

Introduction

International science and engineering (S&E) partnerships engage peoples and nations in cooperative work on mutual problems using the common language and values of S&E. International S&E partnerships provide wonderful opportunities for educating the participating partners in S&E and, perhaps more importantly, building trust and communication. An international S&E partnership can be as modest as two scientists or engineers collaborating on a problem of mutual interest across national boundaries or as complex as the International Space Station or the International Polar Year (IPY). Examples of existing international S&E partnerships are included in Appendix A.

The National Science Board (Board) envisions international S&E partnerships as important tools of U.S. diplomacy. They may be used to strengthen diplomatic relationships worldwide and to promote basic scientific values such as accountability, meritocracy, transparency, and objectivity. Through international S&E partnerships, the U.S. can build and sustain a preeminent role in the international S&E arena; the rest of the world should see the U.S. as a home of strong S&E capabilities and fundamental research values. In today's global S&E enterprise, the U.S. is not the leader in all S&E fields, such as in cyberinfrastructure.⁹ Hence, in order to be at the forefront of discovery and innovation, it is vital that our Nation be fully engaged in international S&E partnerships. The potential products of successful international S&E partnerships are numerous, including economic development, capacity building of civil society, elevation of women and underrepresented groups, and productive, socially responsible solutions to global S&E problems.

Dr. Vannevar Bush highlighted the importance of international science to the U.S. and to the National Science Foundation (NSF) in his 1945 report¹⁰ that led to the establishment of NSF: *The Government should take an active role in promoting the international flow of scientific information.* At about the same time, the United Nations recognized the importance of international science by establishing the United Nations Educational, Scientific and Cultural Organization (UNESCO)¹¹ to contribute to peace and security by promoting international collaboration through education, science, and culture. Following the recognition of the importance of international S&E by these two bodies, a host of non-governmental organizations (NGOs) followed suit. These organizations include the International Council for Science (ICSU),¹² the World Federation of Engineering Organisations (WFEO),¹³ and the Academy of Sciences for the Developing World (TWAS).¹⁴

Currently, the U.S. Government is actively involved in supporting international S&E partnerships. However, its involvement suffers from a lack of coordination among agencies and organizations because no Federal agency is singly responsible for taking the lead. Coordination is difficult because relevant policy issues often transcend individual agencies, requiring agencies – often with different objectives – to work

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together. The U.S. Government could play a more effective role in supporting international S&E partnerships by developing a coherent international S&E strategy to coordinate the activities and objectives of the various Federal agencies that play a role in such partnerships. An effective strategy would utilize the diverse roles and strengths of individual agencies and would respect the autonomy of those agencies. There also needs to be a firm and long-term commitment by U.S. and foreign leadership, and U.S. Federal agencies should have direct and assured budget lines for international programs.

Issues of international S&E are not new to the Board. In 2000, its interim report, *Toward a More Effective NSF Role in International Science and Engineering* (NSB-00-217),¹⁵ made a number of specific recommendations to increase NSF's engagement in and to achieve higher visibility in international research and education. The subsequent Keystone Recommendation in the November 2001 Board report, *Toward a More Effective Role for the U.S. Government in International Science and Engineering* (NSB-01-187),¹⁶ remains fundamental:

The U.S. Government should move expeditiously to ensure the development of a more effective, coordinated framework for its international S&E research and education activities. This framework should integrate science and engineering more explicitly into deliberations on broader global issues and should support cooperative strategies that will ensure our access to worldwide talent, ideas, information, S&E infrastructure, and partnerships.

Two subsequent documents reinforced the importance of the Board's work in international S&E: the *National Science Foundation Investing in America's Future: Strategic Plan FY 2006-2011* (NSF-06-48)¹⁷ and the *National Science Board 2020 Vision for the National Science Foundation* (NSB-05-142).¹⁸ In its vision document, the Board recommended that NSF strengthen existing international and interagency partnerships and develop new partnerships.

In 2005, the Board decided that shifts in the international landscape, along with the unfulfilled recommendations of its 2001 report, warranted a careful reexamination of the U.S. Government's role in supporting international S&E. The Board was particularly interested in the potential of international S&E partnerships to improve international relations, build S&E capacity, improve quality of life, and protect the environment. The Board focused on issues related to partnerships with developing countries, but also considered the potential for the U.S. to partner with other developed nations to aid S&E conducted by developing countries.

