"Global Connections: National Science Foundation International Programs and Activities"

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Good morning. I am delighted to speak with you today about the National Science Foundation's international programs and activities. I look forward to exploring opportunities for us to work together in promoting international science and engineering research and education.

We all recognize that we are living and working in a new age of scientific and engineering discovery. The conduct of science has changed--thanks in part to new information and communications technologies. Combine this with sensors, satellites, and other observational tools that supply ever-burgeoning streams of observations and data, and we have turned science fiction into reality.

Work at the frontiers of discovery has accelerated. The time between discovery, development and commercialization is compressing. Today's science and engineering no longer takes years or generations from insight to realization in new technologies and products.

Science is also growing more complex, and the boundaries between disciplines are blurring. This naturally makes interdisciplinary and collaborative research the norm rather than the exception. In research at the nanoscale, especially, we see disciplines merging and emerging in pursuit of the newest methods for bottoms-up design.

International collaboration is yet another iteration of this process, greatly facilitated by our new communications and computer technologies. Articles authored by U.S. researchers that include an international collaborator rose from about 10 percent of the total in 1988 to 23 percent in 20011.

These changes have raised the profile of science and engineering considerably. A first-rate national science and engineering enterprise is now viewed as central to economic growth, with the goal of creating new jobs and new industries. There is red-hot competition for highly skilled and highly trained scientists and engineers who can make breakthroughs to speed new technologies to market.

International science and engineering collaboration is increasingly important because many of the challenges that confront us today are inherently global. We all have a stake in the results of research in climate change, emerging diseases, the health of the oceans,

biodiversity, sustainable energy, and improved earthquake engineering, to name only a few.

In today's world, U.S. scientists and engineers must be able to operate in teams comprised of partners from different nations and cultural backgrounds.

NSF must carry out its mission within this roiling, complex, competitive context. NSF is the only federal agency with a mandate to insure the overall health of U.S. science and engineering research and education, across all disciplines. At the Foundation, that translates into funding the most promising fundamental research at the frontiers of discovery. It also means educating the young women and men who will make path-breaking discoveries in the future, and providing them with world-class tools to get the job done.

The NSF practice of integrating education and research is uncommon among the world's nations. Yet it has been key to our 50 years of success. Each year, we supports more than 200,000 people--teachers, students, and researchers at every educational level.

With the exception of our operations in the Polar Regions, NSF does not operate its own laboratories or research facilities. Instead, we directly support U.S. scientists, engineers and educators through their home institutions, usually universities and colleges.

Proposals, both solicited and unsolicited, undergo competitive, peer review, guided by two criteria: the intellectual merit of the proposal and the broader impacts of the proposed research. Broader impacts may include: the promotion of teaching, training and learning, promoting the participation of underrepresented groups, developing mechanisms to disseminate the results of the research and potential benefits to society.

To give you some idea of the magnitude of the NSF merit or peer review process, consider these figures. In the past year, over 50,000 scientists and engineers conducted over 250,000 proposal reviews, for about 42,000 proposals. NSF funds about 10,000 new proposals each year, and provides supplemental funding for many more.

Although NSF has long encouraged the engagement of U.S. scientists and engineers with the international research community, the changing context for science and engineering has precipitated a recent change at the Foundation. The NSF international division, previously housed in the Social, Behavioral, and Economics Sciences Directorate, is now the Office of International Science and Engineering in the director's office. This change elevates international activities at NSF and ensures that they are well integrated into NSF activities across all disciplines.

Today, the Foundation's international activities are extensive. They encompass the grants provided to the U.S. science and engineering community for international research and education. NSF management and staff also exercise leadership in international settings to facilitate international cooperation in research and education.

These activities are widely distributed across the continents and oceans of the world. They range from work in the world's most advanced science and engineering laboratories to observation of physical, biological, and human phenomena around the globe, including its polar regions.

