International Cooperation in Science and Technology: Strengthening Ties Between the United States and Japan

Report to NEDO

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Abstract

The Washington, D.C., office of Japan's New Energy and Industrial Technology Development Organization (NEDO) asked Technology Policy International (TPI) to examine the recent history, motivations, barriers, and possible future of Japan-U.S. cooperation in science and technology. This cooperation ranges from informal collaborations and visits between individual Japanese and American researchers to large formal projects sponsored by government agencies in the two countries and conducted under the 1988 Japan-U.S. Agreement on Science and Technology.

This report has three main findings. First, the current relationship between U.S. and Japanese researchers appears strong and growing. For example, data on the number of scientific and engineering papers published in Japan and involving one or more foreign coauthors shows the number of papers with American coauthors more than tripled between 1988 and 2003. Second, however, interviews with American experts that TPI conducted for this study show that barriers do exist that hinder further U.S.-Japan S&T cooperation. For example, barriers exist as a result of differences in the two nations' research systems, differences in government accounting rules, and language and cultural differences. Third, the future of U.S.-Japan S&T cooperation appears good, in part because Japan has increased its national investments in research. However, global research is changing and now Japanese and American researchers have opportunities to work not only with each other and with Europeans but also with scientists and engineers from countries such as China and India. Some research is also becoming more multi-national than bilateral. In the future, these factors may affect U.S.-Japan bilateral cooperation.

Finally, if Japanese agencies and universities would like to reduce the barriers than currently prevent even greater U.S.-Japan S&T cooperation, the final section of this report lists several possible steps. This list is based on suggestions made by the American experts interviewed for this report, as well as by TPI's own analysis of what actions might help.

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Preface

The Washington, D.C., office of Japan's New Energy and Industrial Technology Development Organization (NEDO) commissioned the study underlying this report. The study examines current trends and policy issues surrounding U.S.-Japan bilateral cooperation in science and technology. The authors have undertaken this study as independent consultants working together as the firm of Technology Policy International. The report and its findings are based on the authors' experience in government, the private sector, and academia. The opinions expressed in this report do not necessarily reflect the views of NEDO or the institutions with which the authors are affiliated.

Also, TPI wishes to express its deep appreciation to the very busy American experts who agreed to be interviewed for this study. As we agreed, their names will remain anonymous, but their insights greatly aided this project.

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1. INTRODUCTION

1.1. Purpose of This Study

Since the early 1960s, the United States and Japan have engaged in a wide variety of bilateral and multilateral cooperative activities in science and technology, including many joint research projects and personnel exchanges. These have ranged from informal collaborations on specific projects between university faculty members in Japanese and U.S. universities, to major long-term collaborations involving formal government-to-government agreements signed at the highest levels.

The formal science and technology partnership was recognized in June 1961, when Prime Minister Ikeda of Japan and President Kennedy of the United States announced an agreement to establish the U.S.-Japan Committee on Scientific Cooperation, the first of several bilateral science and technology (S&T) agreements between the two governments.[1] In keeping with these agreements, Japan and the United States have formed a deep and lasting relationship in science and technology.[2]

In the fall of 2005, the Washington, D.C., office of NEDO asked Technology Policy International (TPI) to review this important bilateral S&T relationship, with a focus on its recent history, motivations for cooperation, barriers that arise, and possible steps to improve U.S.-Japan S&T cooperation in

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[1] William A. Blanpied and Christopher A. Loretz, "A Brief History of the National Science Foundation's Tokyo Regional Office," http://www.nsftokyo.org/History.htm. Dr. Blanpied wrote the original version in August 2002, and Dr. Loretz updated and revised the paper in January 2005.

[2] Blanpied and Loretz point out that S&T cooperation between the two countries has included several types of joint activities: cooperative research projects in areas of mutual interest, exchanges of scholars, and exchanges of scientific information and materials. This report uses the term "S&T cooperation" in this broad way, to include all three of these types of activities.

the government and quasi-government sectors. This report is the second of two papers TPI has prepared as part of that review. TPI submitted a shorter interim report in March 2006.[3]

This report focuses on (1) government-funded joint projects in science and technology conducted under these agreements by researchers in government laboratories, independent agencies, universities, and, sometimes, companies, and (2) informal cooperation between Japanese and American researchers – that is, science and engineering collaborations that do not occur under formal bilateral government programs. We do not examine S&T cooperation in the field of national security, since activities in this area are often classified, nor do we examine R&D cooperation between companies. Instead, the focus is on non-defense activities in such fields as basic research, energy, earthquakes and other natural hazards, health, electronics, and the environment. We pay particular attention to current opportunities and challenges for U.S.-Japan S&T cooperation with an eye towards how such cooperation can be strengthened.

1.2. Organization of This Report

This report has four additional chapters, and they cover the following topics:

Chapter 2 provides a general discussion of the motivations for international cooperation in science and technology, the forms that cooperation can take, and the roles governments play in supporting and regulating joint

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[3] Heaton, George R. Jr., Christopher T. Hill, Patrick Windham, and David W. Cheney, "International Cooperation in Science and Technology: Toward a New Prototype for the United States and Japan—Interim Report," Technology Policy International, 34 pages, March 2006.

work. That is, the chapter provides a framework for understanding why governments and researchers want to cooperate and what forms that cooperation can take.

