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Science Collaboration Across Borders

Introduction

Scientific collaboration on both sides of the Pacific Rim will be increasingly important in meeting the many challenges that we face in the twenty-first century, such as understanding and responding to global climate change and finding better therapies or cures for diseases. While most scientists are committed to forging closer ties, practical issues of policy and culture sometimes stand in the way.

Over the past half century, collaborations among scientific researchers working in the United States and Asia have, in many cases, been hindered by uneven and sometimes poor relations between governments, as well as inconsistencies in policies, standards, and practices. Even for commerce-oriented areas of science and technology, researchers have encountered excessive or poorly coordinated regulations and practices. As American and Asian economies and societies continue to integrate under globalization, policymakers and researchers alike need to examine ways to enhance cooperation in the context of competing cultural perceptions, business practices, economic strategies, and customs of the regions. Successful outcomes from research and the advancement of science and technology in any region of the world depend on effective, free, and open communication and cooperation among experts with specialized knowledge.

Cooperation between researchers working in the United States and their counterparts in Asia is increasingly important for each side. According to the Organisation for Economic Co-operation and Development (OECD), approximately half of the world's research and development (R&D) funding comes from the United States and East Asia.[1] Moreover, scientific research remains a key component of China's plan to transition from an agrarian to an industrial society. R&D represented 1.34 percent of Chinese gross domestic product (GDP) in 2005, and Chinese policymakers have set a goal of increasing that figure to 2.5 percent by 2020. The United States, Taiwan, and Singapore—already industrial societies—prioritized scientific research by investing 2.25 to 2.68 percent of their national GDP in R&D in 2005.

Internationally co-authored research papers have increased in the past two decades, according to the OECD, from 30,000 in 1985 to more than 145,000 in 2005. While the percentage of publications involving U.S. co-authors has decreased from 50 percent to 41 percent between 1995 and 2005, the contribution from the Asia-10 (defined as China [including Hong Kong], India, Indonesia, Japan, Malaysia, Philippines, Singapore, South Korea, Taiwan, and Thailand) has increased from 8 percent to 13 percent, according to the National Science Board's "Science and Engineering Indicators 2008."[2] Still, collaborations with U.S. scientists are highly valued, with the United States accounting for 40 and 56 percent of China's and Taiwan's international collaboration articles, respectively. This constitutes approximately 9.7 percent of U.S. international co-authored articles.

Investments in science, engineering, and technology often lay the groundwork for future businesses, industries, and commercial applications that fuel economic growth and prosperity. It is crucial that policymakers both in Asia and the United States take the long view by supporting research, which will take years and even decades to transform into technologies and products. With the current worldwide economic and financial crisis, more—not less—effort should be made to increase research, as well as opportunities for international cooperation.

To better understand the future of international and interregional scientific research collaboration in

general—and the role that governments, industry, and universities might play to enhance it—the James A. Baker III Institute for Public Policy, through the Science and Technology Policy Program, the Transnational China Project, and the Technology, Society and Public Policy Program, hosted a two-day workshop to identify and examine key issues that are important to ensuring the most fruitful scientific collaboration among researchers on both sides of the Pacific Ocean. Officials and scientists from universities across this large region of the world—from Beijing, Dallas, Durham, Hong Kong, Houston, Singapore, Taipei, Tainan, Wuhan, and Washington, D.C.—met in Houston on April 27–28, 2009, to discuss ways to facilitate scientific and engineering research across borders.

The scientists who participated in this workshop were experts in several specific research areas: nanotechnology, quantum materials, climate change, and computer and information technology. These fields were chosen because they are areas of excellence at Rice University, the host institution, and successful collaborations exist between Rice faculty and faculty in the regions and countries represented at the workshop. Furthermore, Rice University faculty members from each of these disciplines served as co-organizers of the workshop and recruited Asian participants from ongoing collaborations.

The goal of the workshop was to develop a set of findings and recommendations based on the workshop deliberations that identified cultural and policy barriers, and to propose possible actions for universities, granting agencies, and federal/central governments to promote enhanced collaboration. While this report was based on discussions and presentation materials from the workshop, it is not a consensus document and it does not necessarily represent the opinions of individuals who participated in the event. This report and its findings and recommendations are solely the opinions of the authors. In addition, much of the content focuses on the United States. This was due to the location of the workshop and issues participants encountered while traveling.

