Science and Technology Trends
Science Diplomacy

Science Diplomacy in the USA: Perspective of a Former Science and Technology Adviser to the U.S. Secretary of State

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1. Introduction

I served for three years (July 2011 − July 2014) as the fourth Science and Technology Adviser to the U.S. Secretary of State. Most of my career, however, has been outside of government, first as a theoretical physicist, then an academic focusing on science and technology (S&T) policy including the role of S&T in international affairs, and for seventeen years as Executive Officer of the U.S. National Academy of Sciences (NAS) and National Research Council. In the latter role, I helped to oversee studies advising the American government and public on domestic and foreign policy issues where insights from science and technology are needed. This article is intended as a personal reflection on the state of affairs of science diplomacy in the USA rather than an objective history of science diplomacy as it has been practiced over many years (often by a different name) in my country.[1]

2. Science Diplomacy

I will give a simple-minded definition of what I mean by science diplomacy. By "science," I include not only the physical and biological sciences, but also the social sciences, engineering, and medicine. Science diplomacy for me is: (i) science and technology aiding diplomacy (for the many diplomatic issues where scientific and technological information is critically important and even for those cases where science and technology engagement can open doors for dialogue on other issues), (ii) diplomacy advancing science and technology (such as by negotiating multinational arrangements for building large facilities and gaining access for research in unique locations), and (iii) science and technology helping to create new options and pathways for making progress on the "wicked" national, regional, and global problems currently too

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1 This article is derived in part from a speech delivered at the 46th Session of the Erice International Seminars on the "Role of Science in the Third Millennium," Erice, Sicily, August 2013. For more information on AAAS international activities, including on the Center for Science Diplomacy and the on-line publication Science & Diplomacy, see <http://www.aaas.org/programs/international-programs> and <http://www.sciencediplomacy.org/>.

difficult for politicians and diplomats to resolve alone.[2] An important purpose of science diplomacy is to help improve relations between countries and to make all people more secure, healthy, peaceful and prosperous. Every country, including my own, pursues science diplomacy for its own national interests, but it also serves our global interests.

The Office of the Science and Technology Adviser to the Secretary (STAS) at the U.S. Department of State helps to facilitate science diplomacy, but also helps to build the scientific and technical human capacity inside the Department, assists bureaus and offices on specific matters where science and technology are relevant, and helps to anticipate scientific and technical issues that may affect international relations and/or disrupt societies in either positive or negative ways.[3] STAS works especially closely with the Bureau of Oceans and International Environmental and Scientific Affairs (OES) in the Department and the Global Development Lab in the U.S. Agency for International Development (USAID). Through creative programs, the Lab has greatly expanded the role of science and technology at USAID in addressing development challenges of the poorest countries.

3. Science, Technology and Innovation

In 2010 the U.S. Department of State and the U.S. Agency for International Development released a strategic blueprint to chart the course of U.S. foreign policy over four years (USAID, 2010). In this first Quadrennial Diplomacy and Development Review initiated by Secretary Clinton, it was stated:

"Science, engineering, technology and innovation are the engines of modern society and a dominant force in globalization and international economic development."

The significance of this observation was emphasized repeatedly during my tenure as S&T Adviser in conversations with representatives of many countries about science and technology. I was struck by the fact that nearly every country puts at the very top of its agenda the role of science and technology for supporting innovation and economic development. This observation was true for countries at every level of development − not only for countries like Germany, Japan, China, India, Brazil, South Korea, and Singapore, but also for countries like Mexico, Colombia, Chile, South Africa, Indonesia, Czech Republic, Malaysia, and Vietnam. They are all seeking insights regarding the right policies and investments to help their societies to become more innovative and competitive to ensure a more prosperous and secure future for their citizens.

Why does nearly every country now have a "laser-like" focus on improving its capabilities in science, technology, and innovation in order to be more competitive in this globalized, interconnected world? My guess is that most countries see two trends clearly: (i) science and technology have a major impact on the economic success of leading companies and countries and (ii) the scientific and technological revolution has been accelerating. If countries do not become more capable in science and technology, they will be left behind. The upside

2 This three-part definition is slightly different from the three-part definition in the January 2010 publication of the Royal Society and AAAS entitled "New Frontiers in Science Diplomacy." The RS/AAAS definition separates "science diplomacy" into "science in diplomacy," "diplomacy for science," and "science for diplomacy." My first category includes the first and third of the RS/AAAS categories. My third category is new and perhaps the most important of all.