Chapter 3 provides an American perspective on U.S.-Japan S&T cooperation – cooperation in the past, today, and possibly in the future. What have been American motives, what types of agreements have been negotiated, what kinds of projects undertaken, and how might changes in American motives and in global science and technology affect the U.S.-Japanese relationship in the future?

Chapter 4 examines barriers to effective S&T cooperation between Japan and the U.S., focusing on American views of these barriers. That is, from the American perspective what financial, administrative, legal, and cultural factors hinder U.S.-Japan cooperation in science and technology? To answer this question and understand which barriers are most significant from the American perspective, TPI has conducted in-depth interviews with American participants in cooperative S&T activities with Japanese researchers and institutions, with selected U.S. government supporters of such activities, and with knowledgeable experts.

Finally, Chapter 5 summarizes findings from the chapters and outlines policy options for enhancing bilateral S&T cooperation between the two countries. Drawing upon findings from the interviews, this chapter identifies steps that might be taken to strengthen and enhance future cooperation in science and technology between Japan and the United States.

1.3. Main Points from the Report

1.3.1. Brief Overview of Motivations, Types of Cooperation, and Government Roles

Why do governments and researchers want to cooperate internationally? There are many motives: to address shared problems, reinforce political alliances and joint objectives, demonstrate the ability to work together, learn from each other, take advantage of complementary strengths, create critical mass, or share costs. However, different groups may have different motives. As Chapter 2 points out, governments, research institutions (such as government laboratories and universities), and individual researchers all have different and sometimes multiple motives for participating in cooperative S&T projects.

For example, governments have both diplomatic and scientific-technical reasons for entering into joint research projects and exchanges of scholars: they may see cooperation as a way to take advantage of complementary strengths, learn from each other, or share costs, but they may also see S&T cooperation as a diplomatic tool to strengthen ties between two nations[4]. Research institutions frequently want to cooperate in order to get additional funding, share costs, raise their visibility in other countries, or give their researchers additional opportunities. Individual researchers usually are less concerned about

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[4] Using science and technology programs to strengthen diplomatic and cultural ties between nations has long been a feature of international science and technology policy in the United States. For example, Title V of the Foreign Relations Authorization Act for Fiscal Year 1979, also known as Public Law 95-426, recognized the importance of scientific and technical cooperation to U.S. foreign policy in general and required an annual report of actions taken in this arena by the United States. As another illustration, one of the goals of the "Framework" program for cooperation in research and development among countries that are members of the European Union is to strengthen ties among those countries.

international diplomacy than they are about the opportunities to work with valued colleagues on projects of mutual interest.

These diverse motives give bilateral S&T cooperation both a "top-down" and "bottom-up" character. That is, top government officials may sign agreements in order to advance high-level national goals, but actual joint projects arise largely because individual research institutions or researchers in two countries want to work with each other. In the process, cooperation may serve several different purposes, including personnel development and exchange, basic research, applied research, problem solving, and diplomatic engagement.

The type of cooperative activity may also vary. Governments may establish very broad programs, which support many individual research projects over many years. Or two governments may agree to a specific project with a finite lifetime, such as the Joint Optoelectronics Project. Or two governments may agree to participate with each other as well as other nations in a multi-national effort, such as the International Thermonuclear Experimental Reactor (ITER) or new research programs on global change and hydrogen fuels. One sign of a healthy bilateral relationship is a high degree of flexibility that allows officials to create new types of programs and projects that fit new needs and interests, within an overall framework that is based on trust and predictability.

Chapter 2 also examines the different roles that national governments play in bilateral S&T cooperation. Specifically, it examines these government roles: establish "umbrella agreements" (overall agreements that provide basic policies that guide more specific agreements and projects), negotiate specific agreements in specific S&T areas, provide funds, encourage cooperation among researchers, make introductions, and monitor and regulate interactions.

1.3.2. Brief Overview of U.S.-Japan S&T Cooperation in the Past, Today, and Possibly in the Future

From the U.S. perspective, S&T cooperation with Japan has served two purposes: to strengthen ties with a vital ally and friend, and to advance knowledge in several areas of science and technology important to both countries. In general, scientific cooperation has proved easier than joint technological research, given that the two countries are competitors in high technology businesses. But even in technology, the two countries have cooperated; the Joint Optoelectronics Project is a notable example.

Today, most U.S. officials appear to believe that the American-Japanese relationship is working well, and American S&T attention has moved on to other countries, not only China and India but also smaller nations whose friendship the U.S. seeks. The Bush Administration remains eager to engage Japan and other nations, particularly in Asia, in multilateral research on environmental and energy issues, including research on global change, hydrogen fuels, and homeland security, or "safety and security." This reflects a growing U.S. interest in multilateral approaches to research on key common problems. At the same time, there is a continued interest in the United States in enhancing bilateral S&T cooperation with Japan.

