CHAPTER THREE

PROBLEMS, CHALLENGES, AND RECOMMENDATIONS

During the NSB task force's information-gathering process and its deliberations, three major issues emerged as immediate critical challenges for the United States Government with regard to its international S&E research and education policy. (See Appendix B for summaries of the three hearings organized by the task force and Appendix C for a list of participants in the hearings and other aspects of the task force's work.)

- The need for more effective U.S. Government coordination of its international S&E and S&E-related activities;
- The need to strengthen international cooperation in fundamental research and education, particularly with developing countries and by younger scientists and engineers; and
- The need to improve the use of S&E information in foreign policy deliberations and in dealing with global problems.

A. COORDINATION OF THE U.S. GOVERNMENT'S INTERNATIONAL S&E ACTIVITIES

Although there are few sources of systematic information, particularly trend data, on international cooperative S&E and related activities, the limited information available suggests such activities supported by the Federal Government are increasing. However, a clear picture of the activities of the various Federal agencies, the degree of coordination among them, and how well they are integrated is lacking. More and better information is needed to ensure that appropriate structures and mechanisms exist for the coordination and management needed to eliminate unnecessary duplication, prevent inefficiencies, and facilitate synergy.

"In addition to the scarcity of funds, the efforts of many Federal agencies on the international front are underappreciated and undervalued. Many of the things they are asked to do are essentially unfunded mandates. The absence of line items for most international activities prevents agencies from being fleet-footed enough to react and deal with international issues, particularly in developing countries, in any coherent way with long-term support."
Alan Hecht, Former Principal Deputy Assistant Administrator, EPA (Summary of key points at NSB hearing, July 1999)

Overall leadership for international science and engineering policy lies in the White House within OSTP. However, the focus of OSTP is necessarily selective, directed at the early stages of an issue and at critical day-to-day issues of diplomacy and security that most often pertain to "science for policy." Since the office is small, the preponderance of the activity related to international S&E is limited to policy development and policy making, with implementation and follow-through left to the agencies. Although CISET has been a valuable contributor to interagency coordination, its role appears to fluctuate over time. In recent years, its role has been less visible. In the future, U.S. leadership will require more visible and consistent attention to longer-term issues of "policy for science."

In many cases official international S&E agreements have no associated budget authority. Only a small fraction of overall Federal expenditures for international S&E activities derives from specifically designated international program budgets. Federal agency expenditures for international activities (with the exception of the Department of State and the U.S. Agency for International Development (USAID)) are justified and budgeted primarily in terms of contributions to the programmatic rather than the international objectives of the respective agencies. This programmatic approach frequently leads to a paucity of funds for management, coordination, and communication of internationally focused activities.

An additional problem is the difficulty of maintaining interest in and support for long-term international projects. The absence of follow-through on several high profile scientific projects has led at times to our international partners regarding us as unreliable.[36] Congress has generally been unwilling to set aside multi-year funding for such projects at their outset, resulting in discontinuities and requiring considerable effort by agencies and the Executive Branch to assure sustained funding. The importance of stable funding to the success of large-scale international science and engineering projects cannot be overemphasized.

The foregoing points to the importance of creating an effective infrastructure for coordination of international S&E policy. Effective coordination and management require extensive and timely information about international S&E activities. Currently, such information is often difficult to gather and interpret, and mechanisms for communication and sharing this information are not always adequate. A number of agencies collect and disseminate information about science and engineering activities in other countries, and the National Science Foundation and the Office of Naval Research (ONR) have overseas offices for this purpose. However, additional information and better mechanisms of communication are needed, especially relating to the resources directed towards international S&E activities by individual Federal agencies. In its biennial publication, *Science and Engineering Indicators*, the National Science Board provides information about science and technology throughout the world, placing U.S. data in an international context. The Board plans to expand and increase the visibility of its international coverage in future volumes of *Indicators*.

