at the GAFOE meeting. The Frontiers of Engineering program is supported by numerous government, corporate, and individual donors.

A related, but independent NAE activity, is the Lillian M. Gilbreth Lectureships for Young Engineers. Established in 2001, the Gilbreth Lectureships recognize young engineers by selecting individuals from among outstanding Frontiers speakers to give talks at the NAE Annual Meeting in Washington, D.C., and National Meeting in Irvine, California. In 2002, four Gilbreth lectures were given at the National Meeting in February, and two were presented at the Annual Meeting in October. Funding for the lectureship is derived from income from an endowment to encourage young engineers. More information is available on the Frontiers of Engineering website at <*www.nae.edu/frontiers*>.

2002 Lillian M. Gilbreth Lectureship Recipients Ms. Cynthia J. Riley, Technology Manager - Biomass Program, U.S. Department of Energy presented "Biomass Energy," and Dr. Andrea Goldsmith, Professor, Stanford University presented "Design Challenges for Future Wireless Systems."

Engineering and the Health Care System

Health care, one of the largest service industries in the United States, accounts for 14 percent of the gross domestic product. As a result, many Americans enjoy access to unparalleled advancements in medical science and technology. But the health care system does not consistently deliver high-quality care. Access to care and the quality of care vary considerably, errors are widespread, and few resources have been devoted to optimizing system operations or measuring the quality of the care delivered.

NAE and the Institute of Medicine (IOM) have undertaken a study to identify opportunities for engineering applications and research avenues to improve health care delivery through system-wide improvements. The 14-month study, supported by the National Science Foundation, the Robert Wood Johnson Foundation, and the National Institutes of Health, is led by cochairs W. Dale Compton (NAE) of Purdue University and Jerome Grossman (IOM) of Harvard University. The study has three primary goals:

1. Identify and describe engineering applications with the potential for significantly improving health care delivery in the short and long term.

2. Identify factors that facilitate or inhibit the deployment and diffusion of these applications.

3. Identify engineering and related research priorities that would hasten the development of a highly effective health care system.

As part of this project, NAE and IOM will host two multidisciplinary, interactive workshops in 2003. The first will focus on the use of information technology and operations research in health care. The second will explore opportunities in areas such as biosensors, remote monitoring, modeling, cognitive engineering, human factors engineering, computer-supported collaborations, supply chain management, and financial engineering. The NAE/IOM study will result in a consensus report with recommendations for action. Additional information is available at <*www.nae.edu/healthcare*>.

Engineering and the Environment

In April 2002, the Engineering and the Environment program sponsored Complements to Kyoto, a symposium on ongoing research to sequester carbon to control global warming, which is thought to be at least partly the result of the increased concentration of carbon dioxide in the atmosphere. Approximately 150 people attended. Twenty presentations were given by academics, government representatives, and private sector representatives. Discussion topics ranged from global warming and rising sea levels to shooting reflective material into the atmosphere to reflect incoming solar radiation (insolation). Most of the talks focused on storage in geologic formations, carbon uptake in biomass, and ocean sequestration. The key message, delivered by Robert H. Socolow, Department of Mechanical and Aerospace Engineering, Princeton University, was that because this problem will be with us for many decades and the concentration of atmospheric carbon dioxide will continue to increase over time, we must find ways to deal with these issues. A collection of these presentations will be published in the summer of 2003.

In spring 2002, *Engineering and Environmental Challenges*, proceedings of a symposium on earth systems engineering, was published and distributed. This volume provides a broad overview of environmental and social issues with global reach. The symposium was chaired by John Gibbons (NAE). The topics covered included: global warming; genetically modified crops; biotechnology; and urbanization. Each paper was written by a well known specialist, but oriented toward general readers.

In summer 2002, NAE and the National Research Council's (NRC's) Board on Energy and Environmental Systems entered into discussions with the U.S. Department of Energy about a major consensus study of alternatives and strategies for future hydrogen production and use. A panel led by Michael P. Ramage (NAE) has

already held two meetings to explore issues that must be resolved for the United States to move toward a hydrogen economy, whereby all transportation and some stationary power generation will be fueled by clean-burning hydrogen. The panel will review potential sources of hydrogen (e.g., natural gas, liquid fuels, coal, electrolysis, etc.), conversion processes, storage and transport, costs, and applications in fuel-cell powered vehicles. Major issues include: the significant amount of energy required to make hydrogen; and, because of hydrogen's low density, the significant amount of energy required to compress it so that enough can be stored onboard a vehicle with a range of 300 miles—the minimum driving distance a vehicle should travel before it requires refueling. Assuming that hydrogen can be stored onboard a vehicle, the efficiency of fuel cells becomes very attractive. The key questions are: cost; net energy production and carbon penalty; and safety.

In fall 2002, Henry J. Hatch (NAE), retired chief of the U.S. Army Corps of Engineers, in cooperation with NAE President Wm. A. Wulf, brought together representatives of major engineering societies to discuss issues that were raised at the World Summit on Sustainable Development (WSSD) in Johannesburg, South Africa, and the possibility that the engineering community could provide technical advice to policy makers in developing countries. In the two years since the WSSD met, it has become clear that the engineering community can no longer remain a passive observer as globalization increases and international tensions mount. Participants in the meeting agreed that the community should adopt a more proactive role by providing advice on matters of technology, project management, and the alleviation of poverty in developing countries.

Implementing the recommendations of the group remains a challenge—especially in terms of securing funds to begin work overseas in conjunction with sister engineering academies. Engineers cannot address all of the problems, so it will be important that we limit our activities to areas in which we can make a difference working face-to-face with local engineers and experts. A prospectus for this project has been prepared and is being reviewed by several federal agencies.

Planning is under way, in conjunction with the Policy and Global Affairs Division of the NRC, to hold a workshop on energy and air pollution in China, a key issue for China's urban residents. The workshop will take place in 2003 in Beijing. Planning is also proceeding for a workshop on computer modeling and uncertainty. The workshop will focus on how computer-modeling results are communicated to decision makers. The idea is to improve the understanding and interpretation of model results by decision makers who must rely on them. Additional information is available on our website <*www.nae.edu*>.