Consequently, the Board charged its new Task Force on International Science (Task Force) to examine the role of the U.S. Government in international S&E partnerships and to focus on the following key issues:¹⁹ (1) to facilitate partnerships between U.S. and non-U.S. scientists and engineers, both in the U.S. and abroad, and in developed and developing countries; and (2) to utilize S&E partnerships

in improving relations between countries and to raise the quality of life and environmental protection in developing countries. As described in Appendix B, the Task Force consulted with members of the scientific community and science policy officials from U.S. Federal agencies and from countries around the world to better understand a wide range of perspectives on the U.S. Government's role in supporting international S&E partnerships. Appendix C lists participants in the Task Force's roundtable discussions and meetings, and Appendix D lists the individuals who submitted comments on drafts of this report.

This report distills key observations from these meetings and recommends actions for strengthening the value-added gained from international S&E partnerships. The Board highlights specific goals and recommended actions in the Strategic Priorities section under three categories: (A) creating a coherent and integrated U.S. S&E strategy, (B) balancing U.S. and foreign research and development (R&D) policy, and (C) promoting intellectual exchange.

Benefits of International S&E Partnerships

Successful international S&E partnerships have widespread benefits for the partners involved, for the advancement of S&E, and for the economic prosperity and well-being of countries. For the U.S. in particular, investing in international S&E partnerships will help energize the economy and promote S&E innovation and research. The U.S. can also benefit from partnerships by learning from the rest of the world in order to advance in S&E fields in which it is falling behind.

A. Builds Global S&E Capacity

International S&E partnerships can play a key role in advancing S&E capacity worldwide. Through cooperative cross-border endeavors, scientists and engineers gain access to foreign data, platforms, facilities, sites, expertise, and technology. Broad access to information and minds allows scientists and engineers to work together to address issues of global concern and to develop, test, and use new ideas on a global scale. The products of such collaborations are improved tools, models, products, and services. As these beneficial outcomes are experienced, governments will likely respond with policy changes that further foster international S&E partnerships.

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International S&E partnerships will also advance S&E capacity worldwide by helping to establish the necessary environment for future generations of scientists and engineers to tackle global problems. As S&E become increasingly global and competitive, it is critical that people working in these fields be able to perform in a globally-aware manner. These future professionals must be cognizant of and able to address international and cultural issues that could otherwise inhibit their

ability to work together and generate solutions to global problems. Strengthening international S&E partnerships now can help lay the groundwork for international networks of S&E collaborators.

B. Energizes U.S. Innovation and Economic Competitiveness

International S&E partnerships can also play a key role in energizing U.S. S&E innovation and overall economic competitiveness. The U.S. has historically been recognized as a leader in S&E research and innovation; however, it now lags behind other countries in some S&E fields. As centers of research excellence emerge around the world and the international scientific community grows rapidly, the U.S. must increasingly strengthen and protect its eminence. U.S. leadership in international S&E partnerships would help to ensure that it maintains a lead position in the global S&E enterprise. Active involvement will ensure that U.S. industry stays at the cutting edge of technology and will help to energize both the U.S. and global economies.

A continuing issue in maintaining innovation and competitiveness is making sure that the U.S. attracts the best and the brightest from around the world and encourages U.S. students to pursue S&E fields. Many of today's most pressing societal problems – such as climate change, natural disasters, food shortages, sanitation, and safe drinking water, energy resources, and the spread of disease – have global consequences and require a global effort from scientists and engineers. International S&E partnerships can help to bring those scientists and engineers together to generate effective, innovative solutions. With its history of prominence in the international S&E community, the U.S. is uniquely positioned to provide leadership in building and shaping the direction of international S&E partnerships to address these important global issues.

Vision for U.S. Support of International S&E Partnerships

As previously discussed, there are tremendous possible benefits for the U.S. if it invests in international S&E partnerships. In this day and age, however, simply partnering with other individuals, organizations, and agencies is not sufficient. There must be a proactive effort on the part of the U.S. Government to utilize these international S&E partnerships as tools to strengthen diplomacy and capacity building around the world.

The U.S. Government must advance “transformational diplomacy” by enhancing a global strategy to support international S&E partnerships.

President George W. Bush and Secretary of State Condoleezza Rice have used the term “transformational diplomacy” to describe their vision for the U.S. to use its diplomatic power to help foreign citizens better their lives, build their nations, and transform their futures. Secretary Rice defined the objective of “transformational diplomacy” as “work[ing] with our many partners around the world to build and sustain democratic, well-governed states that will respond to the needs of their people – and conduct themselves responsibly in the international system.”²⁰ International S&E partnerships are essential to advancing “transformational diplomacy,” because they can lay the groundwork for achieving the goals cited in this definition by creating apolitical connections among people to build trust and communication. This will then facilitate future diplomatic endeavors. International S&E partnerships should therefore be a high priority of the U.S. Government.