[36] Two examples are the International Thermonuclear Experimental Reactor (ITER), which the Department of Energy withdrew from in 1999 due to budget cuts and the International Solar Polar Mission, which the National Aeronautics and Space Administration withdrew from in the early 1990s due to severe budget cuts.

A variety of U.S. Government policy development processes, including those for S&E, often fail to include specific consideration of direct and indirect impacts on international cooperation. The interplay of policies or activities relating to areas such as immigration, intellectual property rights, and data exchange may have unintended consequences, resulting in barriers to effective cooperation in international S&E activities. Similarly, policies of other countries related to intellectual property rights, access fees, restricted access to facilities, and visa problems also create impediments to international S&E cooperation.

RECOMMENDATION 1

The Office of Science and Technology Policy (OSTP) should strengthen its international focus to ensure an effective, integrated, visible, and sustained role in monitoring, coordinating, and managing U.S. international S&E research and education activities. As part of this effort, OSTP should actively encourage Federal agencies to identify and increase the visibility of their international S&E research and education activities, to provide an adequate level of funding for these activities, and to allocate adequate funding and resources for their coordination and management. The Office of Management and Budget should be encouraged to prepare an annual international S&E budget crosscut similar to its annual research and development (R&D) budget crosscut, that includes international activities found outside specifically designated international program budgets.

RECOMMENDATION 2

OSTP should encourage agencies to develop more effective mechanisms for gathering and disseminating information about U.S. collaboration and partnerships in international S&E activities and similar activities in other countries, with emphasis on fundamental research and S&E education.

RECOMMENDATION 3

The United States Government should promote the development of international S&E policy aimed at facilitating international cooperation in research and education. The formulation and implementation of policies related to areas such as immigration, intellectual property rights, and the exchange of scientific information and personnel should include consideration of their impact on cooperation in research and education.

B. ENHANCING AND EXPANDING U.S. INTERNATIONAL S&E RESEARCH AND EDUCATION

"The growth of modern communications technologies, coupled with the existence of cutting-edge scientific research programs in foreign countries, has made it both possible and scientifically useful for the United States to leverage our own investments in research with those taking place in foreign nations. Not only does this allow U.S. researchers access to unique research, it also allows them to reap the full benefits of that research at a fraction of the cost."
U.S. House Committee on Science—Hearing Charter, International Science. (1998)

Scientific leadership requires access to people, knowledge, and S&E infrastructure, wherever they are found. Effective collaboration and partnerships in S&E activities with other nations are key to achieving this access. Such cooperation is also critical to raising the collective international capacity to solve global problems in environment, health, energy, disaster management, and other areas with an important S&E dimension and, in the long term, contributing to economic growth, national security, and quality of life. Collaboration with other countries also makes it possible for the United States to leverage its S&E research and education investments and allows U.S. researchers to obtain the full benefits of collaborative research while sharing the financial costs with others.

Two areas deserve special attention: increased participation in international S&E activities by younger scientists and engineers and increased collaboration with developing countries.

Participation by Younger Scientists and Engineers: U.S. students who study and conduct research abroad not only learn more about the people and culture of the countries they visit but also enhance their skills and capabilities, ultimately making them more productive participants in the U.S. labor force. In the private sector, international experience is highly marketable. It is also increasingly a requirement for success in conducting business. U.S. researchers learn from their peers in other countries, and collaboration with them helps in solving important fundamental research problems on which continued U.S. leadership depends. However, it is often difficult to convince younger scientists and engineers to become involved in international cooperative S&E research and education activities because of limited incentives and a widespread perception in many fields that time spent abroad may be detrimental to one's career. Re-entry after a sojourn abroad may put the young person outside the normal cycle of academic life. Young scientists and engineers may also need assistance re-connecting with networks, assessing opportunities that would make best use of their new skills, and in dealing with an atypical career path with respect to their U.S. colleagues. There is also less emphasis in the U.S. higher education system than in the past on learning a second language. An absence of foreign language skills among many younger scientists and engineers also may limit the opportunities for collaboration in a number of countries.