3 The creation of the position of the Science and Technology Adviser to the Secretary was in response to a recommendation in the 1999 report of the National Academy of Sciences (NAS) entitled The Pervasive Role of Science, Technology, Health in Foreign Policy: Imperatives for the Department of State. In 2015 the NAS issued a follow-on report entitled Diplomacy for the 21st Century: Embedding a Culture of Science and Technology Throughout the Department of State. Free PDFs are available at www.nap.edu.

is great if they can capitalize on the transformative potential of new and emerging technologies. As one example, the information and communication technology (ICT) revolution has shown the potential for developing countries to use new technologies to “leapfrog” over the development paths taken by developed countries, such as with mobile phones in Africa.

Countries also recognize that almost every issue with which they are confronted on the national, regional, and global level has an important scientific and technological component. This is true whether the issue concerns health, environment, national security, homeland security, energy, communication, food, water, climate change, disaster preparedness, or education. Countries know they have smart, creative, entrepreneurial people. They believe their people can compete, even from a distance, if the right investments are made and the right policies are implemented. And they know that to become more capable in science and technology and to create an innovation and knowledge-based society, they must collaborate with the world leaders in science and technology.

New and emerging technologies have also affected the trajectory of fundamental science and engineering research by creating new capabilities for exploring and understanding the natural world. We are only at the beginning of exploiting the potential of these new capabilities. This is another reason for the acceleration of the scientific and technological revolution, progressing at such an incredibly rapid pace that it is hard to imagine, much less predict, what new transformative possibilities will emerge within a decade. Scientists are not much better at predicting the future than anyone else. As renowned computer scientist Alan Kay said, “The best way to predict the future is to invent it.”

How have these developments affected science diplomacy? For the U.S., science has become a strategic asset for our diplomacy because all countries want to engage with our scientists and engineers, with our universities and research laboratories, and with our high technology companies. They want to see how we innovate and how we connect research and development to the productive sector. This desire is true even for countries where our governmental relations are strained or non-existent. Engaging on these issues can help to influence the behavior, policies, and investments of other countries. While at the State Department I spent much of our time in dialogues with other countries about how to stimulate innovation from science and technology.

4. Facilitating an Innovative Ecosystem and Knowledge-Based Society

The fundamental principles describing what to do to spur innovation are generally well understood, but complicated to implement. These principles are clearly described in a report entitled “Rising Above the Gathering Storm,” published by the U.S. National Academy of Sciences and National Academy of Engineering in 2005 (NAP, 2007). The report was initiated by a bipartisan request of the U.S. Congress asking what the U.S. should do to ensure it would be able to compete in the 21st century and produce good jobs and a high standard of living for our citizens. The expert committee that wrote the report included leaders of industry, presidents of research universities, and Nobel Prize laureates. Many of the recommendations in this report were enacted in legislation through the America Competes Acts of 2007 and 2010.

The report’s recommendations for the U.S. government are grouped into four areas. All four require additional investments and improved policies, which are relevant for any country that wishes to enhance its science, technology, and innovation. The first is to improve and strengthen the primary and secondary educational system, when children first enter grade school through high school, so that more students are not only well-trained in the sciences, mathematics, and engineering and the scientific way of thinking, but also interested in pursuing careers that depend on these disciplines. The second is to provide more support for undergraduate and graduate students at universities and for students at vocational schools who pursue advanced training in science and engineering. The third is to provide more support for research and development in universities and national laboratories, especially in fundamental basic research whether it is motivated solely by deep curiosity or by the possibility of uncovering insights relevant for future applications. The fourth is to build stable and supportive government policies that facilitate, rather than retard, building an innovative ecosystem and a culture of innovation throughout society.

