



SCIENCE AND TECHNOLOGY

Science and Technology Policy Institute

2001–2003

A Report to the President

Analytic Perspectives on Science and
Technology Issues Facing the Nation

About the Science and Technology Policy Institute

Originally created by Congress in 1991 as the Critical Technologies Institute and renamed in 1998, the Science and Technology Policy Institute is a federally funded research and development center sponsored by the National Science Foundation. The S&TPI was managed by RAND from 1992 through November 30, 2003.

The Institute's mission is to help improve public policy by conducting objective, independent research and analysis on policy issues that involve science and technology. To this end, the Institute

- Supports the Office of Science and Technology Policy and other Executive Branch agencies, offices, and councils
- Helps science and technology decisionmakers understand the likely consequences of their decisions and choose among alternative policies
- Helps improve understanding in both the public and private sectors of the ways in which science and technology can better serve national objectives.

In carrying out its mission, the Institute consults broadly with representatives from private industry, institutions of higher education, and other nonprofit institutions.

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Director's Foreword

December 2003 marked the end of the RAND Corporation's federal contract for managing the Science and Technology Policy Institute (S&TPI). This transition point offers us an occasion to review and reflect on RAND's experience as it mirrors changes in the broader U.S. S&T policy environment and evolving policy priorities since the early 1990s. Following the publication of the first report to the President in 2001, our attention as a nation has turned to the War on Terrorism. But at the same time that our world was being transformed, the forces that created the institute came full circle. The concerns of the 1980s over U.S. competitiveness and the nation's standing in S&T that led to the S&TPI's genesis (as the Critical Technologies Institute) are once again of concern to us in the 2000s. All of these events and trends are reflected in S&TPI's ever-changing portfolio of research and analysis.

The last few years have also heralded significant changes in the Office of Science and Technology Policy (OSTP) and

S&TPI. With the change in administration came a change in the priorities and emphases of OSTP. The nature of the S&TPI work requested by OSTP shifted to focus on more immediate concerns. In response to the findings of an external panel, S&TPI was reorganized to more closely address OSTP's changing needs. This reorganization allowed S&TPI to work on many projects spanning a broad range of topics while operating within short time frames and with limited resources. These changes proved successful; the results of our efforts are highlighted in this report.

In sum, RAND has been pleased and privileged to have managed S&TPI from its birth to early adolescence, and to have built a strong foundation for S&TPI's future support of OSTP and U.S. leadership in S&T.

Helga Rippen

*Director, FY2001–2003
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The First Ten Years of S&TPI at RAND (1992–2001)

A Brief History

Origins

During the late 1980s, many policymakers voiced concerns about the U.S. trade deficit, the challenges to U.S. technology leadership posed by competitors, and the growing importance of technology to global competitiveness as the Cold War drew to a close and a globalized information-based economy began to emerge.

Given the federal government's central role in the U.S. national innovation system, there was a growing belief that federal S&T policy needed to address civilian technology development more explicitly and also factor industrial perspectives and concerns into policy formulation. As a result, during the administration of President George H. W. Bush, government attention to civilian technology development began to increase.

This occurrence marked a shift in the traditional focus of federal S&T policy. Since the creation of a large-scale federally funded research and development (R&D) enterprise following World War II, the federal government had typically focused on basic science and military systems development. Space was the only area where the government had undertaken nonmilitary technology development on a large scale, and even there a quasi-national security rationale prevailed even before the time of Sputnik.

In response to this changed environment, Congress created S&TPI (then known as the Critical Technologies Institute) in 1992. Key to supporting this development was the recognition that the appropriate format for S&TPI would be as a federally funded research and development center (FFRDC) charged with providing objective, fact-based analysis and advice to the OSTP and other federal agencies. The legislation was written to ensure that the executive branch would have access to the

appropriate data and analysis of S&T trends that could affect the nation and have ready means to initiate policy studies to ensure the long-term strength of the United States in S&T. Specifically, Congress mandated that S&TPI conduct the following activities:

- (1) The assembly of timely and authoritative information regarding significant developments and trends in S&T research and development in the United States and abroad, including information relating to the technologies identified in the most recent biennial report submitted to Congress by the President pursuant to section 6683(d) of this title and developing and maintaining relevant informational and analytical tools.
- (2) Analysis and interpretation of the information referred to in paragraph (1) with particular attention to the scope and content of the Federal S&T research and development portfolio as it affects interagency and national issues.
- (3) Initiation of studies and analyses of alternatives available for ensuring the long-term strength of the United States in the development and application of S&T, including appropriate roles for the Federal Government, State governments, private industry, and institutions of higher education in the development and application of S&T.
- (4) Provision, upon the request of the Director of the Office of Science and Technology Policy, of technical support and assistance—
 - (A) to the committees and panels of the President's Council of Advisors on Science and Technology that provide

advice to the Executive branch on S&T policy; and

- (B) to the interagency committees and panels of the Federal Government concerned with S&T.¹

To support balanced policy formulation, S&TPI was also encouraged to “consult widely”—to solicit the views of relevant stakeholders and experts, including those in state and local government, industry, academia, and international settings, and to serve a convening function when appropriate to bring public- and private-sector interests to the same table.

Under the terms of the legislation, OSTP assumed the role of S&TPI’s principal sponsor, while the National Science Foundation (NSF) managed S&TPI’s contract to help monitor the quality and timeliness of its research.

By the late 1990s, it was clear that OSTP’s reliance on S&TPI for support extended beyond the concern over critical technologies, and so the name was changed from the Critical Technologies Institute to the Science and Technology Policy Institute to reflect its role more accurately.