The U.S. Government does not keep lists of all collaborative U.S.-Japan S&T activities or of all instances of informal cooperation between researchers who choose to work with each other, but one data set does show how strong both research ties are between the two countries. The U.S. National Science Foundation collects data on the percentage of science and engineering papers published in Japan that include one or more foreign coauthor. That figure has steadily risen over the years: the percentage of Japanese research papers that had one or more American coauthors rose from 4.25 percent in 1988 to 7.4 percent in 2003.[5]

Two main trends will affect future levels of U.S.-Japan S&T cooperation. On the one hand, both U.S. and Japanese researchers will increase their S&T cooperation with China and other Asian countries. On the other hand, the rapid globalization of science and technology and Japan's growing strength in basic research may lead more Americans to seek interactions with Japanese researchers. The NSF data mentioned above suggests that both trends are important: Japanese researchers are coauthoring papers with increasing numbers of both Chinese *and* American researchers.

1.3.3. Brief Overview of Barriers and Problems

While U.S.-Japan S&T cooperation is increasing – at least in terms of coauthored papers – it is possible that various barriers are preventing even greater levels of American-Japanese collaboration. Chapter 4 of this report presents an analysis of what a number of American experts believe are current barriers. In a series of interviews conducted for this report, TPI listened particularly for comments about three kinds of barriers:

- *Financial barriers:* insufficient funding on one or both sides, restrictions on using national funds to support activities overseas, costs of project coordination.

[5] NSF data on publications in Japan should be used with care. Some analysts have suggested that the set of journals on which this data is based is biased in favor of journals that are most likely to be read outside of Japan and may, therefore, overstate the extent of American co-authorship of scientific and technical papers published in Japan as a whole. The extent of this overstatement, if any, is unclear.

- *Legal and administrative barriers:* differences in project funding mechanisms, timing and commitment issues that result from different government decision-making processes, contractual and legal issues, dispute resolution, indemnification, intellectual property and other ownership rights, export controls, protections for human subjects

- *Cultural and procedural differences*: language barriers, national preferences of international partners, entrepreneurial versus top-down styles, flexibility of project execution, roles of students and visiting researchers, authorship and attribution, pacing and timing.

1.3.4. Brief Overview of Policy Options: Toward an Improved Prototype for U.S.-Japan S&T Cooperation

Chapter 5 discusses key findings and possible policy options for improving U.S.-Japan S&T cooperation. The goal of this chapter is to contribute toward a new prototype, or framework, for enhanced U.S.-Japan cooperation.

The report has two main findings:

- The NSF data on papers coauthored by Japanese and American researchers shows that collaboration is strong and increasing.

- The interviews TPI conducted with American experts suggest that if the Government of Japan wishes to increase collaborative research even further with American research institutions, particularly American universities, then it may wish to address several barriers identified by the American experts. The most important barriers limiting U.S.-Japan S&T cooperation appear to be (1) differences in the university research systems of the two countries, which make it difficult for one government to apply its rules to research projects in the other country, and (2) continuing cultural differences, including continuing language difficulties.

The report also suggests some policy steps that might help reduce these barriers and facilitate greater S&T cooperation between the two countries.

2. TYPES OF BILATERAL S&T COOPERATION, MOVITATIONS FOR COOPERATION, AND GOVERNMENT ROLES

2.1. Chapter Introduction

This chapter focuses on the types of bilateral cooperation in science and technology, the goals and motivations for international cooperation, and government roles in promoting and facilitating that cooperation. The perspective is that of participants and supporters in the United States who seek to cooperate with counterparts in other countries. Quite naturally, we devote most attention to cooperation with Japan. However, much of the discussion can be applied equally well to cooperation with other countries and to multilateral cooperation. We do not attempt to speak to the question of motivations for Japanese participation in cooperation with counterparts in the United States, although we suspect that much of what is presented here would also apply to Japanese individuals and entities.

This chapter, in keeping with the report as a whole, addresses cooperation among universities, government agencies and laboratories, and other non-profit entities. It does not address the many ways in which for-profit companies cooperate in scientific and technical matters, except insofar as they are funded by governments or participate in government-sponsored programs.

This report is concerned with cooperation in science and technology (hereinafter "S&T"). Most frequently in this report, S&T cooperation refers to cooperation in research and development (R&D) activity. However, S&T cooperation may also refer to cooperation in preparing human resources for careers in science, technology, engineering and mathematics; to cooperation in setting and enforcing technical standards; to cooperation in enabling, facilitating and regulating exchanges of scientific and technical information; to cooperation in achieving concurrence on the foundations of scientific and technical information underlying important decisions of governments generally; and even to cooperation whose purpose is improved mutual understanding and/or achievement of foreign policy goals not directly related to S&T itself.

2.2. Types of Bilateral S&T Cooperation

International cooperation in science and technology takes place at many different scales and involves many kinds of projects, programs and participants. Such cooperation takes place in a complex environment of incentives, rewards, disincentives and barriers. Motivations for cooperation can differ significantly for activities at different scales and of different types. While many types of bilateral U.S.-Japan S&T cooperation exist, Americans interviewed by TPI for this project emphasized five particular types:

- Bilateral research programs and projects officially sponsored by the two governments
- Government money from one country supporting researchers in the other country
- Informal collaborations between Japanese and American researchers
- Collaborations between Japanese and American university research groups
- Extended visits by researchers from one country to laboratories in the other.