Just as international S&E partnerships can advance “transformational diplomacy,” they can also serve as instruments of “soft power.” Dr. Joseph Nye, Harvard University professor, first coined the term “soft power” in 1990 to describe the ability of states to indirectly influence the behavior or interests of other states through an attraction to shared values or other cultural or ideological means.²¹ Successful use of soft power relies heavily on a state’s reputation within the international community and the quality of information flow between the states involved. International S&E partnerships can be important instruments of foreign policy by fostering S&E as an important, apolitical soft-power bridge between nations. International S&E partnerships can contribute to building more stable relations among communities and nations by creating a universal culture based on commonly accepted S&E values of objectivity, sharing, integrity, and free inquiry. Science, technology, and engineering education can also be instruments to promote democracy and good governance.

A. Strengthen Science Diplomacy

Science diplomacy can facilitate relationships throughout the world in developed, developing, and troubled regions. S&E – with its common language, methods, and values – has helped to initiate and to reinforce positive relations between peoples and nations with historic and deep-seated enmities. In developing countries in particular, educational and research partnerships are effective in creating primary through post-doctorate education programs that develop S&E interest and competency among young people.

The Board has inferred the following conclusions about U.S. foreign policy in utilizing successful international S&E partnerships:

- Science diplomacy can be very effective at promoting communication among peoples and nations who otherwise are not disposed to cooperate – for example, a third partner from a “neutral” nation can help to moderate tensions in partnerships among scientists, engineers, and educators from nations with tenuous relations;

- Evenhandedness is important in S&E partnering policies – generous support for one nation can lead to frustration in others unless great care is exercised in explaining the apparent favored status;
- While traditional diplomacy favors bilateral agreements, the regional character of many S&E challenges (such as energy resources for non-oil producing countries in the Middle East) calls for multilateral approaches that engage many regional partners;
- Just as developing regions can benefit from multilateral agreements with a major funding nation such as the U.S., so too can funding nations benefit from entering joint funding agreements – for example, opportunities for diplomatic, aid, and S&E partnerships seem particularly strong between the U.S. and the European Union (EU);²²
- Regional S&E partnerships that have demonstrated positive impacts in improving regional relations should be encouraged by the provision of longer term funding commitments;²³ and
- Much of the tension between neighboring nations can be mitigated by improving communication and trust; U.S. diplomatic efforts can do so by increasing support of S&E partnerships as apolitical vehicles of science diplomacy.

B. Foster S&E Capacity Building

Another potential benefit of international S&E partnerships between developed and developing countries is indigenous capacity building. Indigenous capacity building refers to improving the ability of developing countries to become self-sufficient and to participate in the global enterprise. Improving the national capabilities of developing countries in this way stands to benefit citizens in those countries, as well as citizens in developed countries with whom they interact. S&E partnerships among, and led by, developing countries are equally important in capacity building.

International S&E partnerships have facilitated indigenous capacity building in sustainable development, agriculture, and environmental protection with priority areas defined by the UN Commission on Sustainable Development or by the UN Development Programme's Millennium Development Goals.²⁴ The eight Millennium Development Goals seek to help the world's poorest people and can only fully be achieved through cooperative scientific and technological research. The U.S. Agency for International Development (USAID)'s Initiative to End Hunger in Africa uses science and technology (S&T) to innovate ways to increase agricultural productivity while reducing vulnerabilities from the environment.²⁵ The Caribbean Sea of the Millennium Ecosystem Assessment²⁶ brings together participants from various nations to undertake integrated ecosystem analyses.²⁷ Partnership among the involved nations helps to provide unique interdisciplinary scientific and analytical information to protect the Caribbean Sea ecosystem. NSF and USAID also partner in supporting international S&E programs to facilitate capacity building.²⁸ The new Library at Alexandria exemplifies a different kind of capacity building based on

infrastructure development. The Library was established by Egypt in partnership with UNESCO, the EU, and a number of private sources.²⁹ Partnerships that recognize the benefits in promoting opportunities and careers for women in S&E can also contribute significantly to gender equity and other UN Millennium Development Goals. The potential to use international S&E partnerships for both capacity building and gender equity was exemplified by a workshop, *Empowering Women in Engineering, Science and Technology* that was held in Tunis in June 2007. It was sponsored by WFEO, with support from the Tunisian Government and engineering organizations such as the Society of Women Engineers. Modest funding for initiatives and partnerships like these can result in substantial benefits to the U.S., other nations, and the international scientific enterprise.

Strategic Priorities

A. Creating a Coherent and Integrated U.S. International S&E Strategy

In order to achieve the Board's vision of utilizing international S&E partnerships to strengthen science diplomacy and foster capacity building, the Nation must generate a clear, coherent, and integrated national S&E strategy.³⁰ This national strategy must balance and align contributions from the U.S. Government, NGOs, and the private sector.