The Evolving Research Agenda

S&TPI’s initial research reflected the concerns of the day over civilian technology development and competitiveness. Several of its early large-scale studies were industry-specific examinations of trends and conditions. For example, its first study was a congressionally mandated analysis of the U.S. machine-tool industry that identified reasons for its declining competitiveness in the late 1980s and made recommendations for federal policies to help improve the situation. Another early study looked at the metal-casting industry. S&TPI also played a key analytic support role in the congressionally mandated biannual “critical technologies” foresight process, intended to identify technology sectors that posed potential concern for U.S. economic and security goals, eventually accepting the leading role for design and execution of the formal report.

In the mid-1990s, competitiveness concerns receded amid a dramatic U.S. economic turnaround. OSTP and the federal policy debate began to focus on the rapid pace of change in information and communication technologies and the networked infrastructures that support them. These developments raised concerns and also presented opportunities across a range of areas, most notably infrastructure security, law enforcement, and education. S&TPI was heavily engaged in this issue area:

- A series of studies brought federal, state, and local law enforcement agencies together to identify technological needs and opportunities for upgrading technological tools.
- Another series of studies assessed the security and vulnerabilities of the U.S. information infrastructure.
- A pioneering effort examined the costs and implications of “wiring” U.S. K–12 schools on a large scale to create technology-rich learning environments.

During the same period, S&TPI supported OSTP with studies of abiding S&T policy issues in areas such as space policy, the federal R&D portfolio, energy, and the environment. For example, a critical space policy issue that emerged in the 1990s centered on the Global Positioning System (GPS), a constellation of satellites designed to aid global navigation and position location anywhere on Earth. Developed for the U.S. military, GPS had increasingly become a dual-use technology of global importance and the basis for an emerging worldwide industry. The central policy issues were whether to preserve military control or transfer control to civilian authorities and whether the U.S. government should charge GPS users. RAND’s recommendations—for joint civilian-military control and continued free signals to deter potential competitors from entering the marketplace—were adopted almost verbatim by the President’s official policy directive.

¹42 U.S.C. 6686(c), Science and Technology Policy Institute.

To support OSTP and provide the data necessary for detailed analysis of R&D expenditures, RAND created an analytical tool named RaDiUS (for **R**esearch and **D**evelopment in the **U**nited **S**tates), the first comprehensive database of all federal R&D funding and activities, with the support of NSF. S&TPI has used RaDiUS on numerous projects involving the federal R&D portfolio, technology transfer, international cooperation in R&D, regional economic development, and the war against terrorism.

RAND has developed innovative tools designed to improve decisionmakers' access to information and also to improve the quality of that information. For example, RAND S&TPI developed methods and tools to support planning under conditions of deep uncertainty—

to address, for example, wildly divergent possible outcomes of global warming; geographic information systems to integrate different types of information on environmental indicators and conditions; and a framework and metrics to help federal agencies assess their research programs as required by the Government Performance Review Act (1995).

Overview of Recent S&TPI Research (2002–2003)

Since our previous Report to the President in 2001, S&TPI has continued to conduct research and analysis to help OSTP and the Executive Branch coordinate and improve public policy involving S&T.

Pursuing this mission has meant adapting to important changes in the policy environment. The government's increased focus on public safety and security has required new thinking about how federal R&D resources can contribute to homeland security. At the same time, S&T issues continue to become more complex, more interdisciplinary, and more international. In some areas, the rapid pace of innovation has outrun public policy. While these developments pose challenges, they also present opportunities to apply innovation to policy and analysis in bold and effective ways.

Much of our research over the past two years has addressed innovation, both in theory and practice. In particular, many projects have identified opportunities where scientific research or innovative technologies can help address policy problems; others assess the potential usefulness of innovative research methods and tools.

In the past two years S&TPI has accomplished a great deal in a changing, and often turbulent, policy environment:

- S&TPI was reorganized in 2002 to better serve OSTP's request for fast-turnaround, short-term response and analysis.
- Reflecting the new national priorities since 9/11, S&TPI refocused its agenda to support OSTP on counterterrorism, emergency response, and related safety and security issues.
- At the same time, S&TPI took on a larger number of other OSTP-directed projects addressing a wider range of issues than ever before.
- Several S&TPI projects and publications addressed new international challenges to U.S. leadership in science, technology, and innovation in both national security and non-defense areas.

Our research agenda in the final two years shifted from a collaborative process with OSTP and NSF in 2002 to an agenda directed by OSTP in 2003. The result was a mixed portfolio of short- and longer-term projects (i.e., to be delivered within a month, or more than six months in duration). During the past two years S&TPI continued to leverage core funding to support several self-initiated projects. One of these explored the issue of the possible shortage of scientists and engineers while another considered the nature of an information technology infrastructure for confronting bioterrorism. The final result was a slate of projects that addressed OSTP's needs. We have grouped these activities within the following policy areas: (1) the federal R&D enterprise and national innovation sys-

tem; (2) counterterrorism and emergency response; (3) information technology; (4) education, training, and workforce issues; (5) aerospace and transportation; and (6) energy, environment, and health. Typically, S&TPI projects fall into one of two categories: (1) research studies intended to produce peer-reviewed public documents, and (2) analytic support efforts intended to provide clients with specific information and analysis not intended for publication. For the former projects, we list available publications or note plans for future publications. The latter projects are denoted as "analytic support" projects.

Highlights of S&TPI Research (2002–2003)

THE FEDERAL R&D ENTERPRISE AND THE NATIONAL INNOVATION SYSTEM

In fiscal year 2004, the federal government will invest more than \$120 billion in R&D. This investment provides essential fuel for innovation in vital sectors of activity including defense, public health, and the economy. Managing the federal government's vast R&D enterprise effectively is critical for achieving national goals and for ensuring that this large investment is wisely spent. To support priority setting and coordination in federal R&D, S&TPI has focused on understanding the scope and implications of R&D activities, priorities, and resource allocations. An important thread of this research has also examined U.S. efforts to collaborate in S&T with other nations and international consortia.