2.2.1 Bilateral Research Officially Sponsored by the Two Governments

Of course, some of the collaboration between government-funded researchers in the two countries occurs under programs or projects officially negotiated between the U.S. and Japanese governments. We call this a type of "top-down" cooperation, in the sense that officials at the top of the two governments decide on priority areas for cooperation and make funds available for their researchers to cooperate in these priority areas.

Three general types of official collaborative programs exist: "big science" projects, smaller programs involving government-funded researchers, and student programs.

In many cases, governments emphasize collaborations in "big science" – cooperative programs in S&T fields that require large-scale facilities or equipment and/or large research teams. Notable examples of U.S.-Japanese cooperation in "big science" include programs in high-energy and nuclear physics, energy, oceanography, and earthquake engineering. In some cases, these agreements involve several countries – the International Thermonuclear Experimental Reactor (ITER) and the International Space Station are examples – while in other cases the government agreements and resulting programs involve only the U.S. and Japan.

However, smaller-scale official programs also occur. Government laboratories in the two countries negotiate agreements to exchange information and personnel in areas such as metrology (the science of measurement). Research grant agencies in the two countries may agree to fund individual investigators in an area of common interest; the Joint Optoelectronic Project was one example. And in some cases one government may feel that a particular research area is a priority and will seek help from the other government in locating research partners. For example, currently the U.S. Government places a high priority on research to develop new technologies for homeland security and would welcome Japanese participation in joint projects on this subject.

A recent publication from NSF's Tokyo Regional Office[6] lists several examples of collaborative research that NSF helps to fund. These examples include "big science," smaller projects, and student programs:

- Integrated Ocean Drilling Program
- Atacama Large Millimeter Array, a radio telescope project
- Collaborative Earthquake Engineering Research
- International Rice Genome Sequencing Project
- TransPAC2 Project, a cyber infrastructure collaboration
- Materials World Network
- East Asia and Pacific Summer Institute Program for U.S. Graduate Students

These official government-sponsored collaborations have several other important characteristics. First, usually each government generally provides stable, long-term funding, which in turn helps provide predictability and stability to the collaborative project. This encourages the researchers to participate in these collaborations. Usually – but not always (please see below) – each government funds the activities of its own researchers.

Second, the governments negotiate administrative and legal arrangements (including intellectual property rules) at a high level, ensuring that these issues will not become major problems. Later in this report, the chapter on barriers to

[6] National Science Foundation Regional Office, "Highlights of NSF's Activities with Japan," May 2006 (unofficial print).

collaboration will point out that these two characteristics are very important and help make official government-sponsored collaborations successful.

Third, in the United States, in general individual research agencies – and not the White House or Department of State – arrange collaborative research programs with Japan and other countries. The Department of State certainly helps negotiate overall S&T agreements with Japan, and occasionally the White House will play a major role in establishing a particular research program. (One example is the role the Bush White House took in 2005 to create the Asia-Pacific Partnership on Clean Development.) But typically mid-level officials in agencies such as NSF, the National Institutes of Health, and the Department of Energy work with their Japanese colleagues – under guidelines established by formal agreements – to create, fund, and implement collaborative research projects. So there is no single office within the White House or elsewhere in the United States Government that creates or supervises government-to-government cooperation with Japan. For example, today the White House Office of Science and Technology Policy (OSTP) does not even have a senior official responsible for discussing or supervising international S&T cooperation.

2.2.2 Government Money from One Country Supporting Researchers in the Other Country

In a few cases, researchers from one country can receive funding from the other country's government agencies. Two versions of this type of collaboration are particularly important.

NEDO's International Joint Research Program (NEDO Grant) is an example of the first version: a government program explicitly designed to fund collaborative projects between Japanese researchers and researchers from other countries. One notable feature of NEDO Grant is that occasionally foreign researchers not only participate in these projects but also lead them. For instance, Jacques Zakin of Ohio State University has served as the research coordinator for a NEDO Grant project on cooling systems. In cases where a foreigner leads a NEDO Grant project, a Japanese researcher serves as the accounting coordinator – a valuable step that helps ensure that the project meets Japanese accounting requirements.[7]

In the past, MITI/METI has also funded other collaborative projects. For example, in 2000 MITI's Agency for Industrial Science and Technology (now the independent National Institute of Advanced Industrial Science and Technology) funded nearly 80 collaborations between Japanese and U.S. researchers. The Appendix to report lists these projects. These projects illustrate the wide range collaborative work that MITI/METI has funded. TPI is grateful to the Chief Representative of the Washington, D.C., office of NEDO for making this list available and translating it into English.