Personal Cars and China

The increased use of personal cars in China will bring about significant changes in lifestyle, manufacturing capability, congestion, pollution, energy requirements,

public health and safety, personal autonomy, and overall expectations. Some of these changes could have global as well as local impacts. NAE and the Chinese Academy of Engineering (CAE) conducted a joint study, chaired by W. Dale Compton (NAE) and Gou Kong Hui (CAE). A final report, *Personal Cars and China*, was published in early 2003 and is available through the National Academies Press at <*www.nap.edu*>.

The major conclusions of the study were: the number of private automobiles in China will grow rapidly; the auto manufacturing base will have to expand to keep pace (as well as produce for export); China should initially concentrate on smaller vehicles (1.3 liters) so that individuals can afford them (less than $10,000 each); China should monitor similar progress and impacts in other countries (e.g., India, Malaysia, etc.); and China must anticipate and address problems, such as congestion, accidents, and shortages of foreign exchange, that might result from importing large quantities of petroleum products. The study also concluded that it would be helpful for China to monitor developments in the West in new automotive technology, fuels, and automation.

The committee made a number of recommendations that the CAE could take to government, industry, and municipalities. These included standards for safety, emissions, fuel efficiency, fuel quality, vehicle performance, etc. The committee also commented on the role of government in supporting the automobile industry's research and development agenda, the formation of entirely new support industries with an emphasis on small companies, and business arrangements with Western car companies so that China could benefit from exporting its vehicles. The committee also suggested that China not neglect public transportation and public infrastructure, such as highways and traffic control systems.

Counterterrorism

In July 2001, NAE President Wm. A. Wulf initiated a discussion of NAE's possible contribution to counterterrorism efforts, especially in the areas of (1) protecting the nation's vital infrastructures, (2) proposing a methodology to assist policy makers in prioritizing terrorist threats, and (3) developing mitigation strategies. Raphael Perl, an expert from the Congressional Research Service, served as an NAE Fellow for one year to explore the possibilities. A proposal was developed for a project to (1) develop a methodology to identify, assess, and prioritize vulnerabilities of the nation's vital infrastructures to acts of terrorism and (2) outline strategies (technologies and policies) to mitigate those vulnerabilities in ways that are consistent with a free, open, and prosperous society. The project took on new urgency after the events of September 11, 2001.

The Committee on Combating Terrorism, Prioritizing Vulnerabilities, and Developing Mitigation Strategies was formed to investigate the issues outlined in the proposal. The members of this interdisciplinary committee were drawn from

many fields: risk assessment, systems engineering, human factors engineering, counterterrorism, intelligence, national security, law enforcement, emergency management/medical response, civil liberties, sociology/psychology, and public policy. The committee was chaired by B. John Garrick (NAE) of Garrick Consulting. The committee's report, *Assessing Terrorist Risks: Making Good Decisions*, will highlight quantitative risk assessment methodologies that can be used to assess infrastructure vulnerabilities and allocate resources for mitigating and preventing terrorist attacks.

On November 7, 2002, Wm. A. Wulf, who was involved in the drafting of the Cyber Security Research and Development Act (P.L. 107-305), which became law in November 2002, participated in the Jane's Information Group Conference on Transnational Critical Infrastructure Protection Policies to Counter Emerging and Asymmetric Threats. President Wulf addressed the conference on the topic of cyberterrorist threats and mitigation strategies. Randy Atkins, NAE media relations officer, also addressed the group; his topic was the media as a critical infrastructure. Mr. Atkins delivered a keynote address on the same subject at a conference on Strategic Indirect Warfare, sponsored by Sandia National Laboratories in Albuquerque, New Mexico, on December 4, 2002.

Critical Information Infrastructure Protection and the Law

In 2001, NAE asked the Computer Science and Telecommunications Board (CSTB) of the National Research Council to organize a symposium and follow-on study to explore the legal issues associated with protecting the critical information infrastructure. CSTB convened the Committee on Critical Information Infrastructure Protection and the Law, chaired by Stewart D. Personick (NAE), to undertake the project. Unlike previous CSTB studies, which had addressed the technical, procedural, and policy aspects of information security and crisis management, this project was focused on the law as a barrier to, or a facilitator of, progress.

A symposium on October 22–23, 2001, featured 24 presentations from a wide range of perspectives on legal barriers that have complicated policy making and the development of a legal regime to protect the critical information infrastructure. As the committee was drafting its consensus report, government responses to September 11, including the passage of new laws and the initiation of new administrative procedures under the rubric of homeland security, continued throughout 2002, greatly complicating the task of describing contemporary conditions and prospects. The committee realized that the evolving situation would make any report with specific, detailed recommendations obsolete before it was published. Therefore, the committee decided to highlight enduring observations focused on two issues that could potentially facilitate the protection of critical information infrastructure: (1) information sharing and (2) the liability of unsecured systems and networks. The committee also attempted to summarize the debate surrounding the Freedom of Information Act (FOIA) and antitrust and liability laws. The

report, which integrates very diverse perspectives, provides a road map and stimulus for future, more focused inquiries. The report can be ordered online from the National Academies Press <*www.nap.edu/catalog/10685.html*>.

Accident Precursors

Many accidents result from a series of events—an accident chain—events that occur in just the right, or more correctly, just the wrong way. These precursor events in themselves may not result in damage or loss, but accidents are contingent upon them. Once precursors have been identified and understood, industries can mitigate against accidents, catastrophes, and other extreme events. To further this understanding, industries have developed a number of risk-mitigation techniques, analytical techniques, and management approaches to detecting, modeling, and acting on precursor signals. NAE is undertaking a project to bring together engineers and risk experts from industry and the scientific community to analyze these methods and share ideas.

Based on a planning meeting in February 2002, a proposal was developed for a cross-industry workshop to generate a framework for studying precursors and documenting existing industry approaches. The project is being funded by the National Science Foundation, the Public Entity Risk Institute, and the National Academy of Engineering Fund. Howard Kunreuther (Wharton Risk Center, University of Pennsylvania) and Vicki Bier (College of Engineering, University of Wisconsin) will cochair the project. James Phimister, second-year NAE J. Herbert Hollomon Fellow, formerly with the Wharton Risk Center, is directing the project.

A workshop planned for July 2003 will have two goals: (1) to review and evaluate the automated and voluntary reporting systems used to communicate risks based on precursor information and (2) to identify research opportunities and directions in the field of precursors. A subsequent workshop report will provide industry practitioners, researchers in risk management and safety science, policy makers, and public-sector agencies with guidance on risk mitigation based on precursors.