Building human capacity is the key element in creating an innovative society. We have turned off too many young people from science by teaching in boring ways—emphasizing memorization of facts rather than teaching by inquiry—and by having too many teachers in the early grades who are not adequately trained in the sciences and mathematics. We want more students not only more scientifically inquisitive and literate from a young age, but also passionate about science and its relevance to the modern world. We want them to be well trained in science, technology, engineering and mathematics —the so-called STEM fields. We want many of them to pursue careers that depend on these disciplines. We want them to pursue research, to patent their discoveries, to innovate and to start companies, to teach and to apply their valuable toolsets in many areas.

Also essential are strong research universities and laboratories that carry out fundamental research funded by multiple government agencies. Many U.S. research universities have created interdisciplinary research centers with government and industry support, requiring expertise from a range of scientific and engineering disciplines focusing on fundamental research in areas that are important for future advances and applications, such as in biotechnology, nanotechnology, smart grid, secure computing, synthetic biology, and robotics. These interdisciplinary research centers help to carry on the legacy of institutions like Bell Labs that contributed so greatly to innovation in the 20th century, a story that is well-told in the recent book "The Idea Factory: Bell Labs and the Great Age of American Innovation" (Kakutani, 2012). Applied research on important national priorities is also essential. Every agency of our government supports research and development in priority areas relevant to its mission.

The importance of the private sector in research and development (R&D) and in the innovation system cannot be overestimated. Seventy percent of the research and development in the U.S. occurs in the private sector, carried out by R&D facilities in our large companies and by entrepreneurs and innovators in small to medium-size companies, building on more basic research funded by government. One of the biggest challenges for many countries is increasing R&D expenditures in the private sector and building R&D collaborations between the private and academic sectors. An innovative ecosystem also requires policies that promote efficient markets, intellectual property laws that provide incentive for innovation and reward risk-takers, programs that provide assistance to small entrepreneurial startup businesses, a business climate that rewards venture risk capital investors and angel investors, and encourages foreign direct investment and trade. Further required is the free exchange of information in fundamental research, tax policies that promote innovation and private sector investment, enabling infrastructure investments by government, procedures that minimize corruption, and bankruptcy policies that permit second chances. Additionally important are policies that encourage university faculty to start small companies to exploit promising ideas; immigration policy that attracts the best and brightest from other countries; and government programs that encourage entrepreneurs, accelerate innovation through open competitions and prizes, and support research and development by small high-tech companies. Promoting innovation requires innovative thinking in our policies, organizations, and planning.

5. Science Diplomacy by Non-Governmental Scientists and Institutions

Let me now return to science diplomacy, which is most successful for a country that has an innovative ecosystem. Some of the greatest science diplomacy assets for the U.S. are our non-governmental scientific institutions and people. I will give some examples familiar to me, beginning with several individuals who were mentors. They were great scientists who also made significant contributions to science diplomacy. They never worked inside the government.

One is Sherwood Rowland, Nobel Laureate in Chemistry and Professor at the University of California at Irvine, who died in 2012. Sherry received the Nobel Prize with Mario Molina and Paul Crutzen. They discovered that chlorofluorocarbons (CFCs) in aerosols could destroy the earth's protective ozone layer and thereby create a potentially grave environmental problem. There were many critics of the work—both from industry and academia—until it was vindicated and proven correct. Sherry successfully advocated for a ban on CFCs that was achieved with the 1987 Montreal Protocol Treaty. I worked with Sherry when he served as the NAS Foreign Secretary for eight years. He used science and technology and his worldwide reputation to advance relations between the U.S. and other countries. He was treated like a "rock star" when travelling overseas. He helped to create the InterAcademy Panel of science academies around the world, which fosters the scientific capacity of academies in developing countries (IAP, 2015). He was a scientist who viewed scientific knowledge as a means for protecting our planet and improving lives of people everywhere.