Second, in a few cases professors from one country apply to regular government grant programs in the other country, even though those grant programs are usually reserved for citizens of that second country. For example, some professors at U.S. universities have successfully applied for grant money from regular Japanese government programs. Sometimes these professors are

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[7] For further information about NEDO Grant, see NEDO, *International Joint Research Program (NEDO Grant) 2006*, available at: http://www.nedo.go.jp/kankobutsu/pamphlets/kengyou/grant/index.html. The report is in both Japanese and English. NEDO also has an International Projects program that involves researchers from other nations, although it emphasizes joint projects with other Asian countries. These projects disseminate Japanese energy and environmental technologies to other countries as well as conduct research. For information in English about this program, see NEDO, *NEDO International Projects – Activities to Address Global Environmental Issues*, May 2006, at: http://www.nedo.go.jp/kankobutsu/pamphlets/kokusai/nedo_english2006.pdf.

Japanese citizens, sometimes not. The professors in the U.S. sometimes also hold additional academic appointments in Japan – meaning that funding their U.S. work and graduate students helps promote the exchange of knowledge and students between the U.S. and Japan. The Japan Science and Technology Agency (JST) is one entity that occasionally supports researchers in the United States.

The U.S. Government also occasionally provides grant money to researchers in other countries – although usually only to researchers in developing countries.

For example, NIH funds international research partnerships through its Fogarty International Center for Advanced Study in the Health Sciences. Fogarty International Research Collaboration Awards provide up to $100,000 over three years "to foster international research partnerships between NIH-supported U.S. scientists and their collaborators in the developing world."[8] In some cases, funds from these awards can be used to help pay for salaries and travel expenses of collaborating scientists from the developing countries.

Similarly, NSF generally restricts its grant-making to U.S. institutions. As a rule, NSF funds can be used to support foreign nationals who are doing their research in U.S. institutions, including graduate students, but only under limited circumstances will it permit the use of its funds to support foreign scientists working in institutions outside the United States, even when they are collaborating with American researchers.[9] The following language from one of

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[8] Information on the Fogarty International Research Collaboration Awards can be found at: www.fic.nih.gov/programs/research_grants/firca/.

[9] On occasion, NSF will permit a U.S. grantee to make a "sub-award" from its NSF funds to an overseas institution. However, making such a sub-award requires both a justification for making it and prior approval by NSF (source: Interview).

its program solicitations that inform the community of the availability of grant funds in certain areas is typical:

> In almost all cases, international partners should obtain their own funding for participation. However, if an international collaborator is from a developing country or a country whose currency is not convertible, some support may be provided for that international collaborator.[10]

Another example is comes from 2005 program solicitation for "the 2010 Project," which aims to determine the function of all genes in a particular plant by the year 2010:

> The 2010 Project encourages laboratory-to-laboratory interactions between U.S. and foreign laboratories whenever such opportunities exist. NSF 2010 Project funds may be requested to support foreign investigators and students to work in U.S. laboratories and for U.S. investigators and students to work in international laboratories. However, foreign counterparts should secure support for their projects from their own national programs.[11]

Despite its general reluctance to use U.S. funds to support foreign researchers, NSF has begun to make more awards that support the U.S. portion of international collaborations in research and education. On January 30, 2006, NSF's Office of International Science and Engineering (OISE) announced the first grants – 12 of them – under its new Partnerships for International Research and Education (PIRE) program. Under this program, teams of U.S. researchers ask NSF for funds to pay for the U.S. portion of joint research and education projects with foreign partners. The awards are for up to $2.5 million and for up to five years. One goal of the PIRE program is to help prepare U.S. students to participate in this new era of global research.

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[10] National Science Foundation, "Partnerships for International Research and Education," Program Solicitation NSF 06-589, available at: http://www.nsf.gov/pubs/2006/nsf06589/nsf06589.pdf, page 12.

[11] National Science Foundation, "2010 Project," Program Solicitation NSF 05-624, http://www.nsf.gov/pubs/2005/nsf05624/nsf05624.htm.

One of the 12 January awards funds the U.S. portion of a joint U.S.-Japan research and education project in nano-scale semiconductors. Rice University in Houston, Texas, administers the U.S. part of the project. The project includes not only collaborative research but also an opportunity for American students to undertake summer studies in Japan.[12]

2.2.3 Informal Collaborations

Many productive U.S.-Japan research collaborations are informal, "bottom-up" partnerships developed by individual American and Japanese researchers who decide they want to work together.

The collaborations themselves can take many forms, including: visits to each other's institutions, joint research, joint publications, international research conferences, and the exchange of students.

Usually each researcher will have his or her own individual research funding, and no exchange of government grant money is involved. However, one of the American professors interviewed by TPI for this study pointed out that a Japanese colleague of his had non-governmental money that allowed him to pay for the American professor to visit Japan and give guest lectures. Non-governmental money therefore can play an important role in helping these informal collaborations.

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[12] For information on PIRE, see: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=12819. Information on the Rice University-Japan project is available at: http://nanojapan.rice.edu/. The Rice Web site lists the following Japanese partners as willing to take American students as summer interns: Riken Advanced Device Laboratory, the Tokyo Institute of Technology, Keio University, the University of Tokyo, the NTT Basic Research Lab, the National Institute of Advanced Industrial Science and Technology (AIST), Tohoku University, Osaka University and the Osaka Institute of Technology.