User-Authorized Handgun Technology

Although most crimes are not committed with guns, the majority of gun crimes are committed with handguns. Persons other than the owners or authorized users often fire handguns, and criminals frequently use stolen handguns to commit burglaries and robberies. Handguns are also the weapons of choice for people who decide to kill themselves, and in many cases the weapon is obtained from a family member or friend. A police officer's handgun may be taken and fired by a suspect during a struggle or used later to commit a crime. Tragically, young children sometimes find and accidentally discharge handguns, injuring or killing themselves or others.

The primary method of preventing handgun misuse has been to encourage gun owners to store and handle handguns properly. In recent years, technology has offered a potential alternative solution—the user-authorized handgun—a gun that "recognizes" the owner(s) or other authorized user(s) and fires only when those individual(s), and no one else, uses the gun. A variety of sensor, electronic, mechanical, and other technologies might be used in the design of such a weapon.

In 2002, NAE convened a one-day workshop to explore the technical, social, and product-liability issues surrounding user-authorized handguns. The event attracted nearly 60 participants representing engineering, gun manufacturers, gun-user groups, law enforcement, product-liability law, and health and social sciences. NAE Executive Officer Lance Davis (NAE) chaired the five-person workshop steering committee. T. Dixon Dudderar (NAE), Bell Laboratories (retired), also served on the panel. An edited transcript of the workshop presentations will be available in the summer of 2003 on the National Academies Press website <*www.nap.edu*>.

The Packard Foundation has provided a grant to NAE to conduct a more in-depth and focused study of the technology options for user-authorized handguns. The next phase of the project will begin in the summer of 2003.

PROGRAM SPOTLIGHTS

EngineerGirl!

The EngineerGirl! website <*www.engineergirl.org*> made its debut in early 2001. Designed with the help of a focus group of teenage girls from across the country, the site is intended to bring the benefits and satisfactions of careers in engineering to the attention of middle school and high school girls. The home page offers "Fun Facts," "Great Achievements," "Cool Links," and other interesting features. There is also an interactive page, "Gallery of Women Engineers," that includes biographical sketches and information about the careers of female engineers in various disciplines. *EngineerGirl!* is the sister site to the *Celebration of Women in Engineering* website.

In 2002, Northrop Grumman Litton Foundation provided a grant to support an intern to work on the *EngineerGirl!* website. Emma Seiler, a graduate student at Mississippi State University, improved and updated the information, adding links to other sites, and helped administer an essay contest, "Engineers: Changing the World." The contest, which was open to boys and girls, elicited 270 essays from students all over the United States. The topics were: great achievements in engineering, history's great engineers, and the future of engineering. Eighteen winners were chosen (first through third place in grades 6-8 and 9-12). First place winners were awarded $200, second place winners received $100, and third place winners received $50. The winning essays are posted on the *EngineerGirl!* website.

Meet the Winners

Grades 9-12

Somala Muhammed

First Place:
Engineering's Great Achievements
Somala Muhammed
Eisenhower High School
Houston, Texas
Essay: The Great Pyramid of Giza

"I entered this contest, because I felt strongly about the engineering accomplishments of the Egyptians and wanted to inform others of how they have impacted future generations. Science and math have always been strong areas of interest to me, and I have continuously pondered studying engineering."

Second Place:
Engineering's Great Achievements
Amy Pistone
Bear River High School
Nevada City, California
Essay: Radial Tires

Third Place:
Engineering's Great Achievements
Robert Hill
Loma Learning Center
Lakeland, Florida
Essay: Wall of Hadrian

Jennifer Gee

First Place:
History's Great Engineers
Jennifer Gee
Frederick High School
Frederick, Maryland
Essay: Grace Murray Hopper

"I've always been interested in engineering and computer science, so I thought this would be a good opportunity to gain insight on the historical aspect and heroes of the subject . . . this research helped strengthen my desire in considering a career in engineering. It was good to research women engineers who have done great things in the past and can serve as role models for girls today."

Second Place:
History's Great Engineers
Michael Regner
Madison West High School
Madison, Wisconsin
Essay: Nikola Tesla

Third Place:
History's Great Engineers
James Welton
Madison West High School
Madison, Wisconsin
Essay: Jack St. Clair Kilby

Sonia Tikoo

First Place:
The Future of Engineering
Sonia Tikoo
Central Senior High School
Cape Girardeau, Missouri
Essay: Nanotechnology: A Mission into the Microscopic

"I've always had an interest in engineering and I love to write. This contest seemed like a good opportunity to pursue both interests. I've always been interested in an engineering career, and it was this interest that brought me to the EngineerGirl! website…I am still considering an engineering career."

Second Place:
The Future of Engineering
Patricia Orozco
New Milford, New Jersey
Essay: Asthma Machine

Third Place:
The Future of Engineering
Rider Clauss
Madison West High School
Madison, Wisconsin
Essay: DNA Computers

Grades 6-8

Maureen McCoy

First Place:
Engineering's Great Achievements
Maureen McCoy
Spencer County Middle School
Fisherville, Kentucky
Essay: The Steam Engine

"I was very surprised when I received the email that I had won in my category. I was very excited and pleased, because I had never expected to win. I would probably not consider a career in engineering. Engineering is an interesting subject, but I cannot see myself making it a career. I am interested in other subjects more and would prefer pursuing a career in those."

Second Place:
Engineering's Great Achievements
Aighanym Barzhaksynova
Tashkent International School
Washington, D.C.
Essay: The Yurt

Third Place:
Engineering's Great Achievements
Jason Todd
Home school
Newman, Georgia
Essay: The Great Pyramid

First Place:
History's Great Engineers
Sam Whitesell
Mayfield Middle School
Mayfield Heights, Ohio
Essay: Ole Kirk Christiansen
(Photo not available)

Second Place:
History's Great Engineers
James Crowley
Doherty Memorial High School
(Grade 7&8)
Worcester, Massachusetts
Essay: Thomas Edison

Third Place:
History's Great Engineers
Lauren Jones
Spencer County Middle School
Taylorsville, Kentucky
Essay: Ellen Ochoa


Elizabeth Ford

First Place:
The Future of Engineering
Elizabeth R. Ford
University Laboratory High School
Champaign, Illinois
Essay: The Hydrogen-Powered Vehicle

"My mom is a part of the Society of Women Engineers…and encouraged me to enter. I was very excited, especially because I won first place! I think my peers respected me a little more, but my teachers especially began to hold me in higher regard."