Two other individuals are Paul Doty and Wolfgang (Pief) Panofsky. Paul was a Professor of Biochemistry at Harvard who died in 2011 at the age of 91 ("Paul Doty" 2015). He was a world-class biochemist who served on President Kennedy's science advisory committee. He devoted much of his career in trying to reduce the risk of nuclear war through engaging with Soviet scientists about nuclear arms control. He created the Center for Science and International Affairs at the Kennedy School of Government at Harvard University and the Program in Science, Technology, and Humanism of the Aspen Institute—two places where I worked with him. Pief, who died in 2007, was Director of the Stanford Linear Accelerator Center (SLAC) where I had the good fortune to be a postdoc (Pearce, 2007). Like Paul, Pief devoted much of his career to dialogues with scientists in Russia, China, Europe and elsewhere on nuclear arms control. Both Paul and Pief served for many years on the Committee on International Security and Arms Control of the NAS. This committee was the main "back channel" for communication between American and Soviet scientists on arms control during the height of the cold war. The Soviet scientists involved in these dialogues later became the key scientific advisors to Gorbachev, and their influence helped achieve the breakthroughs that occurred in arms control between these two countries. Nobel Laureate Jim Watson said of Paul: "His strength was in never wanting power." The same can be said of Pief. I also want to highlight Richard (Dick) Garwin, who worked with Paul and Pief and is still active working on all these issues, including serving on CISAC. The tribute to him in Science magazine shows his enormous contributions in "speaking truth to power" (Finkbeiner, 2013). All four of these outstanding scientists serving outside government provided seminal contributions to science diplomacy.

Non-governmental institutions are also critically important to science diplomacy. The U.S. National Academies of Sciences, Engineering, and Medicine—which includes the National Academy of Sciences, National Academy of Engineering, and the National Academy of Medicine—collaborate bilaterally and multilaterally with scientific academies and scientific organizations around the world to provide independent, expert advice to governments and international organizations on important regional and global issues. The goal is not only to make progress on solving problems that countries face, but also to help scientific organizations around the world to become more important advisers to their governments. I learned a great deal from the Presidents of the Academies (Frank Press, Bruce Alberts, and Ralph Cicerone at the NAS; Bob White, Bill Wulf, and Chuck Vest at the NAE; and Ken Shine and Harvey Fineberg at the NAM). All of them have been great science diplomats.

The American Association for the Advancement of Science (AAAS) created in 2008 the Center for Science Diplomacy and in 2012 the open-access online quarterly publication Science & Diplomacy. The Center has focused in part on scientific dialogue with countries where the U.S. government does not have diplomatic relations. The AAAS engaged early with North Korea and Cuba, and was among the first to engage with Myanmar. Both the AAAS and the NAS have engaged in scientific dialogues in non-nuclear areas with Iran; in fact, the NAS has been conducting workshops and exchanges with the Iranian scientific community for over fifteen years. Science cannot break down all the barriers, but when a window of opportunity emerges in governmental relations, the existing scientific contacts can be a great asset, as was the case for U.S. relations with both China and Russia. The U.S. State Department has always encouraged our non-governmental scientific organizations to maintain contact and communications with scientists in countries where diplomatic relations are strained or do not exist.

Private foundations have also played a significant role. As one recent example, the Howard Hughes Medical Institute (HHMI) partnered with South Africa to create a fundamental science research center called KwaZulu-Natal Research Institute for Tuberculosis and HIV (KRITH) in Durban to focus on solving the critical health problem of joint HIV and TB infections (K-RITH, 2015). Durban is the epicenter of this pandemic, and HHMI committed over US$70 million for KRITH. The research center works with the local university and hospitals in Durban and has attracted researchers from around the world. It has built good will between the U.S. and South Africa. The Bill & Melinda Gates Foundation is another example of utilizing science to solve health problems facing developing countries, and has directed enormous resources and expertise at these issues. The foundation provided support for a decade to the U.S. National Academies of Sciences, Engineering, and Medicine to help science academies in Africa to become more important advisers to their governments on health issues. Foundations in other countries have also served this role well. The Alexander von Humboldt Foundation, which was established by the German federal government, is an excellent example of an organization pursuing science diplomacy through collaborations in fundamental science and engineering. The many Humboldtians around the world are an important scientific network as well as a scientific bridge between Germany and other countries (Alexander von Humboldt Stiftung/Foundation, 2015).