(1) Goal: Ensure that the U.S. develops a clear, coherent, and integrated national S&E strategy, to be leveraged worldwide to strengthen government S&E missions and to advance national economic, security, and sustainability goals

No single U.S. agency is responsible for coordinating or supporting international S&E partnerships, and few U.S. agencies that do S&E work have explicit missions in international relations.³¹ Fewer still are committed to assisting developing countries. Thus, responsibility falls to individual agencies to establish their own international S&E research priorities and policies. These agencies, however, have varying latitude in how they fund international institutions and partnerships between U.S. and non-U.S. researchers. In particular, some U.S. Federal agencies are unable to supplement international researchers and institutions from developing countries, where even very modest funding could make a tremendous difference, or to build creative mechanisms to support international S&E partnership programs. Fortunately, some inter-agency coordination is accomplished through information exchanges through various roundtables and panels; however, more needs to be done. For example, the National Academies could organize an annual conference to make on-going international efforts more transparent and better aligned, and to cooperatively work out duplicative efforts.³²

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Among Federal leadership bodies, the National Science and Technology Council (NSTC), a cabinet-level council to coordinate S&T policy across the Federal R&D enterprise, has the most critical role regarding international S&E cooperation. NSTC should reestablish an inter-agency committee on international S&E in order to develop a coherent, integrated, national S&E strategy. This committee must strengthen government S&E missions and advance national economic, security, and sustainability goals. This committee should also prepare a composite budget including all non-classified science, engineering, and technology activities sponsored by the U.S. Government in foreign countries. Budget development would help to coordinate and focus international S&E efforts supported by the U.S. Government. To ensure that policymakers consider both policy concerns and scientific excellence, it is important to ensure active participation by the Office of Science and Technology Policy (OSTP), the Department of State, and USAID.

Recommended Action: *The National Science and Technology Council should reestablish a committee on international S&E to coordinate the activities of the Department of State, the U.S. Agency for International Development, and various Federal mission agencies and to develop a coherent, integrated, national S&E strategy. With guidance from the Department of State, this committee should work with peer governments to establish coordinated programs across international boundaries.*

(2) Goal: Coordinate international S&E activities across Federal agencies and align Federal agency S&E activities with a national S&E strategy

In addition to participating in an overarching committee to organize international S&E activities, each Federal agency stakeholder must designate and strengthen its own point of command for international S&E. Each relevant agency should designate a lead S&E official empowered to facilitate international S&E cooperation in order to increase U.S. ability to participate effectively in international S&E partnerships. This lead official would be responsible for coordinating activities within the agency and with other Federal agencies.

Recommended Action: *Each Federal agency involved in international S&E should designate a lead official empowered to proactively promote and develop international S&E strategy and coordination.*

(3) Goal: Ensure that relevant U.S. Federal agencies subject their international S&E programs and activities to planning, execution, and accountability guidelines

In order for international S&E partnerships to be successful and effective, they must be subject to planning, execution, and accountability guidelines. The Government Performance and Results Act (GPRA) requires Federal agencies to develop strategic plans, performance plans, and scheduled performance assessments. Relevant U.S.

Federal agencies should be directed to incorporate international S&E as a GPRA priority. Including international S&E under GPRA guidelines will better ensure that the U.S. is gaining the benefit of a global planning perspective.

Recommended Action: *Congress should amend the Government Performance and Results Act to require Federal agencies to address strategy development and performance planning for international S&E partnerships. The Office of Management and Budget should include this in its Program Assessment Rating Tool^{B3} guidance to U.S. Federal agencies.*

(4) Goal: Strengthen emphasis on S&E at USAID missions abroad by improving communication among science officers and U.S. embassy personnel both at home and abroad

In order to support international S&E partnerships and activities in foreign countries, U.S. embassy officials and Foreign Service Officers should become more actively involved in promoting international S&E. In 2001, the Board recommended that the Department of State consider the importance of S&E in achieving the agency's objectives and identify mechanisms for improving communication and information sharing among science officers and U.S. embassy personnel both at home and abroad.³⁴ In addition to implementing this recommendation, the Department of State should place a higher priority on S&E at USAID missions abroad and apply new emphasis to the roles of science advisors at key U.S. embassies. Ambassadors overseas should also organize – when warranted by host country size and the scope of its scientific enterprise – science committees in embassies composed of representatives from all science-, engineering-, or technology-related agencies in the host country.

Recommended Action: *The Department of State should consider elevating the role of qualified science advisors at key U.S. embassies to promote science, engineering, and technology in their host countries.*

B. Balancing U.S. Foreign and R&D Policy

To achieve the Board's vision of utilizing international S&E partnerships to strengthen science diplomacy and to foster capacity building, it will be important to balance U.S. foreign policy with R&D policy.