Federal R&D: Trends and Practices

Trends in the Federal R&D Portfolio. S&TPI was asked to examine trends in federal R&D funding from 1975 to the present as part of its ongoing work for the President's Council of Advisors on Science and Technology (PCAST). S&TPI undertook this work in collaboration with the American Association for the Advancement of Science (AAAS) using data from AAAS and NSF sources as well as the RaDiUS data system. The study found that federal R&D spending is at an all-time high—growing from \$60 billion in fiscal year 1976 to \$110 billion in fiscal year 2003 in constant dollars. Despite this increase, however, U.S. R&D funding has not kept pace with the growth in the U.S. economy, steadily declining as a share of the overall economy. Furthermore, funding in nondefense areas other than health has been largely flat or has declined in constant dollars over the same period. A related study analyzed state-by-state trends in federal R&D funding at U.S. universities and colleges from FY1996–FY2002.

Publications: *Federal Investments in R&D.* Elisa Eiseman, Kei Koizumi, and Donna Fossum. MR-1639.0, 2002; *Vital Assets: Federal Investment in Research and*

Development at the Nation's Universities and Colleges, Donna Fossum et al. MR-1824-NSF, 2004.

Federal R&D Facilities. How are large federal science facilities managed? What unique planning and management challenges do they present? Do they maximize return on federal investment? To begin to answer these questions, OSTP asked S&TPI to review the research literature on federal R&D facilities optimization with the aim of identifying planning, efficiency, and effectiveness issues. These included life-cycle management, access, and staffing issues. In addition, S&TPI identified areas in which changes are needed or OSTP or National Science and Technology Council (NSTC) oversight would be beneficial.

Publication: *A Review of Reports on Selected Large Federal Science Facilities: Management and Life-Cycle Issues.* Terrence K. Kelly et al. MR-1728-OSTP, 2003.

Identifying Critical Technologies in the United States. This analysis examined the "critical technologies" movement in the United States between 1989 and 1999 and its limitations as an approach to technology foresight. It discussed the history of U.S. efforts in this realm and the value received and lessons learned, especially in contrast with the goals and processes of similar efforts abroad.

Publication: “Identifying Critical Technologies in the United States: A Review of the Federal Effort.” Steven W. Popper and Caroline Wagner. *Journal of Forecasting*, Vol. 22, pp. 113–128, 2003.

R&D on Reducing Losses from Natural Hazards. In recent decades, the United States has experienced a decline in lives lost due to natural hazards such as earthquakes, hurricanes, floods, and droughts. At the same time, the costs of these events are escalating. The heavy financial burden these losses impose has led to growing pressure on the federal government to “solve” the problem. What role can R&D play in reducing hazard losses? To answer this question, S&TPI studied the full range of federal R&D expenditures focused on hazard losses in order to identify possible holes or imbalances and, on a larger scale, to analyze the criteria governing the allocation spread. The study found that key limitations prevent a more comprehensive and potentially effective portfolio—limitations both quantitative (e.g., the lack of accurate loss data) and qualitative (e.g., an overemphasis on short-term prediction vs. long-term mitigation efforts). The study also considered the demands we place on R&D to “solve” the problem of hazard losses, closing with suggestions for new ways to frame expectations and demands for R&D in tackling the problem of hazard losses.

Publication: *Assessing Federal Research and Development for Hazard Loss Reduction*. Charles Meade and Megan Abbott. MR-1734-OSTP, 2003.

NIOSH Research Relevance and Usefulness Performance Measurement to Support the Government Performance Review Act. This project provided guidance and recommendations to the National Institute of Occupational Safety and Health (NIOSH) on the development and application of performance measures that gauge the relevance and usefulness of their occupational safety and health research activities focused on improving workplace safety. In completing the project, we sought the views of

scientific and other technical experts, stakeholders, other research organizations, and other interested parties. The project’s final report is expected later in 2004.

R&D Management Practice (analytic support).

This project documented the practices that enable selected agencies to evaluate the relevance, quality, and performance of their R&D investments. The project described the practices used by these agencies with the goal of helping agencies government-wide improve their R&D program management and effectiveness.

Gender in Major Federal External R&D

Grant Programs. NSF has been mandated to assess gender differences in grant amounts requested from and awarded by major external grant programs throughout the federal government. NSF asked S&TPI to help assess available data on the subject, develop an approach to conducting such an assessment, and then collect the necessary data. The project’s final report is expected in 2005.

Aspects of the National Innovation System

The Health of the National Innovation

System. The transformation of the U.S. economy over the past 20 years has shown that innovation based on S&T has contributed significantly to national well-being. The system that supports this process has emerged as an important national asset. To understand the importance of this system to the public welfare and the continuing importance of government as both a participant and a provider of support, the NSTC convened a series of discussions with participants and observers from every part of the innovation system—business, industry groups, labor, federal and state government, and universities. S&TPI summarized the major themes that emerged from these deliberations and highlighted proposals that would benefit from early policy attention and action.

Publication: *New Foundations for Growth—The U.S. Innovation System Today and Tomorrow.* Steven W. Popper and Caroline S. Wagner. MR-1338.0-OSTP, 2002.

Partnerships for Innovation. NSF created the Partnerships for Innovation program (PFI) to build a new foundation for innovation based on partnerships among university, industry, and local and regional governments that would respond to the nation's emerging economic and social challenges. NSF engaged S&TPI to assess the most effective role for the foundation in enhancing the innovation system. In support of this effort, NSF sponsored a workshop held in June 2001 that brought together PFI grantees and representatives from universities and industry to consider the roles of PFI and NSF in the larger national innovation enterprise. The workshop revealed strong support for a formal evaluation of the PFI program and endorsed both an expanded NSF role in promoting innovation and partnerships through the PFI and other programs.