Research universities are very international and build linkages between countries. The international collaborations are not only those initiated by individual faculty, but also strategic engagements made by university leaders and partly financed via university funds. It is hard to keep track of all the international engagements that our major research universities are undertaking (Colglazier and Lyons, 2013) American multinational corporations also contribute to science diplomacy. An interesting example is the program that Intel created to help reform engineering education in Vietnam. Intel built its largest chip assembly and test facility in the world outside of Ho Chi Minh City, and subsequently found that Vietnamese engineers and technicians that it hired needed additional skills. Intel partnered with Arizona State University—with support from USAID, Vietnamese ministries, and other companies—to create the multi-year and multi-million dollar Higher Engineering Education Alliance Program to strengthen engineering education in Vietnam (HEEAP, 2015). These international engagements by our universities and companies have been a great asset for the U.S. in building positive relationships with countries around the world. And it is important to remember that one of the greatest benefits for the U.S. innovation ecosystem from international engagement of our universities and companies has been attracting many of the best and brightest from around the world for graduate education and research and for creating and working in innovative American technology companies.

6. Opportunities and Challenges of the Urban World

The number of people living in cities will grow to over 60% of the projected population of 8.3 billion by 2030, and could rise to 85% of the world's population by the end of the century. This rapid urbanization is unprecedented in human history. I am a physicist, and physicists might call this phenomenon a "change of state" or "phase transition." It creates exciting new opportunities and many challenges.

What are the opportunities? Cities are the economic, political, cultural, and academic engines of most countries. People come to cities for a better life. They seek employment, services, health care, education, entertainment, and security. Cities are places where people from different backgrounds and disciplines interact and mix their different skills and experiences to generate new ideas and ultimately innovation, which leads to economic growth, wealth creation, and job creation. Cities have the potential to provide enormous social, financial, and environmental benefits, including an expansion of the middle class and growth of markets for products and goods that can help reduce urban and rural poverty. On the other hand, poorly governed cities can lead to political unrest, regional instability, crime, slums, and failed states.

Science, technology, and innovation are important components for building smart successful cities of the future. An especially promising area is making effective use of new insights that are made possible by advances in information technology and analysis of large amounts of data being collected by sensors of many different types and social media. But equally important is enlightened leadership of cities that creates common purpose from all sectors—government, business, academia—and a shared vision for improving the lives of all citizens. Innovative approaches are being undertaken in cities across the globe, and cities are learning from each other. If we can create cities that are sustainable, innovative, livable, prosperous, and smart, we will ensure the success of most countries

7. Broadband Connecting People and Things Everywhere

Information and communication technologies (ICTs) play a seminal role in enabling science, technology and innovation. Another "phase change" for the world is coming when all people are connected, and that will happen faster than the urban transition. A recent report by the McKinsey Company assessed a large number of "disruptive technologies" that could affect societies in significant ways (Manyika et al. 2013). The McKinsey analysts selected twelve technologies that they believed would have that the largest economic impact on the world by 2025, and attempted to estimate those impacts. The first four technologies in rank order are all connected to the ICT revolution: mobile internet, automation of knowledge work, internet of things, and cloud technology. McKinsey estimated that these four would by 2025 result in 14 to 28 trillion dollars of economic impact on the world. Any such estimate has great uncertainties, but the message is clear about the tremendous potential of ICT advances for affecting economic growth in every country. There is still much work to do over the next few years to bridge the digital divide, particularly to bring broadband internet access to the developing world and to eliminate barriers to access to ICTs by women in developing countries.

While the efficiency and productivity gains brought about by the ICT revolution may displace some jobs, there will be significant employment with the expected economic growth and the infrastructure needed to support the large numbers of people moving to cities. The adoption of ICTs is strongly correlated with economic growth and job creation. Governments will need to provide the enabling policy environments that encourage investments in ICT infrastructure and services to help close the digital divide. And as ICTs become more accessible, a virtuous cycle is created as entrepreneurs and innovators, who are encouraged to take risks, step forward to provide the services that people need and want. Expanding broadband access, both mobile and fixed, centralized and distributed, is one way to provide these opportunities for economic and social growth.

8. Science, Technology, and Innovation at USAID

To advance the role of science and technology in solving the world's most critical development problems, USAID created in 2012 the Office of Science and Technology (OST), and then combined it in 2014 with capabilities in partnerships and innovation to create the Global Development Lab ("About the U.S. Global Development Lab" 2015). This overall effort has helped to transform the development model at USAID to prioritize greater collaboration between the Agency and the global science and technology, university, and business communities. The STAS Office has worked closely with USAID on science and technology initiatives aimed at helping developing countries to build their science and technology capacity.