Second Place:
The Future of Engineering
Palmer Leff
Marlboro Middle School
Morganville, New Jersey
Essay: Space Elevator

Third Place:
The Future of Engineering
Matt Johnson
Doherty Memorial High School
(Grade 7&8)
Worcester, Massachusetts
Essay: Nanotechnology

Honorable Mention
Elizabeth Ford
Doherty Memorial High School
(Grade 7&8)
Worcester, Massachusetts
Essay: Leonardo da Vinci: A Great Engineer

Taylor Flynn
Our Lady of Victory
Floral Park, New York
Essay: When the Worst of Humanity Called, an Engineer with the Best of Humanity Answered

Frontiers of Engineering

Frontiers of Engineering is an annual three-day meeting that brings together 100 of the nation's outstanding young engineers (ages 30–45) from industry, academia, and government to discuss pioneering technical work and leading-edge research in various engineering fields and industry sectors. Participation is by invitation following a competitive nomination and selection process.

The program was initiated to provide an opportunity for top-notch engineers, early in their careers, to learn about cutting-edge developments in fields other than their own, thereby facilitating interdisciplinary collaboration and the transfer of new approaches and techniques. More information on the Frontiers of Engineering program can be found on page 14.

NAE asked several Frontiers of Engineering (FOE) alumni to describe how their participation in FOE meetings has influenced their research. Many have forged collaborative working relationships with engineers in other fields of interest, and all have found the information useful in their research.

Frontiers of Engineering Program Alumni

2002 FOE Symposium Speaker
Melody M. Moore, Ph.D
Director, GSU BrainLab
Computer Information Systems Department
Georgia State University

"One of the major benefits of the Frontiers of Engineering Program for me is that I was able to talk to Dr. Andrew Hunt, materials engineer and CEO of Microcoating Technologies, regarding possible applications of nanotechnology to our brain computer interface research. We have already written two National Institutes of Health proposals. I've also received several invitations to speak, and I just returned from a very productive trip to Yale University's Department of Biomedical Engineering."

Melody Moore's current research centers on assistive technology for people with very severe physical disabilities. She is experimenting with biometric devices, including direct brain interfaces, which would enable a person to control a device solely with brain signals.

2002 FOE Symposium Speaker
John F. Kotek
Manager, Argonne National Laboratory-West
U.S. Department of Energy

"The real value of the Frontiers of Engineering Program for me was meeting smart and articulate people both within and outside my discipline. I have been in contact with several of the symposium participants, and while we have not collaborated on anything yet, I think it's only a matter of time. The FOE symposium also helped to renew my enthusiasm for engineering as a profession. It is sometimes easy to lose sight of why what we do is important; the FOE program makes the importance of engineering abundantly clear."

John Kotek manages Argonne National Laboratory's participation in two U.S. Department of Energy research programs, the Generation IV Nuclear Energy Systems Program and the Nuclear Hydrogen Initiative. Both programs are focused on the development of nuclear energy systems that can produce both electricity and hydrogen in ways that are more economical, create less waste, and are as safe or safer than current systems.

1997 FOE Symposium Speaker
Babatunde A. Ogunnaike
Professor, Department of Chemical Engineering
University of Delaware

"I first participated in the 1996 Frontiers of Engineering Symposium as an attendee. Although there were many papers presented at that meeting, the collection in the microelectromechanical systems (MEMS) session in general were all instrumental in redirecting the group work we were doing at DuPont at that time on reverse engineering of biological control systems for chemical applications. This session brought into clearer focus for us the issues of how we were going to implement in practice whatever we developed from our research, and eventually it changed the path we took. In general, I have found the Frontiers of Engineering Program to be of significant benefit."

At DuPont in 1996-1997, Babatunde Ogunnaike studied the "baroreceptor reflex," the system responsible for short-term control of blood pressure in mammals. The primary objective was to understand how the "baroreceptor reflex" was organized and how it functioned. The ultimate goal was to use this knowledge to improve modeling, monitoring, and the control of human chemical processes.

2001 FOE Symposium
David A. Zumbrunnen, Ph.D., P.E
Professor, Department of Mechanical Engineering
Clemson University

"I found the Frontiers of Engineering Symposium to be stimulating and enjoyable. When I was a Presidential Faculty Fellow, the most memorable experiences involved interactions with other Fellows. Persons at the NAE Frontiers of Engineering Symposium were similarly active thinkers. Minds functioned to identify opportunities. Opportunities for such interactions are too few. I am especially appreciative of the NAE for this reason.

My research has also taken on a new dimension as a result of the 2001 Frontiers of Engineering Symposium. Talks I had with Dr. Mehmet Toner of the Harvard Medical School and Massachusetts General Hospital, a 2001 Symposium speaker, were enlightening. We are now exploring the application of smart blending to construct cellular networks for the assembly of living tissue."

David Zumbrunnen is currently working with his students on "smart blending" of plastic materials. Blending has typically been a mixing process, wherein liquids and particles are randomly dispersed. Zumbrunnen and his students have demonstrated smart blending technology, wherein a variety of fine-scale structures can be controllably formed in multicomponent melts by chaotic motions, which creates new structures in plastic materials.

2000 FOE Symposium
Clas A. Jacobson
Director, Systems Department
United Technologies Research Center

"I attended the Frontiers of Engineering Symposium in October 2000 and the German-American Frontiers Symposium in October 2001. The meetings were very interesting. During both meetings I met several researchers with whom I have maintained contact. One continuing relationship that was a result of these meetings has been with Professor Anna Stefanopoulou of the University of Michigan, who has visited United Technologies Research Center (UTRC) and has developed joint projects with UTRC in the area of fuel cell modeling and control."

Clas Jacobson is currently director of the Systems Department at the United Technologies Research Center (UTRC) in East Hartford, Connecticut. The mission of UTRC is to provide impact through innovation to UTC. UTRC is developing new products and processes in partnership with the business units of UTC. The Systems Department is responsible for developing capabilities in systems engineering using mathematical modeling and analysis to support new product and process development.