Publication: *Building a New Foundation for Innovation: Results of a Workshop for the National Science Foundation.* Eric V. Larson and Irene T. Brahmakulam. MR-1534, 2002.

Innovation in Housing. This study proposed a new framework for understanding the relationship between the housing production process and innovation. The Department of Energy (DOE) Building America program is using this framework to engage partners in the Building America program to think about new ways to accelerate the promotion of energy efficiency in homes. Specifically, the Building America program plans to increase emphasis on a whole-house/systemic approach to energy efficiency in homes.

Publication: *Building Better Homes: Government Strategies for Promoting Innovation in Housing.* Scott Hassell et al. MR-1658-HUD/PATH, 2003.

Perspectives on Federal Technology Transfer. To stimulate technological innovation, the federal government allows universities and other per-

formers of federally funded R&D to retain ownership of inventions developed with federal funds and to license them for commercialization. How effective are federal policies in this area? To examine this question and gain insight on best practices, S&TPI facilitated a public meeting for stakeholders and other interested parties, including university researchers and technology transfer officers, industry experts, and government decisionmakers. The consensus among participants was that federal policies, known collectively as “Bayh-Dole” (after the coauthors of the first legislation), are working reasonably well and that performers of federal R&D are becoming more knowledgeable and sophisticated at partnering with industry to commercialize the fruits of federally funded research.

Publication: *Technology Transfer of Federally Funded R&D: Perspectives from a Forum.* Mark Wang et al. CF-187-OSTP, 2003.

High-Technology Manufacturing and U.S. Competitiveness. There are public concerns over a perceived loss of U.S. manufacturing during recent years, particularly in the high-tech sector. The rise of the semiconductor industry in Asia has been at the heart of a public debate. What actions must the U.S. government undertake to stem the offshore migration of such an economically vital industry? The data suggest increased worker productivity is more responsible for lower U.S. manufacturing employment than foreign competition, as China is also experiencing a drop in manufacturing employment. U.S. corporations are attracted, however, by foreign government incentives to establish operations overseas. U.S. government policy options may include actions to level the playing field regarding both industry incentives and trade practices, and strengthening support for the broader innovation ecosystem including university and industry R&D, workforce education and training, the capital investment communities, and consumer wealth.

Publication: *High-Technology Manufacturing and U.S. Competitiveness.* Charles T. Kelley et al. TR-136-OSTP, 2004.

International Collaboration in S&T

An International Comparative Study of “Best Practices.”

Creating international linkages in S&T supports U.S. national goals and benefits U.S. partners. This study examined the efficiency and effectiveness of government-sponsored collaboration: (1) to improve understanding of international collaboration dynamics, (2) to provide tools for policymakers seeking to improve the effectiveness and efficiency of collaboration, and (3) to coordinate with analysts conducting similar studies in different countries. The project’s final report draws lessons from four case studies and further presents key questions that emerged to be used as a guide for those seeking to formulate similar collaborative programs. The authors found that distributed research is an effective form of collaboration and that national benefits include goodwill and access to key resources.

Publication: *International Cooperation. Linking Effectively: Learning Lessons from Successful Collaboration in Science and Technology.* Caroline S. Wagner et al. DB-345-OSTP, 2002.

Analysis of International Science and Technology Issues. S&TPI undertook a series of studies on bilateral relationships between the United States and its S&T collaborators. The most recent effort analyzed U.S. government spending on cooperative S&T activities with Russian partners. S&TPI collected and analyzed data at the project level and surveyed agency officials about specific projects and pro-

grams. These data were aggregated by spending into categories created by S&TPI. The report provides an analytic, cross-agency overview, presenting a broad picture of the U.S.-Russia S&T relationship between 1994 and 2000.

Publication: *U.S. Government Funding for Science and Technology Cooperation with Russia.* Caroline Wagner et al. MR-1504-OSTP, 2002.

Capacity Building in S&T (analytic support).

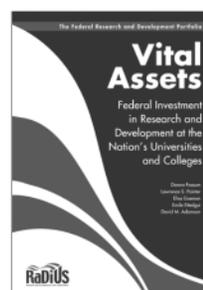
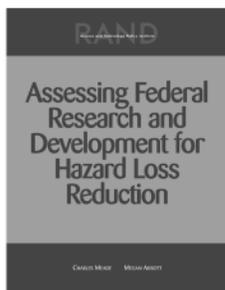
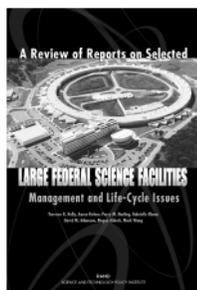
This effort supported OSTP’s examination of strategic options for more effective international capacity building in biotechnology with a focus on agricultural applications. The project brought together industry and development experts to discuss capacity building and public-private partnerships.

Comparison of International Defense S&T Processes (analytic support).

This work compared and contrasted the decisionmaking processes, budgets, and emphases of defense S&T establishments in the United States, United Kingdom, France, Sweden, and Israel.

An Assessment of Nanotechnology R&D (analytic support).

This study developed a taxonomy detailing the various dimensions of nanotechnology. S&TPI used this taxonomy to search the RaDiUS database to identify all federally funded R&D activities related to the field of nanotechnology that were ongoing in fiscal years 2000 and 2001, with the aim of determining the amount of funds going to nanotechnology across all federal agencies.



COUNTERTERRORISM AND EMERGENCY RESPONSE

S&TPI work has long included a component dealing with critical infrastructure and public safety. Our work in this area expanded after the attacks of September 11, 2001, and the subsequent anthrax episodes. In the current environment, national security and critical infrastructure protection issues have coalesced around a heightened security consciousness brought about by the threat of terrorism. Recent S&TPI work assessed the potential for technological innovation to help bolster the nation's readiness to prevent potential terrorist attacks, respond to emergencies, and mitigate potential damage and casualties should an attack occur.