Workshop Findings

The Importance of International Collaboration

Every nation and region of the world benefits from an investment in science and from translation of the knowledge, technologies, and skilled professionals that come out of research activities into applications, when research-driven knowledge or technology lead to beneficial commercial products. International scientific collaborations seem to have become the best and perhaps only way to take full advantage of the innovation that specifically occurs because of globalization—the increased circulation of people, ideas, technologies, and capital across national boundaries. Such collaborations are likely to be the most effective approach to dealing with societal challenges such as climate change, infectious diseases, and sustainable energy sources and production, which all require a strong foundation in basic sciences and engineering.

More generally, such collaborations promote the diversity and sharing of ideas that can lead to realistic solutions to global problems. Indeed, the open communication of ideas and research from different perspectives has often been the key to advancing science in many fields. Otherwise, time and money is wasted on replicating experiments—and possibly the pursuit of "dead ends"—instead of expanding on new ideas and discoveries. Furthermore, exchanges of ideas can lead not only to greater expertise but also a broader set of problems to investigate and address.

There are other benefits to collaboration. For instance, from the perspective of a researcher from an emerging university or laboratory, having a co-author from a better-known institution in a developed country can increase the probability of acceptance by higher-impact and well-regarded publications that lend legitimacy, especially to new programs and academic departments. Sometimes the competitive nature of science interferes with collaboration; some researchers may not be willing to share samples or new ideas, or give up primary authorship or the status and control of being a principal investigator. But competition is critical for innovation; the rewards of personal discovery and the critiquing of ideas and research move fields forward and advance science as a whole. Collaboration and competition are both important—it is a matter of balance. What is essential is that the policies of institutions and governments are sufficiently flexible to allow the researchers themselves to set the balance.

In addition to encouraging research collaborations between individuals, groups, and laboratories, the U.S. research community and funding agencies—e.g. the National Science Foundation (NSF), one of the oldest and most successful R&D granting agencies—have an opportunity to make a positive impact on the development of science policies around the world by sharing experiences and best practices with regard to funding policies, standards for research practice and publication, ethical challenges, legal issues (e.g. intellectual property), and other matters that affect the advancement of science.

Creating Collaborations

Researchers in some fields may be more likely to benefit from U.S.-Asia collaborations than others. For example, China is on the verge of parity in the quality of advanced research in many areas of science and has achieved parity with OECD countries in certain fields already, such as superconductivity. More generally, scientific research in universities and laboratories is advancing in Asia in many fields, so the movement of students and researchers is no longer just toward the United States but is multidirectional, with American researchers going to Asia to work as well.

Effective collaborations across borders require both top-down (university- and agency-driven) and bottom-up (individual-to-individual or lab-to-lab) support. Individuals, research groups, or laboratories working together through personal, face-to-face contact seem better able to establish long-term productive research relationships. Often such collaborations result when former graduate students accept positions in other institutions or foreign-born researchers working in U.S. institutions (or vice versa) broker interactions. Electronic communication certainly has enhanced collaborations, allowing the exchange of ideas and online editing of papers and proposals in real time. But it is not a substitute for personal interaction. Video conferencing offers considerable promise for the future, but because of technical limitations, research collaboration has yet to see significant benefits.

In addition to encouraging collaboration, universities, laboratories, and governments also need to provide financial support. Granting agencies, in particular, are integral to sustaining collaboration through research grants; but often these organizations have a hard time showing the added value of cooperative programs since the real impact of their support may be many years or decades in the future. Some U.S. funding agencies tend to give their international and interregional programs a low profile and limited funding. Fundamental basic scientific research is like cultivating mushrooms—initial investments lead to sprouting in unforeseen and diverse places many years later that government does not see at first. Demonstrating the payoff of research investments to politicians is a challenge in all parts of the world, and that is particularly the case for international and interregional research collaboration, where the benefits may be shared across oceans and, as a result, harder to quantify.