(1) Goal: Make international S&E partnerships a priority for U.S. foreign policy and for U.S. R&D policy

International S&E partnerships can provide increasingly important means to remain at the forefront of new S&E insights and discoveries and to maintain U.S. prominence in key S&E fields. There are currently many examples of bilateral and interagency S&T programs – involving OSTP, the Department of State, USAID,

NSF, and other Federal agencies – that achieve foreign policy objectives, but a more concerted effort is necessary to ensure that international S&E partnering is regarded as a high national priority. OSTP needs to charge U.S. mission agencies to develop specific mechanisms that encourage support for international S&E partnerships.

Recommended Action: *The Office of Science and Technology Policy (OSTP) must work with the Department of State and the Office of Management and Budget (OMB) to make international S&E partnerships a priority for U.S. foreign and R&D policy. OSTP and OMB should include this strategy in the annual OMB-OSTP memo on the science and technology priorities of the Administration. OSTP should consider reestablishing the position of Assistant Director for International Strategy and should directly charge Federal agencies to include specific components of international R&D in their integrated programs.*

(2) Goal: Create and sustain more stable relationships among nations and help build the economic capacity of developing countries, by exercising the universal language and values of S&E³⁵

Many scientific societies and NGOs already engage in S&E partnerships that foster science diplomacy and capacity building. These partnership activities could be expanded and strengthened by access to modest U.S. Government funding. U.S. Federal agencies need to ensure that appropriate NGOs and non-profits are aware of international S&E partnership opportunities and any available support for strengthening their capacity building programs.

Recommended Action: *The Department of State, the U.S. Agency for International Development, scientific societies, non-governmental organizations, and non-profits should do more to encourage and to help fund international S&E partnerships as instruments of diplomacy.*

(3) Goal: Balance U.S. security policies with international S&E needs, including intellectual property protection, management and access to data, data representation policies, export controls, materials/technology transfer, manufacturing standards, and visa access for researchers

Issues of vital importance to international S&E partnerships...require careful balancing between S&E needs and security needs of the U.S. and its allies around the world.

International S&E partnerships require that collaborators from foreign nations have access to U.S. education, facilities, information, and researchers. Security concerns following September 11, 2001 led to the implementation and/or strengthening of policies that inhibit international S&E partnerships, such as limitations on visas.³⁶ Some countries have more restrictive policies regarding the ownership of intellectual property, which can further complicate S&E partnerships. Issues of vital importance to international S&E partnerships – such as intellectual property protection, management and access to data, data representation policies, export controls, materials/technology transfer policies, manufacturing standards, and visa

access for researchers – all require careful balancing between S&E needs and security needs of the U.S. and its allies around the world. Policymakers should work with U.S. scientists and engineers to understand these needs and problems that transcend Federal agencies and research institutions and to formulate effective and appropriate solutions.

Recommended Action: *The Administration and Congress should direct the Department of Commerce, the Office of Science and Technology Policy, the Department of State, and the Department of Homeland Security to balance U.S. security policies with international S&E needs.*

(4) Goal: Improve relations between countries and improve the quality of life and environmental protection in developing countries

International S&E partnerships stand to benefit from the involvement of industry, universities, and NGOs. These entities are uniquely positioned to participate in programs promoting societal benefit through S&E by offering leveraging resources. For example, industrial partners facilitate the transition of technologies from the laboratory to the market, and NGOs and universities can frequently occupy an apolitical role in the international political environment, allowing projects to be pursued regardless of the political situation between their home countries.³⁷ In such situations, these organizations have more flexibility in working with foreign governments and institutions that, for political reasons, do not want to be seen conducting work with or on behalf of the U.S. Government.

Involving NGOs in international S&E partnerships can also help to raise funds for the partnerships. For example, the Green Revolution was instigated and initially funded by two NGOs, the Rockefeller Foundation and the Ford Foundation, and facilitated international as well as domestic progress on many critical societal problems. Currently, although some bodies and organizations fund specific international projects, no body or organization is specifically devoted to fund or to help coordinate the funding of international partnerships and programs. One major challenge is finding “glue money” for initial planning and for continued coordination in developing and maintaining international partnerships and programs. Efforts to coordinate a multitude of national funding bodies to jointly fund a strategic planning activity (e.g. a high-risk activity with no specific short-term tangible product) are often stymied by the diversity of interests and objectives among potential funding bodies. There is hope, though, that NGOs can play a greater role in bringing together funding bodies. For example, the multi-billion dollar IPY program is actually held together on a shoestring, organized through ICSU and the World Meteorological Organization (WMO). The IPY involves over 200 projects, with thousands of scientists from over 60 nations examining a wide range of physical, biological, and social research topics focused on the Arctic and the Antarctic from

March 2007 to March 2009. The U.S. should take a lead role in providing adequate funding to NGOs and scientific and engineering organizations that are planning and coordinating international S&E programs like the IPY.