Mobilizing S&T for the War on Terrorism

Assisting Counterterrorism Efforts (analytic support). S&TPI was involved in several projects relating to the nation's counterterrorism efforts. One focused on identifying existing offices, agencies, and programs within the federal government conducting R&D activities that would be relevant to the then-proposed Department of Homeland Security (DHS). In another project, S&TPI designed, implemented, and assessed a broad survey of federal agencies to provide OSTP with the input required for its decisionmaking and planning. The results were used to create a "map" of federal S&T capabilities for aiding in the war against terrorism and supporting new homeland security missions. In addition, using RaDiUS as a tool, S&TPI created a detailed database of ongoing federal efforts in the realm of countering weapons of mass destruction (WMD). A third project inventoried and assessed relevant federal roles and missions in the event of a terrorist attack on the United States. That project delivered a prototype database to the Office of Homeland Security that summarized response and recovery missions across the federal community and revealed potential needs in the areas of training, coordination, and resources. S&TPI also supported the PCAST panel on countering terrorism as it examined how S&T capabilities might best contribute to the new DHS. In addition, S&TPI conducted a series of summits on developing a framework for a national information technology infrastruc-

ture for bioterrorism. The summits produced an initial articulation of this infrastructure and recommended a course of action.

Innovative Technologies for Global Landmine Removal. Landmines represent a significant global threat to human safety. An estimated 15,000–20,000 people are injured or killed annually by landmines. In comparison, terrorist activity kills or injures an estimated 3,000 annually. Approximately 50 million mines are currently deployed in 90 countries, with one million new mines laid each year. Meanwhile, technologies for detecting and removing mines remain relatively underdeveloped. S&TPI assessed the potential for new technologies to address this problem. The study found that several innovative sensor concepts currently exist. Because each concept has strengths and limitations, the study recommended that the United States develop a landmine detection system combining multiple-detection capabilities. Such a system would cost approximately \$135 million to develop and produce.

Publication: *Alternatives for Landmine Detection*. Jacqueline MacDonald et al. MR-1608-OSTP, 2003.

S&T Protections (analytic support). This study compared and contrasted the approaches that the members of the G-8 countries (United States, Russia, France, Britain, Italy, Germany, Canada, and Japan) use to protect sensitive scientific and technological knowledge and products from being acquired and misused by terrorists, with an emphasis on those technologies that can be used in the production of WMD.

MANPADS Vulnerability (analytic support).

In the wake of an attack on an El Al passenger jet in Kenya and the vulnerabilities faced by U.S. airports, S&TPI assisted OSTP in assessing the threat posed by man-portable air defenses (MANPADS) to commercial airline aircraft and operations, and in considering potential mitigation measures, their costs, and alternative implementation plans. S&TPI presented results to representatives from OSTP, the Transportation Security Administration, the Department of Defense, the Federal Aviation Administration, and the Mitre Corporation.

Blue Ribbon Panel on the Threat of Biological Terrorism Directed Against Livestock.

S&TPI was asked to assemble a blue ribbon panel that would help assess the potential threat of biological terrorism against U.S. livestock and describe a future Federal research agenda that prioritizes steps needed to safeguard industries associated with this sector. The conference proceedings is expected later in 2004.

Protecting Emergency Responders

After 9/11, S&TPI undertook a series of projects for NIOSH Safety and Health as part of a coordinated effort to analyze emergency responder needs associated with large-scale disasters and terrorism. Some focused on management and strategy, others on operations.

Improving Personal Protective Technologies for Emergency Responders: Critical Needs for Critical Missions.

To support the newly established National Personal Protective Technology Laboratory (NPPTL), NIOSH asked S&TPI to help it design an R&D agenda that would improve the equipment and training for emergency responders. S&TPI held a conference of emergency workers who responded to the bombing of the Murrah Building in Oklahoma City, the September 11 attacks on the World Trade Center (WTC), and the anthrax incidents that occurred during autumn 2001. The conference resulted in a report addressing the equipment, training, and infor-

mation needs of emergency responders as they meet the challenge of protecting communities. In addition to the conference, S&TPI also undertook an extensive research effort to examine the protective needs of emergency responders more broadly. That effort included interviews with members of the responder community and analysis of available data on responder injuries and fatalities.

Publications: *Protecting Emergency Responders—Lessons Learned from Terrorist Attacks.* Brian Jackson et al. CF-176-OSTP, 2002. *Protecting Emergency Responders: Community Views of Health and Safety Risks and Personal Protection Needs.* Tom LaTourrette et al. MR-1646-NIOSH, 2003. *Emergency Responder Injuries and Fatalities: An Analysis of Surveillance Data.* Ari N. Houser et al. TR-100-NIOSH, 2004.

Health & Safety Data for Emergency

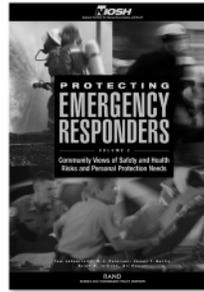
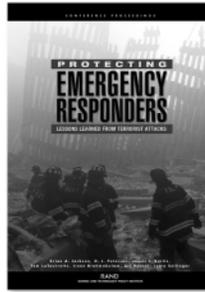
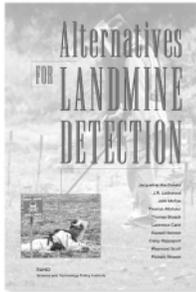
Workers. S&TPI worked with NIOSH to compile scientific and technical information and expert judgment required for publishing a comprehensive report on management processes and training that will improve the health and safety of disaster rescue and recovery workers. The final report will contain data, insights, and recommendations based on lessons from the WTC attacks and other major disasters. Using a research team approach, this effort integrates the work of NIOSH, RAND, and external experts on emergency worker safety and health. The focus is on the management issues and training implications most relevant to local emergency response managers and workers. The project team identified the key elements of an effective disaster safety management program that can deal with both natural disasters and large-scale terrorist attacks.