Because these collaborations are informal, they may not last beyond the retirement of one or both of the participating researchers. Sometimes their students or associates will continue the relationship, but this depends very much on the personal interests of these individuals.

2.2.4 Collaborations Between Japanese and American University Research Groups

Today, much of the research in American universities is conducted in research groups or centers that involve multiple professors and many students. The large number of research groups and centers is the result of several factors: the increasingly interdisciplinary/multidisciplinary nature of much of today's research, the need to share expensive equipment or computers, and interest from both government agencies and private companies in supporting centers that focus on important and complex areas of science and technology. For example, since the 1980s America's NSF has funded engineering research centers, science and technology centers, and more recently nanotechnology centers and user facilities. Other U.S. Government agencies also support centers, including in nanotechnology. Some state governments in the United States also fund interdisciplinary university centers. California, for example, supports four large California Institutes for Science and Innovation, all based at University of California campuses; these institutes also receive corporate and federal funding.

Of course, Japan also has important research groups and centers in its universities.

In some cases, university research groups in the two countries have explored the possibility of working together. The Rice University-Japan partnership in nano-scale semiconductors mentioned earlier in this chapter is one example. However, TPI can find no data on the number of such partnerships that exist between university research groups and centers in the United States and Japan, and our interviews suggest that these collaborations among centers are rare.

Chapter 4 of this report will discuss the barriers that appear to discourage this kind of collaboration. In particular, it will discuss the fact that American universities depend primarily on grants, contracts, and gifts for their research, and if neither the U.S. Government nor a Japanese university can provide funds to pay for an American center's costs in a collaboration then the American center is usually uninterested and unable to pursue it. American research centers appear much more interested in working with Japanese companies – which can provide funds – than in working with Japanese universities, although barriers also arise that can delay agreements with Japanese firms.

2.2.5 Visits by Researchers from One Country to Labs in the Other Country

Both the U.S. and Japanese governments sponsor programs that enable graduate students and post-doctoral fellows from one country to study in the other country. In the U.S., for example, the National Institutes of Health (NIH) accept post-doctoral fellows from many countries, including Japan. The National Institute of Standards and Technology (NIST) has long had a program under which it accepts both graduate students and more established experts from Japan and many other countries as long-term visitors in its laboratories. Japan of course offers opportunities for American and other foreign students to study in Japan.

2.3. Motivations for S&T Cooperation

Much is known about the motivations of individuals, organizations, and governments to engage in scientific and technical activities within a single national context. In this section, we review these motivations for S&T in general along with the additional motivations for engaging in international S&T cooperative activities.

2.3.1 Individual Motivations

Individuals participate in research for a complex of reasons. Most fundamental of these motivations is a desire to understand how the world works. Scientists want to know the answers to "why" questions, and engineers want to find workable solutions to "problems." Each is motivated, additionally, by the usual human desire to earn money in order to purchase the necessities and luxuries of life. An important motivation for scientists is the desire to be the *first* person to discover a phenomenon or to explain it; in fact, it has long been held, following the work of Robert Merton, that the recognition of being first is one of the strongest motivators for doing research. Being first to discover or explain something can establish a place for the researcher in history; being second usually leads to no recognition at all. Primacy, or being first, can sometimes translate into new and better opportunities to obtain additional research funding, to enjoy activities to consult and advise, and to travel and enjoy the adulation of one's peers.[13]

To explain why scientists and engineers would be interested in international cooperation, we need to identify the additional factors that

[13] Since the United States uses a "first-to-invent" criterion for determining which of competing applicants should be recognized as the inventor and be awarded a United States patent, being the first to make certain achievements or accomplishments can also result in substantial financial rewards if the invention is successfully commercialized.

motivate them. These factors can be both professional and personal. From a professional perspective, international cooperation may be motivated by the fact that a potential collaborator in another country has special skills, access to special facilities or special objects of study, or other unique characteristics that are not available in the home country. From a personal perspective, international cooperation generally yields opportunities to experience different cultures and to learn about how research or education or problem solving are done in a different country. International cooperation, per se, may also enhance one's recognition among peers, as it is a marker of recognition of accomplishment by external interests.

2.3.2 Institutional Motivations

Universities, government laboratories, and other non-profit organizations are also often motivated to participate in international S&T activities.

Universities as institutions may be attracted to international S&T cooperation as a means of raising their visibility and reputation in other countries in order to help recruit students and/or faculty from those countries. Such cooperation may also enhance the attractiveness of the institution to top quality students and faculty from the U.S. who can expect that the university's international engagements may open up international opportunities for them as well. For example, U.S. universities with extensive research and educational programs in or with Japanese universities are seen as more likely to have strong "study-abroad" programs and to open opportunities for research and educationally-related travel. Such universities are also in a position to respond rapidly when new problems or conditions create new circumstances in which S&T activity would be welcomed. For example, a university with a strong overseas presence in a country or region is well-positioned to respond quickly to research opportunities created by important events such as natural disasters, political realignments, new scientific discoveries, and so on.