As you can see from this slide, NSF international activities cover a rich mixture of platforms designed to meet our international objectives.

Workshops and planning visits can provide the catalyst that ignites Innovative international partnerships, training activities or collaborative research frequently emerge from workshops or planning visits. Workshops are also useful in the early stages of emerging research projects and the development of large research facilities.

Recently, researchers at the State University of New York in Buffalo and partners in The Netherlands and Slovenia organized jointly a Workshop on Electronic Networks and Democratic Life. More than fifty researchers from Europe, Asia, Africa and North America gathered to discuss three major topics: how these technologies are used in the public sphere; the nature of democratic deliberation in online contexts; and using the Internet to promote civic engagement. These meetings play an additional role by encouraging personal relationships that can often lead to long-term partnerships.

Research experience abroad is particularly vital for U.S. students and early-career scientists and engineers. The U.S. needs scientists and engineers from all disciplines who can lead or participate in international teams. They also need this experience to track international discoveries in some of the most challenging research arenas.

Our International Research Postdoctoral Fellowships provide support for post-doctoral researchers or young faculty to conduct research abroad. Universities and research centers in Europe, South America and Australia are hosting the most recent crop of Fellows, from more than 20 states and 25 universities. Dr. Alexander Agrios, a 2004 Fellow from Northwestern University, is working with solar-cell pioneer Michael Grätzel in Switzerland. The goal is to fabricate a new generation of dye-sensitized solar cells aimed at lowering the cost of solar energy. Dr. Agrios and the other International Fellows ensure that America continues to be the world's science and technology leader.

The Pan American Advanced Studies Institutes (PASI for short) are 2-4 week courses, modeled on the NATO Advanced Studies Institutes. They aim to disseminate advanced knowledge and stimulate cooperation among researchers of the Americas in engineering and in the mathematical, physical, and biological sciences.

The institutes cover cutting-edge topics from Micro-Electro-Mechanical Systems to Grid Computing and Advanced Networking Technologies for e-science. The program depicted in this slide will explore Systems Process Engineering. It is jointly sponsored by the Chemical Engineering Pan American Collaboration (CEPAC) involving Argentina, Brazil, Mexico, Chile, Canada and Carnegie Mellon University. This PASI will involve

50 advanced graduate students and 20 lecturers in the field from the U. S., Canada, and Latin America. The Department of Energy also supports the PASI program.

The East Asia and Pacific Summer Institutes (EAPSI) provide a similar experience for U.S. graduate students, who enjoy first-hand research experiences in Australia, China, Japan, Korea, or Taiwan.

We all know that research experience is considered to be one of the most effective avenues for attracting talented undergraduates to pursue graduate degrees and careers in science and engineering, including careers in teaching and education research.

An NSF-wide activity, Research Experience for Undergraduates gives undergraduate students the opportunity to engage in high-quality research, often at important international sites.

One of these sites is CERN, the European Laboratory for Particle Physics in Switzerland, and one of the world's premier international laboratories. Undergraduate students work with faculty mentors and research groups at CERN, where they have access to facilities unavailable anywhere else in the world.

CERN is the birthplace of the World Wide Web, and the future site of the Large Hadron Collider, pictured here. NSF is providing partial support for the LHC.

International contacts must be nurtured in order to flourish over the long term. NSF supports international research collaborations across the full range of NSF's disciplinary programs and priority areas.

One of these is AfricaArray, a project that combines top-notch research with education and training for young U.S. and African geophysicists. The project, led by researchers from Penn State and the University of the Witwatersrand in South Africa, will use a network of seismometers to examine the structure of the superplume of magma beneath the African continent. The team plans to study the Bushveld Complex, a geologic feature that is the source of about half the world's mined platinum and that contains vast quantities of gold, nickel, copper, chromite, vanadium, magnetite, and tin.