In Press. *Protecting Emergency Responders Volume 3: Safety Management in Disaster and Terrorism Response.* Brian Jackson et al. MG-170-NIOSH, 2004.

Post-Structural Collapse Hazards (analytic support). This project provided the NPPTL

with scientific and technical information and expert judgment for the purpose of publishing health and safety guidelines for emergency responders required to work near or on the remains of a recently collapsed or partially collapsed building or group of buildings. This effort focuses on high-rise commercial and residential buildings. The guidelines will address personal protective equipment options for emergency responders as they perform time-critical missions of lifesaving, suppression of fire and other hazards, recovery of vic-

tims, site restoration, and on-site investigations, including the gathering of forensic information. The guidelines will apply to the full range of emergency workers who are likely to respond to a large structural collapse, including local fire, medical and hazardous material teams and law enforcement assets, as well as reinforcements, such as the Federal Emergency Management Agency Urban Search and Rescue (USAR) teams and relevant members of the trades, such as heavy equipment operators.



INFORMATION TECHNOLOGY

Information technology—notably computers and networked systems—touch nearly every aspect of public policy. On the positive side, these technologies have enabled access to vast amounts of data and information that can improve decisionmaking. On the negative side, they have raised policy concerns about privacy and intellectual property. S&TPI's work on information technology seeks to understand the potential uses of information technology to achieve policy goals and to assess its potential impact across a range of activities, focused on improvement of government services and collaborative decisionmaking.

Global Spatial Data Infrastructure.

Geospatial data, information, and technologies are becoming increasingly common tools throughout the world because of their capacity to improve collaborative decisionmaking in such areas as natural resource management, agriculture, and mapping. This study analyzed international collaboration for the Global Spatial Data Infrastructure (GSDI). S&TPI conducted ten in-depth international and regional collaboration case studies to assess lessons learned for GSDI development and implementation. Representatives at the United States Geological Survey (USGS), Federal Geographic Data Committee of the GSDI have used the S&TPI study results to help in the development and implementation of the GSDI.

Publication: *Lessons for the Global Spatial Data Infrastructure: International Case Study Analysis.* Beth E. Lachman et al. DB-380-USGS, 2002.

A Survey of State Laws on Privacy and Spam (analytic support). An unanticipated effect of the computer revolution and the rise of networks is “spam,” defined as unsolicited electronic mail that is beginning to pose serious network traffic problems and leading to increased loss of privacy and vulnerability to unwelcome information. The United States does not have a com-

prehensive policy or federal statute governing privacy and spam. American privacy law is a patchwork of statutes and judgments passed largely at the state level. States have also taken the lead on addressing the problem of unsolicited electronic mail or spam. This project surveyed recent privacy- and spam-related statutes passed by the states and analyzed similarities, gaps, and conflicts among them.

Department of Justice Communication Infrastructure (analytic support). Advances in computer and telecommunication technologies hold the potential to dramatically improve government operations and services. In the past, S&TPI has helped a variety of federal agencies improve communication and customer relations. This analysis for the Department of Justice (DOJ) helped DOJ create an overall information technology strategy, including network implementation and improvements to border control systems. The study considered the need for cost-effectiveness, likely technological advances over the next decade, and the need for interoperability among both DOJ components and DOJ's customers.

EDUCATION, TRAINING, AND WORKFORCE ISSUES

Two important developments—concerns about U.S. science education and the growing demand for a technologically literate workforce—have brought S&T issues to the fore in education and training policy. Our recent work in this area has focused on addressing gaps in the scientific literature and examining workforce issues posed by the changing demand for scientific and technological skills.

Strategic Agendas for Research in Reading Comprehension and Mathematics Education.

S&TPI's most recent work on education was intended to help the Department of Education design an effective educational research program to answer longstanding questions about how children acquire reading and mathematics skills and how this knowledge can be put to practical use in the classroom by teachers. Recommendations of the reports were reflected in solicitations issued by the Institute of Education Science in fiscal years 2002 and 2003.

Publications: *Reading for Understanding: Toward an R&D Program in Reading Comprehension.* Catherine E. Snow. MR-1465-OERI, 2002. *Mathematical Proficiency for all Students: Toward a Strategic R&D Program in Mathematics Education.* Deborah Ball. MR-1643-OERI, 2003.

The Supply of U.S. Scientists and Engineers.

Is there a shortage of scientists and engineers in the United States? Many experts believe there is. This study examined the issue from several perspectives and concluded that by most measures there is no clear evidence of such a shortage. However, when measured against the growth among the scientific and engineering output of foreign competitors, there is some evidence that the United States is losing ground.

Publication: "Is There a Shortage of Scientists and Engineers? And How Would We Know?" William P. Butz et al. IP-241, 2003.

How Will We Recognize a Shortage of Scientific and Technical Workers? Data Needs for Decisionmaking.

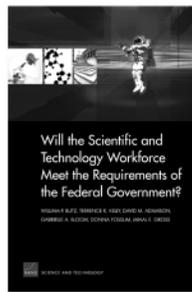
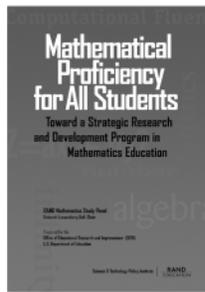
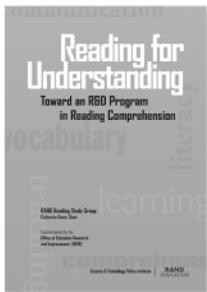
As a follow-up to the study of the U.S. science and engineering workforce, S&TPI conducted a workshop to explore data and collection methods needed to improve the ability of federal policymakers, university administrators, and students to recognize impending shortages or surpluses of scientific and technical workers in particular fields. Participants included labor market researchers, policymakers and administrators from federal science agencies, and experts from federal statistical agencies. The conference proceedings is expected later in 2004.