"Our production sectors will be effective competitors only if they have the knowledge base, including workers and staff who are knowledgeable about other countries, to develop effective strategies for competing. At the same time, the knowledge generated by international collaboration will help serve our foreign and economic policy more generally by producing new knowledge on the institutional arrangements in other countries, by increasing our understanding of the cultures of other countries, and by increasing the knowledge base to compete with them."
Edward Schuh, 2000 AAAS Annual Meeting

Foreign students and researchers coming to the United States learn about U.S. culture and values. Those who remain in this country are an important addition to our S&E workforce and those who return home bring a deeper understanding of U.S. culture and values to their own countries. This cross-fertilization, with U.S. scientists and engineers spending time abroad and foreign scientists and engineers spending time in the United States, is important in enhancing communication among diverse people and building on the values of cooperation, open-mindedness and tolerance that are necessary for solving many of the critical problems facing the world.

In a recent study focused on re-envisioning the Ph.D., U.S. students indicated that international graduate students in the United States are more aware than American students of what is going on in the world. The U.S. students also indicated a need to acquire a more global perspective and said that they wanted more concrete ways to understand their education and training within the context of the global economy. [37]

RECOMMENDATION 4

Federal agencies should encourage and support policies and programs that provide incentives for expanding participation in international cooperative research and education activities by younger scientists and engineers.

Collaboration with Developing Countries: The world economy is changing and knowledge and human capital are supplanting physical capital as the major ingredients for sustainable economic development. Although favorable natural resource positions may continue to be a source of growth in some developing countries, a skilled work force and scientific and technological capabilities are likely to be much more important factors. In addition to having a major impact on long-term economic well being, science and technology also help provide solutions to many of the problems that afflict the poorest countries, including health and natural and man-made disasters. Most developing countries are aware of the need to build their science and engineering infrastructure capacity, and especially their human capacity through education and training. Developing new tools and technologies, building networks of research organizations to promote research, and enhancing indigenous research capacity will help to ensure sustainability and self-reliance in carrying out future research relevant to their diverse needs.

Particularly in the S&E realm, traditional forms of development assistance such as foreign aid are being replaced by a new emphasis on sustainable development through creation of the necessary infrastructure, including human resources, for participation in the S&E arena. Supporting the training of people and the creation of conditions where those people can work at top levels in their countries is a critical priority.

The developing countries are a source for diverse S&E talent and knowledge, produce key imports, and provide a market for exports. Also, because of U.S. entrepreneurial and innovative leadership, the S&E knowledge obtained through international collaboration provides mutual benefits to the United States as well as the developing countries. Expanding scientific and technological cooperation with these countries may also be a vehicle to achieve other important goals, such as improved relations and support for the U.S. position on an array of global issues.

"For developing countries the global expansion of knowledge contains both threats and opportunities. If knowledge gaps widen, the world will be split further, not just by disparities in capital and other resources, but by the disparity in knowledge. Increasingly, capital and other resources will flow to those countries with the stronger knowledge bases, reinforcing inequality. There is also the danger of widening knowledge gaps within countries, especially developing ones, where a fortunate few surf the World Wide Web while others remain illiterate. But threat and opportunity are opposite sides of the same coin. If we can narrow knowledge gaps and address information problems, it may be possible to improve incomes and living standards at a much faster pace than previously imagined."
John Daley, World Bank, 1998

[37] Jody D. Nyquist and Bettina J. Woodford. *Re-envisioning the Ph.D. What Concerns Do We Have?* , University of Washington, 2000, pp. 21, 28. Funded through the Pew Charitable Trusts.