Similarly, U.S. Government laboratories may be motivated to participate in S&T cooperation with Japan because Japanese institutions (universities or laboratories) have important and unique or expensive-to-replicate equipment and facilities in which Japanese partners may work to contribute to a complex S&T project. Or, a U.S. project or program may have as its focus a natural phenomenon that takes place in Japan or to which Japan as a place is important. There have been many such projects, for example, in fields such as earthquake engineering, fisheries management, global-scale air quality management, and astronomy.

2.3.3 Government Motivations

The U.S. Government is motivated to engage in or to fund international S&T cooperation for a number of reasons. It is worth noting that in any bilateral or multilateral S&T cooperative project, each country's government may have a mix of motivations, and the various countries are not necessarily motivated by the same objectives to participate.

From the point of view of the United States government today, S&T cooperation with advanced countries such as Japan is carried out first and foremost for the purpose of advancing the interests of the United States. Put simply, such activities must meet at least a notional cost/benefit test. However, the potential benefits are seen to cover a wide range. For example, some activities are supported because they can contribute to resolving important diplomatic challenges. Such is the case, for example, with U.S. and Japanese research in Antarctica. Cooperative R&D there has been used for decades as the means by which major nations have participated in a shared program that both contributes to new knowledge and forestalls activities by individual countries to develop Antarctica for economic or national security purposes.

Similarly, invitations by the U.S. to Japan and other countries to participate in the International Space Station can be understood as part of a commitment by both countries to ensuring that the then-Soviet Union was as engaged as possible in a shared program of peaceful exploration and exploitation of space so as to forestall its militarization.

Some activities are responsive to broad political imperatives. The U.S.-Japan Bilateral Agreement in Science and Technology seems to have been entered into in the first instance as a gesture of the shared determination of the two countries to treat each other as equals in world affairs. The intellectual property provisions of that agreement also served as a signal to the two nations that each is prepared to help protect the intellectual property rights of the citizens of the other.

Another motivation for R&D cooperation among countries, as among any two entities, is to share the high costs of expensive projects. The ITER project clearly involves a desire to control the costs that fall on any one country, as do other large scale "MegaProjects" such as the Large Hadron Collider at CERN and the International Space Station.

Still another reason for S&T cooperation is that one or both countries want to learn from the knowledge that the other brings to the table, either knowledge in entirely different fields or knowledge that is more advanced on one side than on the other. Japan's Human Frontiers Project was widely interpreted in the

United States, fairly or not, as an effort by Japan to invest heavily in cooperation with the United States in a field in which the United States had a clear lead.

Governments may also mount international projects to address shared problems that can only be effectively addressed through multilateral efforts. Studies of global weather and climate, ocean circulation, geotectonics, and other topics have international cooperation as a central element in any serious inquiry.

2.4 Government Roles in Bilateral S&T Cooperation

Governments play a wide range of roles in international cooperative S&T activities, ranging from disinterested observer to central participant. Here we discuss some of these roles and what is necessary to carry them out.

In particular, we discuss five key roles: provide funds, sanction "intrusions", enter into umbrella agreements, make introductions, and monitor and regulate interactions.

2.4.1 Provide Funds

As in any sort of S&T project or program carried out in U.S. universities, government laboratories or other non-profits, it is very likely that a government program will supply some or all of the funds needed to pay for an internationally cooperative activity.

In keeping with most cooperative research activities, and perhaps more than most, international S&T cooperation carries higher "overhead" costs than do activities carried out in a single institutional or country. These overhead costs include the extra costs of travel and coordination, as participants and administrators need to visit each other in their home institutions and as additional costs inevitably arise in negotiating the formal conditions of funding and of cooperation.

The U.S. Government typically budgets very limited funds to help cover the extra overhead cost of international cooperative S&T activity, which can be a barrier to participation and success, as noted in the next chapter of this report.

It is an empirical question as to whether cooperative S&T activities can, on balance, offset some of their high overhead costs through making it possible to achieve certain outcomes that could not be achieved by one country acting alone, through increased productivity and efficiency of research, or through taking advantage of a cost-saving division of labor among the participating countries. To our knowledge, analysts of S&T programs and policies have not examined this question.

2.4.2 Sanction Intrusions

By "sanction intrusions," we refer to the occasional need for sovereign governments to give permissions to foreign researcher to conduct studies within their territories. Such intrusions may involve nothing more disruptive than the presence of a foreign guest researcher in a domestic laboratory or university. In such a case, ordinary visa procedures, sometimes augmented with appropriate attention to regulations designed to forestall export of militarily critical technologies, are sufficient as a foundation for government approval of the activity.

At the opposite extreme, foreign researchers may ask for permissions to do studies in places, on populations, or using techniques that may raise ethical, moral, environmental or political issues for the host country. In such cases, formal country-to-country agreements may need to be negotiated before a project can go forward.

2.4.3 Enter into Umbrella Agreements

As discussed in Chapter 1, the United States has entered into a number of "umbrella" science and technology agreements with other nations. Typically, these agreements contain relatively few provisions to "actualize" the conduct of named programs or projects involving the participating countries. Instead, they are intended to set forth a general framework and a set of understandings that would govern government-to-government cooperation in science and technology. They typically express a general commitment on the part of the signatories to work together and support each other in the pursuit of scientific and technical goals. As noted in Chapter 3, the current bilateral agreement between the United States and Japan is focused heavily on the rules governing ownership and benefit from intellectual property resulting from science and technology cooperation.