Recommended Action: *The Office of Science and Technology Policy, the Department of State, and other U.S. Federal agencies should work with non-governmental organizations and the private sector to build and sustain international S&E partnerships using “transformational diplomacy” and “soft power.”*

(5) Goal: Renew USAID’s role in building S&E capacity in developing countries and encourage USAID to better employ S&E

In the past, USAID achieved widespread improvements in the stability and well-being of many developing countries through a commitment to S&E capacity building.³⁸ Unfortunately, the underdevelopment of S&E infrastructure in many countries and more immediate imperatives for USAID to deal with conflict and disaster situations have discouraged long-term efforts, such as sustained capacity building. By recommitting to S&E capacity building, USAID, with the help of the Executive and Legislative branches, can advance S&E in many countries across a wide range of S&E frontiers. Developing economies are home to the greatest biodiversity, climate sensitivity, and health challenges in the world. USAID can help bring many benefits of S&E advances to these countries.

It is vital that USAID restart its efforts now to ensure that critical S&E problems are addressed in developing countries. Previous USAID programs were successful at populating universities in developing countries with U.S.-trained faculty; today, however, there is a stark paucity of similar programs. In order to ensure that future generations in developing countries are occupied with trained scientists and engineers, these programs should begin now to enable and constructively engage young people in these countries. Adequate aid funding is essential to these programs.

The Board supports the key recommendations put forth in the National Academies report, *The Fundamental Role of Science and Technology in International Development: An Imperative for the U.S. Agency for International Development*.³⁹

- USAID should reverse the decline in its support for building S&T capacity within important development sectors in developing countries;
- USAID should strengthen the capabilities of its leadership and program managers in Washington, DC and in the field to recognize and take advantage of opportunities for effectively integrating S&T considerations within USAID programs; and
- USAID programs that promote substantive S&E partnering to address issues of sustainable development and capacity building should be revitalized and augmented.

USAID should also encourage other U.S. Federal departments and agencies that engage in S&E-related activities in developing countries to orient these programs towards the development priorities of the host countries. As an overall goal, USAID should provide leadership in improving interagency coordination of development-related activities.

Recommended Action: *The Administration and Congress should enact the recommendations of the National Research Council's report, The Fundamental Role of Science and Technology in International Development: An Imperative for the U.S. Agency for International Development.*⁴⁰

➤ **Guidance for NSF**

By continuing to assist USAID to support international S&E partnerships, NSF can both advance its basic science mission and play a key role in building S&E capacity in developing countries.

C. Promoting Intellectual Exchange

To achieve the Board's vision of utilizing international S&E partnerships to strengthen science diplomacy and to foster capacity building, it is essential to enhance the global mobility of scientists and engineers so that they can participate fully in joint research ventures and intellectual exchange. It is also important to find ways to actively engage more U.S. scientists and engineers in international S&E partnerships.

(1) Goal: Promote global quality of life and economic well-being by facilitating the involvement of and exchange among the best and brightest scientists and engineers, regardless of home country

Historically, the U.S. has been at the forefront of scientific discovery and innovation due to the work of both U.S.-born scientists and engineers and of foreign nationals who relocated to the U.S. to conduct science. In the past, some other parts of the world – especially the developing world in the 1980s – experienced the problem of “brain drain.” Scientists and engineers left their home countries to be educated and did not return because their home countries lacked S&E infrastructure. With increasing S&E capacity and globalization, however, “brain circulation” may become the prevalent phenomenon. Under this model, scientists and engineers leave their home countries to build bridges with foreign professionals leading innovative studies abroad. Unlike in “brain drain,” these researchers then return to their home countries to share their knowledge and networks with their compatriots and to assist in capacity building and infrastructure development.

Scientists and engineers in the U.S. and in other developed countries also stand to benefit from participating in research and educational opportunities abroad.⁴¹ Discovery and problem solving are often catalyzed by bringing together different expertise and varied perspectives, and by enabling access to unique data and resources. Global fora can be held to identify priority research ventures and to develop common funding and governance schemes. Priority research sites could draw scientists and engineers from around the world to gain international experience to take back to their home countries.

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Taken together, the circulation of scientists and engineers from the U.S., other developed countries, and the developing world represents a new pattern of international S&E interaction and workforce migration. In order to continue to enhance this pattern, two challenges must be addressed: (1) barriers to migration and (2) lack of supportive home environments to which scientists and engineers can return.