In 2012 USAID launched the Higher Education Solutions Network (HESN), a constellation of seven "Development Labs" that harness the intellectual power of American and international academic institutions to catalyze the development and application of new science, technology, and engineering approaches and tools to solve challenging development problems. The goal is to help the development community to discover more innovative, results-driven, efficient, cost effective, and accessible solutions in areas such as global health, food security, and chronic conflict. One of the seven collaborations involves Makerere University in Uganda, which is leading a consortium of 20 universities focused on its region.

USAID also provides grants to researchers in developing countries who are collaborating with U.S. government-funded scientists through its Partnerships for Enhanced Engagement in Research (PEER) program. PEER is a key tool for building more partnerships of mutual benefit among scientists from developing and developed countries to approach research and development challenges in innovative ways. By 2013 more than 1,000 scientists in developing countries had applied for PEER grants, and USAID had funded more than 100.

USAID is also partnering with other governments and NGOs to pioneer open source development mechanisms through its Grand Challenges for Development program and other prize competitions. These programs provide seed and transition-to-scale funding for successful proposals, on topics that include maternal and child health, energy and agriculture, literacy, citizen empowerment, and water. More than 2,500 innovators, entrepreneurs, small and medium business owners, researchers, and students have proposed innovative solutions through various pioneering open source development mechanisms. Applications are open to anyone in the world, and many of the winners are from developing countries. USAID has also partnering with the Department of State, NASA, and NIKE on the LAUNCH program, which helps innovators scale and commercialize their innovations by providing them with mentoring and support from experts and successful entrepreneurs. LAUNCH program cycles focused on the topics such as water, health, energy, waste, and materials, and have enabled innovators to network and receive specific advice from venture capitalists and business consultants on how to best implement their solutions to major development problems (LAUNCH.org, 2015).

9. Human Capacity Building

Building human capacity is absolutely essential for any knowledge and innovation-based society. One new way the State Department is tapping into our existing human capacity is by engaging science and engineering diaspora groups through the State Department's Networks of Diasporas in Engineering and Science, or NODES. In partnership with non-governmental scientific institutions, NODES seeks to strengthen diaspora networks and encourage their members to collaborate with their countries of origin and ancestry through initiatives in science and technology, entrepreneurship, and social innovation.

With regard to building local capacity, an important aspect is focusing on the role of women in science, technology, and innovation. Any country that wishes to compete globally cannot allow the potential talent of half of its population to go to waste. Women themselves are increasingly involved in research and innovation. More women than men are now enrolled in higher education institutions globally, and in both developing and developed countries alike, women are excelling. Women graduate from college at higher rates than men in many countries around the world, including the U.S. and E.U. Women also earn more than half of all graduate degrees and are even a majority of faculty at top universities in some countries. Countries with higher participation of women in education and the skilled workforce do better economically. In the science and engineering fields, all countries need to ramp up efforts to close the gender gap, particularly in the areas of technology and engineering where the percentage of women remains at an extremely low level.

10. Objective Science and Technology Advice

In my conversations with representatives of other countries about enhancing the role of science and technology in society, there are two areas that I emphasize. The first is to encourage every government to seek the independent advice of its non-governmental scientific community on public policy issues where scientific and technical insights are relevant. The goal is for a country to have high quality, objective, and credible scientific advice—free of politics and special interests, independent of government control, and conveyed to the public as well as to the government. In their decisions, political leaders necessarily incorporate value judgments and other considerations that go beyond science, but objective scientific advice may help lead to wiser decisions. It is in everyone's interest for all countries to have decisions informed by the best scientific information, conveyed transparently, without bias, and with accurate representation of scientific uncertainties.

My second effort is to encourage governments to consider creating opportunities for young scientists, engineers, and medical professionals to have an opportunity to experience working in government. The STAS office is the steward of several outstanding fellowship programs that bring science and engineering PhDs to work at the State Department. Over thirty fellows sponsored by the AAAS are currently in their first or second year in the State Department, and approximately seventy former fellows have become regular civil service or Foreign Service. Wherever I went inside the Department, I found current and former fellows. They have permeated the Department, greatly added to the science and technology human capacity, and formed a network outside of the hierarchy. The same is true for AAAS S&T Policy fellows working at USAID as well as many other agencies of the U.S. government ("AAAS Science and Technology Policy Fellowships" 2015).