2002 NAE AWARDS RECIPIENTS

Charles Stark Draper Prize

Recognized as one of the word's preeminent awards for engineering achievement, this prize honors an engineer or engineers whose contributions have significantly impacted society by improving the quality of life, providing the ability to live freely and comfortably, or permitting the access to information. Presented annually, the prize carries a $500,000 cash award.

Robert Langer

Dr. Robert Langer, Kenneth J. Germeshausen Professor of Chemical and Biomedical Engineering, Massachusetts Institute of Technology, "for the bioengineering of revolutionary medical drug delivery systems."

Bernard M. Gordon Prize

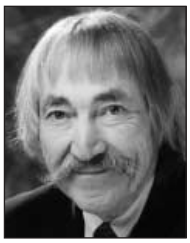
Awarded for the first time in 2002, the Gordon Prize recognizes innovative improvements in engineering and technology education that advance and contribute to a stronger engineering workforce. Presented biennially, the prize carries a $500,000 cash award dispersed at 50 percent to the recipient and the remainder granted through the recipient's institution to support the recipient in continued development, refinement, and dissemination of the recognized innovation.

Eli Fromm

Dr. Eli Fromm, Roy A. Brothers University Professor, professor of electrical and computer engineering, and director of the Center for Educational Research in the College of Engineering, Drexel University, "for innovation that combines technical, societal, and experiential learning into an integrated undergraduate engineering curriculum."

Founders Award

This award honors an outstanding NAE member or foreign associate who has upheld the ideals and principles of the NAE through professional, educational, and personal achievement and accomplishment. The Founders Award is presented each year during the NAE Annual Meeting in October.



Stuart W. Churchill

Dr. Stuart W. Churchill, Carl V. S. Patterson Professor Emeritus of Chemical Engineering, University of Pennsylvania, "for leadership in research, education, and professional service, and for continuing contributions in combustion, heat transfer, and fluid dynamics over a half-century."

For additional information about the NAE awards, please visit our website at <*www.nae.edu/awards*>.

2002 NEW MEMBERS AND FOREIGN ASSOCIATES

Individual's affiliations are current for year 2003

Membership

Election to membership in the National Academy of Engineering (NAE) is the highest professional honor that can be bestowed upon engineers by their peers; more than 2,000 distinguished professionals from business, government, and academia hold membership in the NAE. Members and foreign associates voluntarily serve the NAE as liaisons to the National Research Council (NRC), and its study committees.

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(Gifts Received between January 1 and December 31, 2002)

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The Golden Bridge Society recognizes the generosity of current members who have made cumulative contributions of $20,000 or more, as well as planned gifts of any size made prior to 2000.

$1,000,000 or more

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NATIONAL ACADEMY OF ENGINEERING FUND FINANCIAL REPORT

Governed by the National Academy of Engineering Fund (NAEF) Board of Trustees, the NAEF is the tax-exempt corporation (under section 501(c)(3) of the Internal Revenue Code) that serves as a holding entity for the independent assets and operating funds of the National Academy of Engineering (NAE). The NAE operates within the charter and framework of the National Academy of Sciences (NAS).

The table on page 41 summarizes both the NAEF and outside operating revenue and expenses as well as non-operation-related transactions for the NAE for 2002 and 2001. The information on the NAEF presented in this table has been extracted from the Fund's audited financial statements also contained in this report.

During 2002, contributions for the National Academy of Engineering were solicited as part of the overall fund-raising campaign for the National Academies (includes the NAE as well as the NAS, the Institute of Medicine, and the National Research Council). Contributions from corporations, NAE members, and private foundations, and contracts and grants from the federal government are a major source of support for the Academy's self-initiated programs, which are described in this report.

A second source of revenue for the Academy is the allocation from the overhead charge assessed on government and privately funded contracts for National Research Council (NRC) projects; the NRC is the operating arm of the NAE and the National Academy of Sciences. This allocation is used to offset expenses incurred in the oversight function and for such other administrative operations as NAE membership services and governance.

Under a policy established by the NAEF Board of Trustees, the Academy may use a certain percent of its unrestricted invested assets for operations each year. In 2002, 5 percent was allocated for normal operating expenses; an additional 3 percent was authorized for program support and fund-raising expenses. This allocation, combined with annual meeting registration fees, membership dues, and investment earnings on current operating funds, make up the remainder of the Academy's operating revenue.

The Academy welcomes corporate and private gifts, which are used to help finance the research, education, and public information programs of the institution. The NAE does not, however, conduct proprietary studies for private clients or corporations.

NAE/NAEF Combined Summary of Revenues, Expenses, and Changes in Net Assets (Unaudited-Pro Forma)

(Thousands of Dollars)

	2002	2001
Net Assets, Beginning	$52,326	$55,640
Contributions Receivable, Net	11,990	2,782
Total Assets, Beginning	$64,316	$58,422
OPERATIONS		
Revenue		
Contributions (Unrestricted)	$1,534	$1,395
Dues (Annual), Fees, Miscellaneous	221	226
Indirect Allowance From Contracts and Grants	2,638	2,481
Award Specific Funds Allocation to Operations*	1,488	1,469
Program Specific Funds Allocation to Operations*	1,974	1,207
Unrestricted Allocation to Operations	3,686	3,577
Total Operations Revenue	$11,541	$10,355
Expenses		
Awards	$1,505	$1,484
Development	990	865
Management	1,896	1,507
Membership	1,311	1,298
National Academies Activities	307	307
Programs	4,953	3,324
Total Operations Expenses	$10,962	$8,785
Operations Surplus	$579	$1,570
NONOPERATIONAL TRANSACTIONS		
Allocation to Operations	($6,390)	($5,635)
Contributions to Reserves	2,287	3,763
Dues (Lifetime)	109	99
Gain (loss) on Investments	(2,823)	(5,453)
Investment Earnings (Interest and Dividends)	1,102	2,347
Investment Fees	(162)	(5)
Nonoperational Loss	($5,877)	($4,884)
Net Assets, Ending	$47,028	$52,326
Contributions Receivable, Net	11,968	11,990
Total Assets, Ending	$58,996	$64,316

*Restricted funds are reported in this unaudited-pro forma report as operating revenue when earned

NOTE: The audited financial statements that follow record contributions as revenue the year in which the pledge is received in accordance with generally accepted accounting principles.