Barriers to International Collaboration

There are substantial barriers in all countries and regions that limit the effectiveness of international and interregional collaborations. Different academic, fiscal, and cultural calendars make coordination between institutions problematic. General literacy and scientific literacy vary greatly across countries, with anti-science movements taking root even in OECD countries such as the United States. In addition, varying standards for peer review of proposals and research articles, research ethics, and accreditation, as well as different policies regarding intellectual property, factor in the sustainability of collaborations. There has also been a proliferation of scientific journals, which increase the volume of research published but use different standards for acceptance. Without an agreement in the global scientific community about the quality standards for publication, many published articles are ignored and the impact of the research, whether of high quality or not, is lost.

Collaborations between scientists in the United States and the four regions and countries studied at the workshop (China, Taiwan, Hong Kong, and Singapore) face additional problems. Each government views collaborations differently. Singapore and Taiwan greatly encourage, as well as support, international collaboration, while policies in the United States have been known to make such collaborations difficult for scientists. China has been open to U.S. visitors, but sometimes does not permit Chinese scientists to attend meetings in the United States.

Examples of problematic policies are U.S. visa and export control policies. Obtaining a visa to visit the United States is often a long and overly complex process for Asian researchers and students. This

policy, which is driven by political responses to public views about immigration, security, and other foreign affairs, sometimes leads to protectionism and disregard for the positive impact of visiting scientists on U.S. science.

After the terrorist attacks on September 11, 2001, the United States revised the visa process to more closely survey individuals and prevent potential terrorists or other unwanted individuals from entering. This created long periods of waiting for visas because the U.S. State Department lacked the manpower to manage the extra paperwork. Although improvements were made in the last few years, waiting periods began to increase again this year, perhaps due to the change in administration. Some of the workshop participants from mainland China were told they would have to wait six weeks to interview for a visa, and many Chinese invitees were not granted visas in time to attend the event. In addition, if the scientist's area of expertise was on the U.S. State Department's list of sensitive topics, known as the Technology Alert List, the visa request could be subject to a Security Advisory Opinion (SAO), a review that can take an indefinite amount of time, but usually is an additional six to eight weeks.

Furthermore, there are problems related to transporting materials, technical information, and equipment across national and regional borders. Because of the concern that sensitive military or nuclear information could be transferred overseas, or biomaterial moved from its native environment (such as genetic information from the population or samples of plant life), restrictive policies have been implemented that, in some cases, obstruct research collaborations. These regulations, such as the International Traffic in Arms Regulation (ITAR) in the United States, have crippled industries and impeded research in technology. In order to export items included on the U.S. State Department's list, one must obtain an export license, an uncertain and often laborious process. The definition of "export" includes selling or sharing items, even within the United States, with anyone who is not a U.S. citizen or legal permanent resident. In general, ITAR is not supposed to apply to academic research, but there are exceptions, such as computer software and hardware, biological materials, and space technology. In addition to ITAR, there are also export control regulations enforced by the U.S. Department of Commerce. Some of these, called "deemed exports," also obstruct research collaborations.

These national policies are not formed in a vacuum; one country often chooses a policy in response to that of another country. For instance, if the United States decides to tighten its policy, China is likely to do the same.

The Role of Universities, National Laboratories, and Science Organizations

Universities, national laboratories, and other scientific institutions and organizations represent large numbers of scientists and have the ability to improve the flow of ideas, people, and technologies across borders by voicing the concerns of their members to governmental agencies and departments. Universities and national laboratories also play a role in creating an environment that supports and nurtures international collaborations. Rice University has embraced this idea by offering small grants each year to faculty members interested in international collaborations. In 2008, the Rice's International Collaboration Travel Fund awarded 10 grants between U.S. $2000–$7000 to help cover travel expenses to Asia and Latin America. These funds have helped faculty researchers, including some attending the workshop, develop collaborations in East Asia.

Universities and national laboratories are also ideal places to test new approaches to promoting cross-disciplinary and international collaborations, such as organizing funding based on broader research areas rather than traditional disciplines. One local example is the nanotechnology group at Rice University's Richard E. Smalley Institute for Nanoscale Science and Technology. The institute's researchers include chemists, physicists, biologists, mathematicians, computer scientists, Earth scientists, statisticians, engineers (bio, chemical, mechanical, civil and environmental, electrical, and computer), and even policy scholars, historians, and economists. This broad range of disciplines leads to new ways of addressing problems and encourages collaboration with scientists, engineers, and scholars at different institutions and in different parts of the world.