The Jefferson Science Fellows Program, which was initiated by one of my predecessors more than a decade ago, brings senior tenured faculty to work for a year in the Department or USAID ("Jefferson Science Fellowship Program" 2015). Approximately thirteen Jefferson Fellows serve each year, and Jefferson Fellows continue to serve as resource experts after returning to their universities. Two professional societies—the Institute for Electrical and Electronics Engineers (IEEE) and the American Institute of Physics (AIP)—support several fellows each year as well. Current and former fellows are the majority of the staff members of STAS. In fact, the current Science and Technology Adviser to the Secretary—Dr. Vaughan Turekian—and the current Deputy S&T Adviser—Dr. Frances Colon—are former AAAS Science and Technology Policy Fellows. Former fellows contribute to science diplomacy and science policy whether they stay in government or pursue careers outside of government.

11. Special Opportunity for Progress with the 2030 Agenda

For the past several years beginning when I was inside the U.S. government, I have been involved with the process at the United Nations for strengthening the "science policy interface" for what is now called the 2030 Agenda with 17 Sustainable Development Goals (SDGs) ("Transforming our world" 2015). Science, technology, and Innovation (STI) are absolutely essential in making progress on all of these goals (Colglazier, 2015). Equally important are building STI capacity worldwide and facilitating wider global availability of knowledge and technologies. Our greatest legacy to the sustainability of future generations, in addition to avoiding wars and conflicts, may be building knowledge-based societies and accelerating the expansion of scientific knowledge and useful technologies. The 2030 Agenda can be as important for supporting the development of knowledge-based and innovative societies as for making near-term progress on the 17 SDGs.

Science diplomacy is needed to help other countries to become more capable in STI. One might worry that this assistance to developing countries creates more capable competitors, but I believe that it is in the interest of technologically-advanced societies to encourage more knowledge-based societies worldwide that rely upon science. The only way to stay in the forefront of the scientific and technological revolution, which is where I want the U.S. to be, is to run faster and to work with the best scientists and engineers wherever they reside in the world. That is why I support more global scientific engagement by the U.S. with leading scientists and engineers around the world. The approach that I favor was captured well in the title of an article in the October 2012 issue of Scientific American: “A measure of the creativity of a nation is how well it works with those beyond its borders.”

The world has a special opportunity with the 2030 Agenda. The political leaders of so many countries are focusing on improving capabilities in science and technology and willing to make fundamental changes in investments and policies to build more innovative societies. If we can minimize wars and conflicts with skillful diplomacy, the potential is there for more rapid economic growth, faster expansion of the middle class, and increased democratic governance in many countries as well as increased trade between countries. This is an optimistic scenario. Several future scenarios, including some that are quite pessimistic, are laid out in the illuminating report Global Trends 2030 published in 2012 by the U.S. National Intelligence Council (“National Intelligence Council” 2015). Nevertheless, I believe that we can make the hopeful scenario a reality. Science diplomacy is one of our most important tools in achieving the desired outcome.

12. Science and Human Values

Let me conclude with a sentiment that I learned from another mentor, Bruce Alberts. He is a distinguished biochemist at the University of California at San Francisco, former President of the U.S. National Academy of Sciences, former U.S. Science Envoy to Indonesia, and former Editor of Science Magazine. He has emphasized that the values and ethics that come from doing science are congruent with democratic values. Both the scientific revolution and the democratic revolution grew out of the Enlightenment. Science values the individual, relies on freedom of inquiry and the entrepreneurial spirit, rewards excellence and merit, bases decisions on evidence, supports academic freedom, relies on peer review, and encourages transparency via publication. Science is also an agent of change, is an equalizing force in society, works for the common good, and is a source of optimism about the future. So the ultimate connection between science and diplomacy is shared values, which is the fundamental reason why science diplomacy is a strategic asset for democratic countries.

Bruce Alberts often quotes the great scientist-humanist Jacob Bronowski from lectures delivered at Harvard and published in the book “Science and Human Values” (Bronowski, 1956). I will quote only one sentence among the many memorable lines in the book: “Men have asked for freedom, justice, and respect precisely as the scientific spirit has spread among them.”

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