The U.S. has always attracted many international students and researchers, but numbers declined when security regulations implemented after the September 11, 2001 attacks made it more difficult for foreign students and researchers to enter the country.⁴² The Department of State has done much to address these problems, but a perception continues to persist in the international community that the U.S. does not welcome non-U.S. scientists, engineers, and students as it once did.

Scientists and engineers around the world report being discouraged from leaving their home countries by a lack of viable opportunities after their return. U.S. Federal agencies can do more to encourage U.S. scientists and engineers to participate in international exchange programs. Agencies must create incentives for international training by establishing international research fellowships. These fellowships could include financial provisions for moving and working abroad, and professional and research opportunities upon returning to the U.S.

Recommended Action: *Congress and the Department of State should facilitate “brain circulation,” as opposed to “brain drain,” in employing S&E talent through:*

- *Reinvigorating the interest of American students in S&E by supporting study abroad opportunities, during which they would collaborate with foreign scientists and engineers;*
- *Streamlining the visa process for foreign S&E scientists, engineers, and students;*
- *Encouraging foreign study and collaborative scientific work for U.S. scientists, engineers, and students by easing their transition to working abroad and by providing professional and scientific opportunities upon their return to the U.S.;*
- *Identifying and increasing the use of certain U.S. and foreign specialized facilities for collaborative work by scientists and engineers from around the world;⁴³ and*

- *Supporting global fora to identify priority research ventures and to develop common funding and governance schemes, in order to draw scientists and engineers from around the world to gain international experience to take back to their home countries.*

(2) Goal: Encourage partnerships with the accountability community so that common ground rules can be established in international S&E partnerships in order to minimize both misconduct and bureaucratic overhead

For the U.S. to support international S&E partnerships, there must be accountability, research integrity, and minimal bureaucratic overhead from many sources. Common standards for research integrity among participants in international S&E partnerships must be created, because scientific misconduct and excessive bureaucratic overhead have become issues of global concern. Currently, efforts are underway to foster common research integrity values and to establish definitions of misconduct – generally considered to include plagiarism, fabrication, and falsification of data. A well-designed strategy to promote integrity, deter misconduct, and minimize bureaucracy within international partnerships should be an integral part of all collaborative agreements. While there is no established methodology for setting common research integrity standards, the Organisation for Economic Co-operation and Development (OECD) Global Science Forum is working to develop models that may facilitate accountability in international S&E partnerships.⁴⁴ These efforts are supported by OSTP, NSF, and the NSF Office of Inspector General.

A well-designed strategy to promote integrity, deter misconduct, and minimize bureaucracy within international partnerships should be an integral part of all collaborative agreements.

A number of U.S. and foreign scientists and organizations report that they have been discouraged from participating in international S&E partnerships due to the difficulty of working with different funding agencies in the countries involved. The burden of bureaucratic overhead appears to outweigh the obvious scientific and societal benefits of such partnerships. This difficulty can be mitigated by developing common standards and rules for research integrity and information sharing. NSF has made good progress in employing common standards with the EU, its member states, and other developed countries, but partnerships with scientists and engineers in developing countries are still hindered by excessive bureaucratic intervention. One method to decrease the potential of overly bureaucratic intervention in international S&E partnerships is to encourage partnerships with the accountability community so that common ground rules can be established.

Recommended Action: *The U.S. Government should:*

- *Continue to work with other countries with significant partnership potential to institute scientific standards and processes;*
- *Create joint and collaborative program announcements for the following activities:*
 - *To review and fund proposed international S&E projects;*
 - *To grant ownership of intellectual property developed with government support; and*

- *To develop and institute financial and compliance policies for international S&E projects.*
- *Utilize the National Resource Center Program of the International Education Programs Service of the U.S. Department of Education in order to provide grants to establish, strengthen, and operate language and area/international studies centers that will be national resources for teaching modern foreign languages.*

➤ **Guidance for NSF**

NSF should continue to facilitate international S&E partnerships by continuing to work towards the establishment of scientific standards and practices in foreign countries.

(3) Goal: Actively promote and fund U.S. scientists and engineers to engage in and sustain international S&E partnerships throughout NSF

Adequate funding is essential to international S&E partnerships. Unlike the EU, the U.S. Government has few significant sources of funds specifically identified for building international S&E partnerships. Moreover, science, engineering, and technology agreements between nations are often viewed as being no more than statements of good intentions, because they lack funds to actually support research initiatives.

In addition to having no significant central funding source, international S&E partnerships are financially supported in only a piecemeal manner by U.S. funding agencies. With the notable exceptions of the Department of Defense, the National Institutes of Health (NIH), and NSF, most U.S. funding agencies have varying, but little, latitude to fund international institutions and partnerships between U.S. and non-U.S. researchers.