This brief description cannot match the richness of the presentations and discussions at the workshop. The attendees brought considerable experience and constructive ideas about what makes international and interregional research collaborations successful, as well as suggestions to improve them, particularly between scientists and engineers in the United States and Asia. While the purpose of the workshop

was to focus on U.S. government policies that affect international and interregional collaboration, several of the findings and recommendations that follow may be worthy of consideration by other governments as well.

Recommendations for Improving International Collaborations

Workshop discussions led to 12 recommendations involving U.S. visa and export issues, funding of international and interregional collaborations, the roles of universities and laboratories, and future directions for the project.

Visa and Export Issues

- Governments should hire more specialists with scientific and technical backgrounds to efficiently process visa applications.
- U.S. export controls and International Traffic in Arms Regulations (ITAR) should be reviewed and revised to avoid unintended damage to research collaborations and the exchange of research findings. This recommendation is consistent with the findings and recommendations of a number of studies, including a report from the U.S. National Academies.[3]
- U.S. university presidents and the leaders of research institutions and professional societies should write to the U.S. secretary of state about the negative impact of current policies on the flow of people, ideas and technologies across borders, and to commend efforts to improve the system.

Difficulty obtaining a U.S. visa was the most often discussed issue at the workshop. The problem negatively affected the participants' impression of the United States and even the number of people that could attend the event. Hiring more qualified specialists to review visa applications will reduce unduly long processing times.

Direct interaction between researchers—represented by university presidents and the leadership of science organizations—and policymakers should be encouraged. In addition to the U.S. secretary of state, letters should be sent to the Department of Defense, the Department of Homeland Security, the national security adviser, the president's science adviser, and the members of the President's Council of Advisors on Science and Technology (PCAST). Change is possible only if concerns are expressed to the appropriate parties.

Funding Issues

- Additional funding is needed for international and interregional collaborations. Granting organizations should also consider changes in their policies to permit more flexibility in the use of funds outside of their country, including funding the salaries of foreign scientists.
- Researchers, through their institutions and professional organizations, should encourage granting agencies to stress international and interregional collaboration and credible mechanisms to evaluate their impact.
- All institutions and organizations, including universities, national laboratories, and government funding agencies, should recognize the challenge of working across traditional disciplinary boundaries and consider a more horizontal and agile organization that gives high priority to important interdisciplinary areas of interest to the research community.
- Governments should ensure that science, engineering, and technology R&D are considered a part of diplomacy, with developed countries cooperating with developing countries to cultivate science and technology policy and education.

Money is often the best motivator for stimulating the exploration of new ideas and new collaborations, but sometimes allowing flexibility in the use of existing funds can be just as important. This kind of policy change will require that researchers, through their service on granting-agency advisory committees and with the support of their professional societies, emphasize that international and interregional collaboration are essential to their work. The argument may be particularly apt for multi-disciplinary research centers since they, by nature, promote collaboration between departments within the university or national laboratory.

Finally, recognizing the link between international and interregional research collaboration and diplomacy—referred to as "science diplomacy"—can encourage cooperation between countries and regions that may be at different stages of development and, in some cases, do not always have warm relations. The United States should use "science diplomacy" as an opportunity to help guide policies on research and publication standards, the peer

review process, and research ethics for science in other countries. This could help advance science globally as well as build lasting relationships in other parts of the world.

Universities and National Laboratories

- Universities and national laboratories at all levels (presidents, deans, divisions, and departments) should strongly promote and facilitate collaboration with other universities overseas.
- University science and engineering programs should encourage students to learn a foreign language and study abroad.
- Universities and national laboratories should give higher priority to providing financial support for visiting faculty and students from other parts of the world and create a better infrastructure to support exchanges of scholars through housing, health care, and family support.
- Universities and international scientific organizations should try to synchronize academic and fiscal calendars, as well as set world research and publication standards for peer review, research ethics, and accreditation.