Geophysicists are in very short supply in mineral- and oil-rich Africa. One of NSF's longer-term objectives is to build stronger collaborations with developing countries--collaborations that can increase the research and education that leads to expanded economic opportunities for these countries.

At the other end of the world, scientists and their students from the University of Washington and from the Far East Division of the Russian Academy of Sciences are studying the history of earthquakes, tsunamis, and coastal deformation in the Kamchatka region.

The research is notable because it has applications to natural hazards studies, not least because Kamchatka tsunamis propagate toward Hawaii.

NSF supports literally dozens of such collaborations worldwide. This year, we will launch Partnerships for International Research and Education, a new initiative to enable U.S. institutions to establish long-term collaborative relationships with foreign groups or institutions. The aim is to foster research efforts that neither partner could accomplish on its own.

Scientists and engineers need access to today's cutting-edge tools and communications technologies to work at the very frontiers of discovery.

At the center of all disciplines and research programs is the need for a comprehensive cyberinfrastructure. Cyberinfrastructure encompasses the most advanced computer and communications technologies, but it goes well beyond. Tools to store, access and mine data, and advanced analytical, visualization and simulation tools are all part of the mix.

My vision for cyberinfrastructure is that it will ultimately join the ranks of the electrical grid, the interstate highway system and other traditional infrastructures.

Our International Research Network Connections Program is working with peer groups throughout the world to develop a global integrated network environment.

The program includes links to GEANT and CLARA, the European and Latin American regional research and education networks. This slide depicts the planned North American-South American linkages. Similar collaborations across the Pacific Rim are creating enhanced connectivity to research and education networks in China, Japan, Korea, and Australia. From there, they will connect to other Asian research and education networks.

Earlier, I mentioned CERN, the world's largest particle physics laboratory, and the site of the Large Hadron Collider, which NSF is supporting. Increasingly, the cost of large-scale facilities like the Large Hadron Collider is beyond the reach of any single nation. International cooperation is absolutely vital to build and maintain facilities of this magnitude. Two examples come to mind.

The drill ship JOIDES Resolution, depicted here, is one of two vessels operated by the Integrated Ocean Drilling Program. NSF and Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) are the lead funding agencies, with assistance from the European Consortium for Ocean Research Drilling and the People's Republic of China. The IODP is an international marine research program that explores Earth's history and structure recorded in seafloor sediments and rocks, and monitors subseafloor environments. The Research objectives aim for a better understanding of environmental change and the deep ocean biosphere.

NSF leads U.S. efforts to develop a suite of ground-based telescopes, including IceCube, which explore the history and nature of the universe. World-class telescopes, like the LCH, are generally too costly to build and operate without international support. Pictured here is the South Pole station, site of IceCube, a high-energy neutrino telescope that is under construction over a kilometer beneath the clear Antarctic ice. Agencies in Belgium, Germany, and Sweden will join NSF and DOE in providing support for IceCube.

Last but by no means least, I should mention that the National Science Foundation funds and manages the U.S. Antarctic Program. U.S. activities in Antarctica support the nation's adherence to the Antarctic Treaty. The treaty is designed to reserve the region for peaceful purposes and encourage international cooperation in scientific research. At present, 45 nations adhere to the treaty, and 29 of them are involved in Antarctic field activities.

The slide shows the dramatic breakup of a massive portion of the Larsen-b ice shelf--an area larger than Rhode Island. Researchers continue to explore the causes of this event.

NSF also has an extensive program in the Arctic. The Polar Regions together comprise about a third of the earth's surface--and influence what happens everywhere else.

As we near the International Polar Year in 2007 to 2008, we are looking for ways to link U.S. scientists with counterparts in other nations for collaborative IPY efforts. One potential focus area for NSF during the IPY might be Arctic climate change research, and building an Arctic Observation System--that includes the Arctic peoples.