Assessing the Federal Scientific and Technical Workforce. Concerns have emerged in federal policy circles that the federal scientific and technical workforce may face shortages of personnel and key capabilities in the near future. This study examined available personnel data

and interviewed R&D managers at key federal agencies. The analysis found no consistent and convincing evidence that the federal government faces current or impending shortages of scientific and technical workers. However, existing data are uneven and do not support comprehensive analysis, especially of future requirements. Given concerns that personnel shortages and skill gaps may become a problem, the federal government needs to monitor this issue closely and assemble more complete and consistent scientific and technical workforce data.

Publication: *Will the Scientific & Technical Workforce Meet the Requirements of the Federal Government?* William P. Butz et al. MG-118-OSTP, 2004.

Toward a New Strategy for Federal Research on Child and Youth Development. This study examined federal research on children and youth. In particular, it sought to improve coordination across the 22 federal funding agencies that study children's issues. A panel of leading researchers and research administrators with diverse disciplinary training and research experience provided input into this study, which will result in recommendations for further research and potentially useful program initiatives.



AEROSPACE AND TRANSPORTATION

Budget constraints and a growing private sector role have transformed the U.S. space enterprise. The National Aeronautics and Space Administration (NASA) and the U.S. space industry have grappled with the challenge of containing costs while maintaining high levels of performance and safety and generating technological innovation at static or reduced levels of R&D funding. At the same time, shifts in the aerospace industry and the growing burden on the nation's air-traffic system have created new policy concerns. Our work in aerospace and transportation has focused on broad policy directions in space and aviation policy as well as space system project management, program costs, and operating models.

NASA Shuttle Competitive Sourcing Task Force. Recent S&TPI work for NASA exemplifies our ability to help federal clients balance multiple objectives. Seeking to improve the cost-effectiveness of its activities while maintaining the highest levels of safety, NASA turned to S&TPI to provide analytic support for the independent Space Shuttle Competitive Sourcing Task Force.

Publication: *Alternate Trajectories: Options for Competitive Sourcing of the Space Shuttle Program.* Space Shuttle Competitive Sourcing Task Force, Washington, D.C. Prepared for the Office of Space Flight, NASA, 2002.

R&D in Aircraft Manufacturing Supply Chain. Federally funded, high-risk, capital-intensive R&D is critical to ensure the flow of innovation that undergirds a competitive advantage for U.S. aviation vendors. The structure of the modern aeronautics industry depends on supply-chain vendors for a significant element of its innovative vitality. This analysis examines changes in the commercial aircraft industry that have led to an increased role of the supply chain in the R&D of aircraft components. It evaluates the allocation of federal R&D funding to the supply chain relative to the increased role for the supply chain in performing R&D. It also examines the roles that federal R&D agencies can play in overcoming inefficiencies in R&D that are inherent in the aviation supply chain.

Publication: "Redirecting R&D in the Commercial Aircraft Supply Chain." Lance Sherry and Liam Sarsfield. IP-212, 2002.

History and Impact of Aerospace R&D. This NASA project analyzed the history of federal R&D investments in space and aviation and assessed their influence on the U.S. S&T base and on industry. The final report focuses on the National Advisory Committee for Aeronautics' and NASA's contributions to help foster and sustain the U.S. aerospace industry at the national, regional, and local levels. NASA is expected to publish this document in its history series.

Assisting NASA Decisionmaking and Planning (analytic support). Four efforts provided analytic support for various NASA units. The first helped NASA's Office of Earth Science (OEA) Applications Division (AD) think strategically about its mission to promote the use and development of earth science data and remote sensing technologies. S&TPI conducted a short-term strategic planning analysis to help AD assess appropriate future paths and developed a process for designing program and project metrics to help AD develop and evaluate future activities. A second effort focused on the International Space Station Management

and Cost Evaluation (IMCE) Task Force. This project supported the Cost Analysis Support Team of NASA's IMCE Task Force by providing independent technical and financial analysis of the plans, budgets, and engineering strategies for the completion and operation of the International Space Station. A third effort helped NASA's financial office review its cost estimating procedures.

Ongoing Support for Space Policies and Programs. S&TPI analyzed issues of interest to OSTP in conjunction with space-related programs, technologies, and national policies. The project team most recently provided support concerning space transportation policy. S&TPI discussed potential changes in the National Space Transportation Policy Review in a working paper that is available on RAND's Web site.

Publication: *National Space Transportation Policy: Issues for the Future*. Thor Hogan and Vic Villhard. WR-105-OSTP, 2003.

Available for download at
<http://www.rand.org/publications/WR/WR105/>.

U.S. Commercial Remote Sensing (analytic support). The objective of this research was to assist the USGS, the National Atmospheric and Oceanic Administration, NASA, and their U.S. civil agency partners, in the development and documentation of an implementation plan for commercial remote sensing, in accordance with the new White House Commercial Remote Sensing Policy. This research involved direct participation in civil agency and other meetings, research on related issues, and documentation of the plan as well as the process undertaken.



ENERGY, ENVIRONMENT, AND HEALTH

These fields are intertwined and also share a point of convergence on the issue of technological innovation. Technological change in all three has produced revolutionary improvements in the quality of American life, but has also created unanticipated problems. Potential future progress, in turn, holds the promise for addressing problems and producing further improvement. S&TPI has examined the issue of innovation in all three areas, with a particular focus on the potential benefits and costs of technologies, research methods, and information tools.