National Academy of Engineering Fund
December 31, 2002 and 2001

Report of Independent Certified Public Accountants

Board of Trustees
National Academy of Engineering Fund

We have audited the accompanying statements of financial position of the National Academy of Engineering Fund (the Fund) as of December 31, 2002, and the related statements of activities and cash flows for the year then ended. These financial statements are the responsibility of the Fund's management. Our responsibility is to express an opinion on these financial statements based on our audit. The prior year summarized comparative information has been derived from the Fund's 2001 financial statements and, in our report, dated March 22, 2002, we expressed an unqualified opinion on those financial statements.

We conducted our audit in accordance with auditing standards generally accepted in the United States of America. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion.

In our opinion, the financial statements referred to above present fairly, in all material respects, the financial position of National Academy of Engineering Fund as of December 31, 2002, and the changes in its net assets and its cash flows for the year then ended in conformity with accounting principles generally accepted in the United States of America.

Grant Thornton LLP

Grant Thornton LLP
Vienna, Virginia
March 28, 2003

Statements of Financial Position

December 31,	2002	2001
Assets		
Current Assets		
Cash and cash equivalents	$ 801,408	$ 583,920
Short-term investments	679,570	1,002,819
Contribution receivable, net	10,678,306	1,396,644
Accounts receivable—		
National Academy of Sciences	415,678	523,303
Accounts receivable—other	20,000	30,000
Award medals	64,179	71,212
Total Current Assets	12,659,141	3,607,898
Non-current Assets		
Contribution receivable—		
long-term portion, net	1,289,607	10,592,940
Investments	45,046,823	50,115,555
Total Non-current Assets	46,336,430	60,708,495
Total Assets	$58,995,571	$64,316,393
Liabilities and Net Assets		
Liabilities	$ —	$ —
Commitments and Contingencies	—	—
Net Assets		
Unrestricted	31,423,171	35,748,850
Temporarily restricted	6,664,027	8,532,705
Permanently restricted	20,908,373	20,034,838
Total Net Assets	58,995,571	64,316,393
Total Liabilities and Net Assets	$58,995,571	$64,316,393

Statements of Activities and Changes in Net Assets

Years ended December 31,

	Unrestricted
Revenue	
Interest and dividends	$ 794,732
Realized gain on investments	114,463
Contributions	1,088,531
Membership dues	227,600
Registration fees	86,275
Miscellaneous revenue	9,378
Net assets released from restrictions	
Satisfaction of program restrictions	2,773,036
Satisfaction of time restrictions	508,755
Total Revenue	5,602,770
Expenses	
Program services	
Programs	3,937,528
Member programs	366,681
Support for NRC and NAS	307,336
Awards	1,504,891
Total program services	6,116,437
Supporting services	
Fundraising	989,720
Operations	651,561
Total supporting services	1,641,281
Total Expenses	7,757,718
Change in Net Assets Before Unrealized Loss on Investments	(2,154,948)
Unrealized loss on investments	(2,170,731)
Change in Net Assets	(4,325,679)
Net Assets, beginning of year	35,748,850
Net Assets, end of year	$ 31,423,171

2002			2001
Temporarily Restricted	Permanently Restricted	Total	Total
$ 312,963	$ —	$ 1,107,695	$ 2,362,798
42,702	—	157,165	11,916
1,964,153	873,535	3,926,219	14,355,672
—	—	227,600	217,300
—	—	86,275	86,750
—	—	9,378	15,102
(2,773,036)	—	—	—
(508,755)	—	—	—
(961,973)	873,535	5,514,332	17,049,538
—	—	3,937,528	2,353,595
—	—	366,681	392,403
—	—	307,336	307,001
—	—	1,504,891	1,482,899
—	—	6,116,437	4,535,898
—	—	989,720	864,948
—	—	651,561	289,214
—	—	1,641,281	1,154,162
—	—	7,757,718	5,690,060
(961,973)	873,535	(2,243,386)	11,359,478
(906,705)	—	(3,077,436)	(5,464,668)
(1,868,678)	873,535	(5,320,822)	5,894,810
8,532,705	20,034,838	64,316,393	58,421,583
$ 6,664,027	$ 20,908,373	$ 58,995,571	$ 64,316,393

Statements of Cash Flows

Years ended December 31,	2002	2001
Cash Flows from Operating Activities		
Change in net assets	$ (5,320,822)	$ 5,894,810
Adjustments to reconcile change in net assets to net cash (used in) provided by operating activities:		
Realized gain on investments	(157,165)	(11,916)
Unrealized loss on investments	3,077,436	5,464,668
Decrease (increase) in contributions receivable	21,671	(9,207,331)
Decrease (increase) in receivable from National Academy of Sciences	107,625	(363,671)
Decrease (increase) in receivable–other	10,000	(30,000)
Decrease (increase) in award medals	7,033	(13,655)
Total adjustments	3,066,600	(4,161,905)
Net Cash (Used in) Provided by Operating Activities	(2,254,222)	1,732,905
Cash Flows from Investing Activities		
Proceeds from sale of investments	310,956,774	8,211,406
Purchase of investments	(308,485,064)	(9,669,789)
Net Cash Provided by (Used in) Investing Activities	2,471,710	(1,458,383)
Net Increase in Cash and Cash Equivalents	217,488	274,522
Cash and Cash Equivalents, beginning of year	583,920	309,398
Cash and Cash Equivalents, end of year	$ 801,408	$ 583,920

Notes to Financial Statements

December 31, 2002 and 2001

Note A—General Information and Summary of Significant Accounting Policies

General Information

The National Academy of Engineering Fund (the Fund) is an independent nonprofit organization established by the National Academy of Engineering (NAE) to collect and disburse funds for accomplishing the goals of the NAE. The NAE operates within the charter and framework of the National Academy of Sciences (NAS), which accounts for the NAE's expenses. The operating expenditures of the NAE are accounted for by offices of the NAS and are offset by reimbursement from funds received from the Fund and from contracts administered by the NAS on behalf of the National Research Council (NRC), which is the operating arm of the NAS and NAE. The net expenditures of the NAE, except for the approved budgeted indirect costs, are paid by the Fund to balance accounts with the NAS.