The senior management of the Foundation plays a major role in international statesmanship. Besides interacting with the scientific leadership of other countries, senior NSF staff participate in such international bodies as the Global Science Forum (GSF) of the Organization for Economic Cooperation and Development (OECD), the Board of Trustees of the Human Frontier Science Program (HFSP), the International Group of Funding Agencies for Global Change Research (IGFA), the activities of the Arctic Council, and the consultative meetings of the Antarctic Treaty.

NSF is an active participant in the OSTP-led Interagency Working Group on Science in UNESCO, which is exploring future collaborative opportunities between the U.S. science and engineering community and UNESCO. Dr. Marburger and I serve as Federal advisors for science in the newly reconstituted U.S. National Commission for UNESCO. I also participate in the G8 meetings of Heads of Research Councils.

In addition, NSF supports or participates in international activities whenever it contributes to accomplishing NSF's overall goals more effectively. The Global Biodiversity Information Facility is an example. This international organization works to ensure that biodiversity data is collected and accessible anywhere in the world.

In concluding, I want to explore briefly how we might work together to promote international collaboration in research and education.

NSF maintains regional offices in Tokyo and Paris, and we will be opening a new office in Beijing later this year. NSF staff in these offices are excellent resources for information on current and emerging issues in science and engineering throughout their regions.

The Embassy Science Fellows program is another resource that I encourage you to consider using. Begun in 2001 as a State Department - National Science Foundation (NSF) partnership, the Embassy Science Fellows Program now includes a number of other agencies2. Embassy Science Fellows take two-month assignments at U.S. embassies around the globe to provide expertise, advice and assistance with science and technology-related issues. An embassy may request an Embassy Fellow--and I encourage you to do so!

On another front, NSF sometimes has the ability to move quickly to mobilize scientific resources in times of need. Knowing how to locate expertise and information rapidly is a boon in emergency situations. Within days after the recent tsunami disaster, researchers had modeled the path of the earthquake and tsunami, and the areas of greatest impact. Within two weeks, teams were on the ground, gathering perishable data before it was lost in the cleanup.

Researchers also interviewed survivors, to determine how individuals and communities responded, and their ability to cope in the aftermath. The data on both physical damage and on social and behavioral responses are equally vital for scientists and engineers hoping to prepare communities for future disasters.

NSF also supports IRIS, a university research consortium that collects and distributes data from the earth's interior through the Global Seismic Network. These data are critical to the government response to earthquakes, tsunamis, and volcanoes. National and international nuclear treaty verification and monitoring programs also routinely use the data. IRIS is a vital part of the larger Federation of Digital Broadband Seismic Networks, an international forum that coordinates the worldwide deployment of seismic sensors.

Lastly, public diplomacy is no small part of your portfolios. Communicating the benefits of international collaboration emphasizes the value that shared discovery contributes to international relations and the broader benefits it offers to societies worldwide. Scientific partnerships are positive stories that need to be shared more widely--both at home and abroad. The collaborative pursuit of new knowledge is a powerful tool for bringing people together to pursue common goals of solving problems and building a world of peace and prosperity.

Finally, I am delighted that the State Department, and particularly, all of you, are focused on important science and technology issues around the globe. The progress of humankind has depended increasingly on the new knowledge of science and technology. The future holds an amplification of this trend. In the 1950's, scientist and writer Jacob Bronowski wrote, "The world today is powered by science3." It is hard to think of an appropriate

exaggeration that he could find to describe the era in which we now live. It is good to know that there are science and technology-minded officers like you minding the nation's ship of state.

1 NSF Science and Engineering Indicators 2004, Appendix Tables 39 and 40.

2 In addition to NSF, the U.S. Geological Survey (USGS), U.S. Department of Agriculture (USDA), National Oceanic and Atmospherics Agency (NOAA), Environmental Protection Agency (EPA) and the National Aeronautics & Space Administration (NASA) now participate in the program.

3 Bronowski, Jacob, Science and Human Values, Julian Messner, Inc, New York, 1956, p.13