Energy

High-Temperature Superconducting Technologies. One critical dimension for energy policy involves meeting growth in energy demand without compromising environmental standards. High-temperature superconducting power technologies can address existing problems and help meet growing demand in the U.S. electric power transmission grid, especially problems with transmission constraints and electricity line losses.

Publication: *Strengthening the Grid: Effect of High-Temperature Superconducting Power Technologies on Reliability, Power Transfer Capacity, and Energy Use.* Richard Silbergliett et al. MR-1531-DOE, 2002.

Support for the Department of Energy's Energy Efficiency and Renewable Energy Program. S&TPI assisted DOE's Energy Efficiency and Renewable Energy office in identifying and assessing the full range of emerging issues that will affect future energy use and supply, with particular attention to R&D for energy efficiency and renewable energy technologies. This study was part of an effort to identify state-level factors that may contribute to efficient energy use nationwide. The project team examined changes in energy intensity in 48 states from 1977 through 1999. Some factors that may explain differences in states' energy intensity are energy prices, new construction, capacity utilization, population, climate, technology innovations, and government energy policies.

Publications: *State-Level Changes in Energy Intensity and Their National Implications.* Mark Bernstein et al. MR-1616-DOE, 2003. *E-Vision 2002: Shaping our Future by*

Reducing Energy Intensity in the U.S. Economy. David Ortiz and Jerry Sollinger. CF-184-DOE, 2003.

Environment

Assessing the Prospects of "Next Generation" Environmental Technologies. A range of innovative technologies can potentially reduce the negative environmental effects of manufacturing processes. This study examined the potential benefits of a new science-based approach to environmental protection that focused on redesign of key production processes at the molecular level to reduce environmental impacts. The study encompassed the range of relevant S&T opportunities, their potential environmental and economic benefits, and key actions needed to remove impediments to their further adoption.

Publication: *"Next Generation" Environmental Technologies: Benefits and Barriers.* Robert Lempert et al. MR-1682-OSTP, 2003.

Greater Yellowstone Ecosystem Environmental Indicators (analytic support). OSTP asked S&TPI to explore the potential for a science-based indicator and information technology system to support collaborative natural resource management decisions in large watersheds. S&TPI examined the potential value of an indicator system designed within a geographic information system (GIS) as a decision-support tool. The focus was on decisionmaking in the Greater Yellowstone Ecosystem (GYE), an ecosystem of national interest. The project developed a prototype of a GIS-based indicator system that would support decisionmaking in the GYE and facilitate greater collaboration and

information sharing. S&TPI analysts presented the prototype indicator system in the field to over 40 different scientists and local, state, and federal managers. Federal, state, and local agencies are using the database and study results from this project to help improve collaborative and integrated data management in the region.

Methylmercury in the U.S. Gulf Coast (analytic support). S&TPI provided analytic support to OSTP and the NSTC Interagency Working Group on Methylmercury examining potential human health concerns in the U.S. Gulf Coast region. This included assisting OSTP in synthesizing existing data into a coherent matrix and identifying gaps in the research activities and data. Identifying these gaps will guide a set of recommendations for future research in federal agencies.

Health

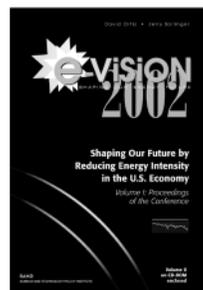
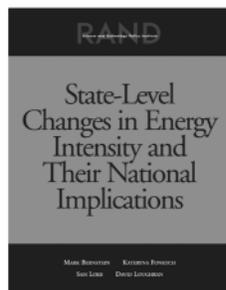
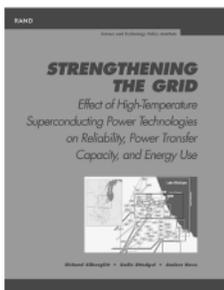
Cost of Clinical Cancer Trials. Many health insurance providers restrict payments for participation in studies of new cancer treatment protocols because of concerns that participation in such trials—especially those conducted under federal auspices by the National Institutes of Health (NIH) increases patient care costs. Such restrictions by insurance providers threaten to undermine the effectiveness of clinical trials and the ability of patients to participate. Yet data on costs of clinical trials have never been gathered. For this multiyear project, S&TPI tracked treatment costs for 750 patients enrolled in clinical trials funded in part by the NIH at 55 randomly selected institutions across the country. Costs for the 750 partici-

pants were compared to costs for 750 “control” patients enrolled in cancer treatment programs that are not part of clinical trials. The final results showed that added costs of participation in clinical trials were small—less than 4 percent on average, a statistically insignificant difference.

Publications: “Incremental Treatment Costs in the National Cancer Institute-Sponsored Clinical Trials.” Dana P. Goldman et al. *Journal of the American Medical Association*, Vol. 289, No. 22, June 11, 2003, pp. 2970–2977. “Measuring the Incremental Costs of Clinical Cancer Research.” Dana P. Goldman et al. *Journal of Clinical Oncology*, Vol. 19, No. 1, January 1, 2001, pp. 105–110. *The Cost of Cancer Treatment Study’s Design and Methods.* Dana P. Goldman et al. MR-1169-NCI/NIH/OSTP, 2000.

Impact on Health Care Industry of Moving to a New Diagnosis and Procedures Classification System. The International Classification of Diseases is the standard used in the United States for reporting medical diagnoses and procedures. The National Committee of Vital and Health Statistics (NCVHS), in the Department of Health and Human Services, is considering adoption of an upgraded standard. S&TPI helped NCVHS assess the potential healthcare industry costs and benefits of such a change.

Publication: *The Costs and Benefits of Moving to the ICD-10 Code Sets.* Martin Libicki and Irene Brahmakulam. TR-132-DHHS, 2004.





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