"In a world where globalization and competitiveness are the rule, progress requires that developing countries find areas in which they are significantly better than their competitors because of a better trained work force, favorable natural resources, or scientific and technological capabilities. Science and scientists can play an important role in determining those choices and implementing development strategies."
Jose Goldemberg, *Science*, 1998

Since a number of international and multilateral organizations have recently taken a fresh look at scientific and technological support to developing countries, this is an especially auspicious time to focus on the U.S. Government's role with respect to developing countries. In 1997, USAID established a policy on research support that laid out the standards and criteria for determining research priorities.[38] In the past, the World Bank has mainly responded to client demands in this area rather than taking an integrated approach. But in the 1998-1999 "World Development Report on Knowledge for Development," a flagship statement, the Bank stressed the role of knowledge in the process of development.[39] The Inter-American Development Bank has recently unveiled a new strategy on science and technology to take a systems approach to ensure that all the pieces in national innovation systems are available to ensure that technological development can take place.[40] The World Bank and the United Nations Education, Scientific, and Cultural Organization (UNESCO) convened a task force on higher education in developing countries whose report, issued in 2000, concluded that without more and better higher education, developing countries will find it increasingly difficult to benefit from the global knowledge-based economy.[41] Private foundations also play a role in promoting international S&E research and education cooperation. The United States is in position to strengthen its collaboration with all of these types of institutions, allowing leveraging of resources, reducing costs and risks, enabling activities that might not have been undertaken otherwise, and bringing U.S. S&E expertise into the planning process at an early stage.

Recommendation 5

Federal agencies should encourage development of human and physical infrastructure for science and engineering in developing countries through partnerships with international, multilateral, and private organizations providing support to developing countries for S&E research and education.

C. Foreign Policy and Global Problem Solving

"Today the United States is in an unenviable position. Among the world's leading nations, its process for developing foreign policy is the least well coordinated with advances in S&T and the policies affecting them."
J. Thomas Ratchford, *Science*, 1998.

While science and technology have always influenced foreign policy, and vice versa, there is growing concern that foreign policy and related deliberations on many issues of international importance give inadequate attention to science and technology. Today, it is especially important to include them as an integral

[38] Testimony by Ray Kirkland, Associate Assistant Administrator for Population, Health, and Nutrition, Global Bureau, United States Agency for International Development, at the NSB International Task Force Hearing on Global Science and Engineering: Foreign Perspectives, Multicultural and International Organizations, November 16, 1999, Arlington, VA.
[39] Testimony by Michael Crawford, a science and technology specialist at the World Bank, at the NSB International Task Force Hearing on Global Science and Engineering: Foreign Perspectives, Multicultural and International Organizations, November 16, 1999, Arlington, VA.
[40] Testimony by Laurence Wolff, Senior Consultant for Education Unit, Sustainable Development Department, at the Inter-American Development Bank, at the NSB International Task Force Hearing on Global Science and Engineering: Foreign Perspectives, Multicultural and International Organizations, November 16, 1999, Arlington, VA.
[41] The World Bank/UNESCO, Task Force on Higher Education and Society, *Higher Education in Developing Countries: Peril and Promise*, Washington, DC. 2000,

part of foreign policy development, in light of the rapid S&E advances underway throughout the world and the proliferation of problems having an important S&E dimension. Science and technology play a large role in a number of issues with international ramifications including nuclear nonproliferation, use of outer space and space-launch technology transfer, population growth, trade issues, intellectual property rights negotiations, food supply, global climate change, infectious diseases, terrorism, energy resources, disaster prevention and management, and encryption technology, to list just a few.