Basis of Accounting

The Fund's financial statements are prepared using the accrual basis of accounting.

Cash and Cash Equivalents

For purposes of the statement of cash flows, the Fund considers all investments purchased with an original maturity of three months or less to be cash equivalents, except for the cash in the investment portfolio, which will be reinvested on a long-term basis.

Short-term Investments

Temporary investments consist of money market funds that are used to fund normal operations of the Fund and are recorded at their readily determinable fair values as determined by quoted market prices.

Contributions Receivable

Unconditional promises to give are recognized as revenue and contributions receivable in the period the promises are made. Unconditional promises to give that are expected to be collected within one year are recorded at their net realizable value. Unconditional promises to give that are expected to be collected in future years are recorded at the present value of their estimated future cash flows. The discounts on those amounts are computed using risk-free interest rates commensurate with the risk involved applicable to the years in which the promises are received. Amortization of the discounts is included in contribution revenue. Conditional promises to give are not included as support until the conditions are substantially met.

Awards Medals

The Fund maintains gold medals for various awards, which are carried at cost.

Investments

Investments, consisting of cash and money market funds, federal agency securities, treasury securities, corporate debt securities, and equity securities are recorded at readily determinable fair values determined by quoted market price.

Temporarily Restricted Net Assets

Temporarily restricted net assets consist of amounts that are subject to donor-imposed time or purpose restrictions and income earned on temporarily and permanently restricted net assets. The Fund is permitted to use or expend the donated assets in accordance with the donor restriction.

Permanently Restricted Net Assets

Permanently restricted net assets consist of assets whose use is limited by donor-imposed restrictions that neither expire by the passage of time nor can be fulfilled or otherwise removed by action of the Fund. The restrictions stipulate that resources be maintained permanently, but permits the Fund to expend the income generated in accordance with the provisions of the agreement. Permanently restricted net assets consist of the following:

- *Draper Prize*—represents an endowment given by the donor for the purpose of establishing and awarding an annual prize in honor of the memory of Charles Stark Draper. It is the Fund's intention to use the investment earnings of the endowment to cover the expenses incurred in connection with administration of the prize and in providing the honorarium awarded with the prize.

- *Gordon Prize*—represents an endowment given by the donor for the purpose of establishing and awarding a biennial prize in honor of Bernard M. Gordon. It is the Fund's intention to use the investment earnings of the endowment to cover the expenses incurred in connection with administration of the prize and in providing the honorarium awarded with the prize.

- *Capital Preservation and Hans Reissner*—represent endowments requiring that the principal be invested and that only the income be used for general operations of the NAE.

- *Hollomon*—represents an endowment requiring that the principal be maintained in perpetuity and that the income be used to support the Hollomon Fellow.

- *Industry Scholar*—represents an endowment to support fellowships for recently retired corporate executives to assist with strategy and management of program activities in the NAE and NRC.

- *Senior Scholar*—represents an endowment to support an outstanding member of industry or another field working as an advisor and assistant to the president of the NAE in the management and execution of the NAE's programmatic activities.

- *Young Engineer*—represents an endowment to support programs aimed at engaging engineers at a younger age in the activities of the NAE, and to provide an opportunity to identify nominees from industry for membership in the NAE.

Restricted Support

The Fund reports gifts of cash and other assets as restricted support if they are received with donor stipulations that limit the use of the donated assets. When a donor restriction expires, i.e., when a stipulated time restriction ends or purpose restriction is accomplished, temporarily restricted net assets are reclassified to unrestricted net assets and reported in the statement of activities as net assets released from restrictions.

Allocation of Expenses

The costs of providing various programs and other activities have been summarized on a functional basis in the statement of activities. Accordingly, certain costs have been allocated among the programs and supporting services benefited.

Financial Instruments and Credit Risk

Financial instruments, which potentially subject the Fund to concentrations of credit risk, consist principally of corporate debt securities, treasury securities and federal agency securities. The Fund places its investments with creditworthy financial institutions and investment firms. By policy, these investments are kept within limits designed to prevent risks caused by concentration. At December 31, 2002 and 2001, the Fund had no significant concentrations of credit risk.

Income Taxes

The Fund is incorporated under the District of Columbia Non-profit Corporation Act and is exempt from income taxes under Section 501(c)(3) of the Internal Revenue Code. In addition, the Fund has been determined by the Internal Revenue Service not to be a "private foundation." The Fund is required to remit income taxes to the federal government and the District of Columbia for unrelated business income. For the year ended December 31, 2002 and 2001, there was no unrelated business income and, consequently, no provision for income taxes has been made.

Use of Estimates

In preparing financial statements in conformity with accounting principles generally accepted in the United States of America, management is required to make

estimates and assumptions that affect the reported amounts of assets and liabilities and the disclosure of contingent assets and liabilities at the date of the financial statements and revenue and expenses during the reporting period. Actual results could differ from those estimates.

Note B—Contributions Receivable

Contributions receivable consist of unconditional promises to give and are deemed fully collectible as follows at December 31, 2002:

	Unrestricted	Restricted	Total
Unconditional promises to give	$122,117	$12,084,936	$12,207,053
Less: unamortized discount	—	239,140	239,140
Net unconditional promises to give	122,117	11,845,796	11,967,913
Amounts due in:			
Less than 1 year	122,117	10,556,189	10,678,306
1 to 5 years	—	1,289,607	1,289,607
	$122,117	$11,845,796	$11,967,913

Contributions receivable consist of unconditional promises to give and are deemed fully collectible as follows at December 31, 2001:

	Unrestricted	Restricted	Total
Unconditional promises to give	$126,944	$12,715,838	$12,842,782
Less: unamortized discount	—	853,198	853,198
Net unconditional promises to give	126,944	11,862,640	11,989,584
Amounts due in:			
Less than 1 year	126,944	1,269,700	1,396,644
1 to 5 years	—	10,592,940	10,592,940
	$126,944	$11,862,640	$11,989,584

Net restricted contributions consist of $1,040,123 and $1,630,498 at December 31, 2002 and 2001, respectively, which is subject to time restrictions and $10,805,673 and $10,232,142 at December 31, 2002 and 2001, respectively, which is subject to donor-imposed purpose restrictions.