NSF currently funds international S&E partnerships through its Office of International Science and Engineering (OISE), which also brokers additional funding from other directorates. Unfortunately, many U.S. researchers perceive that NSF does not provide tangible incentives or much funding for international S&E partnerships. It is essential, therefore, for NSF to better promote and encourage international partnerships. NSF currently provides supplementary funding to U.S. principal investigators to cover the costs of their collaborators in developing countries, but there needs to be greater publicity of these opportunities. NSF should also continue to encourage the huge potential for improving S&E education in international S&E partnerships, both in the preparation of future teachers at the elementary and secondary levels, and in the development of higher education curricula.

➤ **Guidance for NSF**

NSF should:

- *Better publicize its practice of encouraging principal investigators to request supplemental funding through their research grants for foreign collaborators from developing countries;*
- *Encourage all of its directorates to develop specific plans and programs to support international partnerships and then to publicize them to the appropriate domains and disciplines;*
- *Link international S&E research partnerships with curricular pathways for students; and*
- *Through OISE, and in coordination with NSF directorates, continue to provide services such as training, research matchmaking, culture and language information, software tools, and legal and intellectual property information in support of international partnerships.*

Conclusions

The U.S. Government must support international S&E partnerships for multiple beneficial reasons, which must be understood by both Congress and the greater public. These benefits are not only vital to the future prosperity of the U.S., but also stand at the forefront of solving the most pressing issues facing the entire world. Climate change, natural disasters, food shortages, sanitation, safe drinking water, energy resources, and the spread of disease are a few issues that have global consequences and that require a collaborative worldwide effort from not only scientists and engineers, but from policymakers at all levels. The U.S. must help shape the direction of international partnering and provide leadership in building international S&E partnerships that address these important global issues.

In addition to addressing global challenges, U.S. leadership in international S&E partnerships would help ensure that the U.S. moves forward as a full partner in the global S&E enterprise. These partnerships can enable U.S. scientists, engineers, and students to participate more fully in the rapidly growing international S&E effort, which can in turn help the U.S. business community stay on the cutting edge of technologies and help energize both the U.S. and global economies. Economic development, cultivation of civil society, elevation of the roles of women and underrepresented groups, and redirection of scientists and engineers towards more productive, socially responsible pursuits are also indirect positive benefits of these partnerships.

International S&E partnerships are important tools of international diplomacy; they strengthen international relationships and uphold many ideals that the U.S. holds dear: accountability, meritocracy, transparency, and objectivity. The U.S. puts its best face forward in international S&E partnerships, so that the rest of the world can

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view it as a great place to conduct S&E and as a Nation that upholds fundamental research values. Robust and vibrant international S&E partnerships and effective communication are also vital for Federal agencies to carry out their missions.

The U.S. Government currently plays an active role in supporting international S&E partnerships. However, that role could be performed far more effectively. In the U.S., no single agency is responsible for coordinating international S&E partnerships, in spite of the fact that some policy issues transcend individual agencies and require greater cross-agency coordination. Greater coordination of international S&E partnership activities among U.S. Federal agencies needs to occur, while respecting the autonomy of individual agencies.

Moreover, individual Federal agencies have varying latitude in how they fund international institutions and partnerships between U.S. and non-U.S. researchers. Some domestic research funding agencies are unable to supplement international researchers and institutions from developing countries, where even very modest funding could make a tremendous difference. The U.S. needs to address this issue and build creative mechanisms to support international S&E partnership programs.

Finally, security measures put in place following September 11, 2001 have presented new challenges for international S&E collaboration. While the U.S. Government has made progress on these issues, further improvements are needed. The U.S. must continue to attract the best and brightest from around the world, while also encouraging its citizens to choose S&E careers. U.S. researchers and students should be encouraged to take advantage of research and educational opportunities abroad (e.g. at foreign centers of S&E research excellence). For the U.S. to continue to prosper, these global issues and concerns should be addressed now through international S&E partnerships as described in this report. As a Nation, we must not only face the challenges that require S&E expertise today, but we must be prepared to confront issues of global opportunity, and even survival, of the future.

The Board's goals and recommended actions in this report are the beginning of a more high profile, coordinated, and vigorous course of action for the U.S. Government to ensure its leadership as goodwill ambassadors in S&E. These recommended actions can only succeed with the firm and long-term commitment of U.S. and foreign leadership. U.S. Federal agencies should have direct and constant budget funding lines and appropriate assessment mechanisms for international S&E partnerships and programs. By doing so, the U.S. will remain a leader in S&E issues, help solve global challenges, and gain respect and admiration throughout the world.