In 1998, the Department of State requested that the National Research Council (NRC) initiate a study of the contributions that science, technology, and health can make in the formulation and implementation of foreign policy and suggest how the Department might better carry out its responsibilities to that end. Consistent with a number of earlier studies on this topic, the NRC report, *The Pervasive Role of Science, Technology, and Health in Foreign Policy: Imperatives for the Department of State,*[42] emphasized the need for a fundamental change in the orientation of the U.S. foreign policy community. The report recommended strengthening the capabilities of the State Department in areas involving S&E considerations through the commitment of agency leadership, an improved organizational structure, and an informed and motivated staff. The report also noted the need to increase available resources to implement the report's recommendations. As of late 2001, a number of changes have already taken place at the Department in response to the recommendations made in the NRC report. Some of these include the appointment of a Science and Technology Advisor to the Secretary of State, an increase in the number of external S&E fellows from private organizations and Federal agencies, and the holding of a number of S&E roundtables for senior officers at State and other U.S. Government agencies.

The National Science Board concurs with NRC's conclusions and notes that a number of Federal agencies are in a position to assist State with respect to advice, information, and data on S&E issues affecting foreign policy decisions. For example, NSF, with its broad mandate in basic research and S&E education is in a position to make its expertise available on a wide range of fundamental science and engineering issues. Also, U.S. agencies with significant S&E responsibilities (for example, ONR, DOE, and NOAA) frequently have information and staff located in the United States and abroad that can serve as valuable resources to U.S. foreign policy staff. This resource is especially important since the number of science officers has decreased markedly in recent years at a time when S&E advice on foreign policy and other global issues has become more important than ever. However, increased assistance by other agencies may be difficult without both an additional Federal investment in financial and human resources and a strong signal at the highest levels of government that increased cooperation and coordination are desired objectives.

"Issues involving science, technology, and health (STH) have moved to the forefront of the international diplomatic agenda. Other vital issues linked to technological developments pervade longer-range foreign policy concerns. In addressing these issues, expert STH knowledge is essential to the anticipation and resolution of problems and to the achievement of foreign policy goals. Precisely because STH developments are a pervasive global force, they cannot be isolated from the fundamental workings of foreign policy, and effective foreign policy must reflect a comprehensive approach within the Department [of State] to integrating STH competence into policy and program formulation and execution."
National Research Council, 1999

[42] National Research Council, Office of International Affairs, *The Pervasive Role of Science, Technology, and Health in Foreign Policy: Imperatives for the Department of State,* Washington, DC. 1999.

"That is why scientific societies across the globe must take a more active role in helping political leaders and the public make more informed decisions. It's not enough to recognize that every nation today needs its own scientific capacity—both to address local issues and to take advantage of the vast resources of science. This scientific capacity also needs to be organized in a way that gives it a powerful voice."
Bruce Alberts, *The Scientist*, May 2000

However, reliance solely on U.S. institutions to improve the integration of science and engineering with foreign policy and global problem solving will not be enough. International organizations around the world may also have to take a more active role. There are a number of such organizations—both governmental and non-governmental—that already play a role in science and engineering activities on an international scale. International organizations having long-standing interests in this area include the OECD, several United Nations agencies, including UNESCO, and the International Council for Science (ICSU). Additionally, last year in order to address related issues of international concern, a group of science academies from around the world, the InterAcademy Panel, announced formation of a new organization, the InterAcademy Council. This organization plans to bring together scientists, engineers, and medical experts to provide advice to international bodies such as the United Nations system and the World Bank on issues involving science and technology.

RECOMMENDATION 6

The U.S. Government, especially the Department of State, with its primary responsibility for U.S. foreign policy, should recognize and address the importance of science and engineering in achieving its objectives. Mechanisms should be identified to improve communication among science officers, other U.S. embassy personnel, and science and engineering staff of other Federal agencies, including those working abroad, to facilitate sharing of information critical to planning and decision making, and to improve the general flow of information on critical S&E issues.

RECOMMENDATION 7

The U.S. Government should strongly endorse the spirit of the recommendations of the 1999 NRC report to the State Department and ensure that responses to those recommendations are implemented expeditiously. Because developing an appropriate U.S. capability in this arena requires a long-term concerted effort, effective change will require a multi-year, multi-Administration, and bipartisan response, with appropriate levels of funding.