To expand international relationships, universities and national laboratories should directly support (through awards and housing) as well as indirectly support (through language study and promotion) collaboration across borders. These actions will promote and improve the development and sustainment of interactions that would not have occurred otherwise. In addition, universities and scientific organizations should encourage universal standards for peer review, research ethics, and accreditations to advance science to a higher level, as well as help coordinate academic and fiscal calendars to recognize and reduce religious and cultural barriers.

Future Directions

- Future workshops, similar to the Baker Institute event, but perhaps with expanded Asian participation, should be hosted in Asia to continue the discussion of international and interregional collaboration.

Participants in the workshop were pleased to have a venue to voice their concerns, ideas, and success stories. It was suggested that the Baker Institute should continue the workshop model and encourage another institution to host a similar event in Asia. While researchers from China, Hong Kong, Taiwan, and Singapore were able to participate, most of the participants were from the United States. By holding the next workshop in Asia, it is expected that many more Asian researchers will be able to attend.

Conclusion

Scientists, government officials, and policy scholars from the United States, China, Hong Kong, Taiwan, and Singapore participated in the workshop and shared their views on international and interregional collaborations. While consensus between the participants was not an objective, the authors of this report were able to capture a shared vision of how international scientific collaboration should be created, supported, and encouraged. Overall, the findings and recommendations suggest three broad actions necessary to support and encourage international and interregional scientific collaborations.

First, create a culture that values international and interregional scientific collaboration in each country and region. This involves identifying and encouraging researchers through the policies and programs of universities, national laboratories, and government granting agencies, as well as hosting events in Asia and the United States that bring researchers together—the proven path toward effective collaboration. Such a culture also includes promoting and rewarding collaboration at all levels, including the tenure decision process at universities.

Second, encourage and sustain collaborations by improving policies within institutions, regions, and countries. This can be done by establishing worldwide standards for peer review, research ethics, and accreditation. In addition, increased efforts need to be made to remove federal/central government regulations (e.g. visa and export controls) that restrict travel and impede collaborations and the open sharing of scientific information.

Finally, recognize that enhancing collaborations requires reducing language and other cultural barriers. Currently, English is the principal language for scientific research. In order for research articles to be appropriately reviewed and receive maximum recognition by researchers around the world, they need to be published in English-language journals. But researchers from English-speaking countries can only be effective collaborators and "science diplomats" if they understand something about the

languages and customs of other nations and regions. By adding study abroad and appropriate language requirements to science and engineering degrees, the next generation of scientists will be better able to understand their partners in foreign countries. While normalizing academic calendars might not be feasible, using scientific organizations to encourage more coordinated schedules would help alleviate other cultural barriers, so that conferences are not scheduled on important religious or cultural holidays.

In the end, our discussion of international and interregional science research collaborations led to a dialogue about "science diplomacy"—the building of diplomatic relationships through science. Scientists often have better relations with their counterparts in other nations and regions than do their governments. "Science diplomacy" involves taking advantage of those professional relationships to keep the lines of communication open.

For instance, over the past eight years, the U.S. approval rating across the world has been steadily decreasing. In contrast, the approval ratings of scientists are traditionally high. In a 2004 Zogby poll taken in Jordan, the United States' favorability rating was only 15 percent while U.S. scientists had a rating of 83 percent.[4]

By promoting science in developing countries (including regions and countries outside those considered at the workshop), the United States has the opportunity to improve the way it is viewed in other parts of the world and to build relationships. In strengthening ties with less friendly nations, scientists can help build stability and hopefully reduce the odds of conflicts in the future.

Endnotes

1. Organisation for Economic Co-operation and Development (OECD), http://www.oecd.org.
2. National Science Board, "Science and Engineering Indicators 2008," National Science Foundation: 2008, http://www.nsf.gov/statistics/seind08/.
3. National Research Council (U.S.) Committee on Science, Security, and Prosperity, "Beyond 'Fortress America': National Security Controls on Science and Technology in a Globalized World," National Academy Press: 2009. http://www.nap.edu.
4. Based on "A New Era for Science Diplomacy," a presentation by Vaughan Turekian at "Science Collaboration Across the Border" on April 28, 2009.

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