Note C—Investments

Investments at fair value consist of the following at December 31:

	2002	2001
Cash and money market	$4,143,376	$47,724,233
Treasury securities	5,667,473	3,394,141
Federal agency securities	10,143,996	—
Corporate debt securities	5,152,249	—
Equity securities	20,619,299	—
	45,726,393	51,118,374
Less: Short-term investments	679,570	1,002,819
	$45,046,823	$50,115,555

Investments are further classified as follows at December 31:

Unrestricted	$31,605,672	$34,990,685
Temporarily restricted	3,446,709	5,943,792
Permanently restricted	10,674,012	10,183,897
	$45,726,393	$51,118,374

Investments income consists of the following at December 31:

Dividends and interest	$1,107,695	$2,362,798
Unrealized loss	(3,077,436)	(5,464,668)
Realized gain	157,165	11,916
	$(1,812,576)	$(3,089,954)

Note D—Permanently And Temporarily Restricted Net Assets

Permanently and temporarily restricted net assets consist of the following at December 31, 2002:

	Permanently Restricted	Temporarily Restricted
Draper Prize	$8,000,000	$2,062,209
Russ Prize	—	820,068
Capital Preservation	1,960,829	525,516
Great Achievements	—	501,324
Public Understanding	—	469,379
Bechtel-Public Understanding	—	282,142
Hollomon	201,200	211,262
Committee on Diversity	—	181,749
Gordon Prize	9,318,967	151,113
Futures Fund	—	113,404
Bueche Award	—	96,609
Forum on Diversity	—	76,768
AT&T	—	64,050
U.S./German American Frontiers	—	43,356
Engineering Education	—	31,222
Frontiers Fund	—	27,299
Hans Reissner	25,624	25,998
Communication with Public in Crisis	—	24,976
Battelle	—	9,207
Homeland Security	—	6,542
Information Technology	—	3,380
Engineering & Services	—	2,670
Bechtel Inventory	—	(122)
Technology and Environment	—	(2,479)
Industry Scholar	353,038	(4,652)
Senior Scholar	291,670	(9,326)
Young Engineer	757,045	(89,760)
Unrestricted contributions to be received in future years	—	1,040,123
	$20,908,373	$6,664,027

Permanently and temporarily restricted net assets consist of the following at December 31, 2001:

	Permanently Restricted	Temporarily Restricted
Draper Prize	$8,000,000	$3,179,253
Gordon Prize	8,875,384	796,913
Capital Preservation	1,600,673	599,433
Bechtel-Public Understanding	—	455,808
Hollomon	201,200	253,855
Great Achievements	—	200,055
Public Understanding	—	183,214
Technology and Environment	—	143,570
Frontiers Fund	—	127,781
Committee on Diversity	—	126,052
Engineering Education	—	119,882
Bueche Award	—	107,135
Futures Fund	—	106,702
Bechtel Inventory	—	103,098
AT&T	—	94,187
Russ Prize	—	91,790
Forum on Diversity	—	91,060
Guy Stever Memoirs	—	71,720
Battelle	—	57,168
Hans Reissner	25,624	28,961
U.S./German American Frontiers	—	4,801
Information Technology	—	3,352
Engineering & Services	—	2,650
Home Land Security	—	1,500
Industry Scholar	353,038	(964)
Senior Scholar	283,650	(3,163)
Young Engineer	695,269	(43,606)
Unrestricted contributions to be received in future years	—	1,630,498
	$20,034,838	$8,532,705

Note E—Description of Program and Supporting Services

The following program and supporting services are included in the accompanying financial statements:

Programs

Programs that address relevant issues in the engineering field including, but not limited to, Education, Engineering Practice and the Engineering Workforce; Engineering and the Environment; Engineering, the Economy and Society; Information Technology and Society; National Security and Crime Prevention; and Public Policy and Program Reviews.

Member Programs

Organization and administration of the Annual Meeting and publication of NAE Memorial Tributes.

Support for NRC and NAS

Contributions to joint activities of the National Academies including, but not limited to, the NAS/NAE/IOM Committee on Human Rights, the NRC Office of Scientific and Engineering Personnel, and Issues in Science and Technology.

Awards

The NAE presents five awards: the Bernard M. Gordon Prize, the Charles Stark Draper Prize, the Fritz J. and Dolores H. Russ Prize, the Arthur M. Bueche Award, and the NAE Founders Award. Activities include soliciting nominations, selection of the recipients, announcement of the recipients and presentation of the prizes.

Fundraising

Provides the structure necessary to encourage and secure private financial support from individuals, foundations and corporations.

Operations

Includes the functions necessary to provide an adequate working environment; provide coordination and articulation of the Fund's programs; secure proper administrative function of the Board of Trustees; maintain competent legal services for program administration; and manage the financial and budgetary responsibilities of the Fund.

Note F—Related Party Transactions

The National Academies Corporation

The National Academies Corporation (TNAC) is a non-profit corporation that was incorporated in January 1986 for the purpose of constructing and maintaining a study and conference facility, the Arnold and Mabel Beckman Center, in Irvine, California, to expand and support the general scope of program activities of NAS, NAE, the Institute of Medicine (IOM), and NRC. TNAC is organized as a tax-exempt supporting organization for NAS and the Fund. The Board of Directors and officers of TNAC include certain officers of the Fund (NAEF). The Fund had no transactions with TNAC for the years ended December 31, 2002 and 2001.

National Academy of Sciences and National Research Council

The Fund reimburses NAS by making monthly payments based on the NAE's estimated expenditures for the year. This resulted in a receivable from NAS at December 31, 2002 and 2001, of $415,678 and $523,303, respectively. Payments made to NAS by the Fund for the Fund's allocated portion of the expenditures shared jointly by the NAS, NAE and IOM were $1,297,056 and $1,171,949 for the years ending December 31, 2002 and 2001, respectively. The Fund made no payments to the National Research Council for the years ended December 31, 2002 and 2001. See Note A for the relationship of related parties.

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† Indicates term ended June 30, 2002. Years in parentheses indicate the year his/her term will expire.

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Advisers to the Nation on Science, Engineering, and Medicine

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Bruce M. Alberts is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. Wm. A. Wulf is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Harvey V. Fineberg is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Bruce M. Alberts and Dr. Wm. A. Wulf are chairman and vice chairman, respectively, of the National Research Council.

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