It should be noted that many ad hoc bilateral and multilateral international scientific and technical activities are carried out without particular regard to any bilateral agreements that exist between the parties. One does not expect such ad hoc arrangements to violate the terms of a bilateral agreement, but neither do bilateral agreements serve as the exclusive means of implementing international cooperation.

2.4.4 Make Introductions

One of the very practical roles that governments can play in encouraging bilateral scientific and technical cooperation is to make introductions between potential partners in various institutions in the two countries. For example, one of the functions of the official representative of the U.S. National Science Foundation in the U.S. Embassy in Tokyo is to help make introductions of U.S. officials and researchers to counterparts in Japan. Similarly, that office routinely prepares and publishes widely available reports on S&T developments and on trends in S&T policy matters in Japan, as well as, more recently, other East Asian countries. These reports serve to keep Americans and others informed of possible mutual interests with Japanese programs and researchers.

2.4.5 Monitor and Regulate Interactions

Many, if not most, bilateral S&T projects and programs pose little or no challenge to the national interests of the parties involved. On the other hand, some projects, such as those involving national security or other "critical matters" such as homeland security, advanced technologies, or public health may require some level of government supervision to ensure that they are conducted in full compliance with rules governing national security classification, export of sensitive technical information, protection of endangered species, protection of national "patrimony" such as antiquities and historical sites, and the like. Government-funded projects can most easily be monitored through explicit requirements to inform sponsor agencies of the nature and outcomes of the work. Other sorts of interactions may only be monitored by the performing institutions through, for example, their compliance with the Export Administration Act.

2.5 Concluding Remarks for This Chapter

S&T cooperation between the U.S. and Japan can take many forms, ranging from interactions formally sponsored by the two governments to informal or "bottom-up" collaborations by individual American and Japanese researchers who want to work with each other.

Why do individuals, research organizations, and governments want to cooperate? Diverse organizations, institutions and individuals often find it worthwhile to cooperate with counterparts in other countries in carrying out programs that support advances in science and technology. They are motivated, as usual, by the hopes of making major contributions to the advance of knowledge and in the resolution of important human problems. They are motivated, as well, by expectations that foreign partners will bring special capabilities or access to special research subjects that will enhance the project's success. Individuals may be motivated to cooperate by the promise of opportunities to travel in and learn about other parts of the world, while funding agencies may be motivated by the hope of saving money and sharing costs. Governments may be motivated to cooperate as a means of getting access to unique natural phenomena, as a way to control costs, and as a means of demonstrating that good relations exist between the two countries, in general.

3. U.S.-JAPAN SCIENCE AND TECHNOLOGY COOPERATION IN THE PAST, TODAY, AND POSSIBLY IN THE FUTURE

3.1. A Brief History of U.S.-Japan S&T Cooperation

3.1.1. Motivations and Early Agreements

William Blanpied and Christopher Loretz, two former directors of the Tokyo Regional Office of the U.S. National Science Foundation (NSF), have prepared an excellent history of official government-to-government S&T cooperation between Japan and the United States. This section of our report draws heavily from their analysis.[14]

America's original reason for proposing a formal S&T cooperation program with Japan was political, not scientific.[15] In 1960, many Japanese protested the Mutual Security Treaty signed between the two governments, and John Kennedy, who became President in January 1961, was looking for ways to improve relations. At a June 1961 summit meeting with Prime Minister Ikeda, President Kennedy proposed, among other things, a U.S.-Japan Committee on Scientific Cooperation. Minister Ikeda agreed to the idea, and the result was the U.S.-Japan Cooperative Science Program. NSF became the implementing agency for the U.S. Government, and the Japan Society for the Promotion of Science (JSPS) represented Japan.

While the original motive for cooperation was political and "top-down" from the level of the President and the Prime Minister, science officials helped to

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[14] Blanpied and Loretz, "A Brief History of the National Science Foundation's Tokyo Regional Office."

[15] As noted in this report's Introduction, the analysis in this report focuses on non-defense S&T cooperation between the two governments. It does not discuss defense S&T cooperation, nor does it examine purely corporate R&D collaborations funded and conducted by private companies. Both defense R&D and private R&D are important, but they are not subjects included in this study.

decide the specific types of cooperative activities. The two governments proposed three types of cooperation: exchange of scholars, exchange of scientific information and materials, and cooperative research projects in areas of mutual interest, specifically earth and atmospheric sciences, biological and medical sciences, typhoon and hurricane research, and education in the sciences. NSF and JSPS contributed funds for these activities.

The 1961 agreement to create the U.S.-Japan Committee on Scientific Cooperation was, Blanpied and Loretz tell us, "the first of several bilateral science and technology agreements negotiated between the two governments." Several of the later agreements involved cooperation among government agencies other than NSF and JSPS. Examples included:

- The 1964 U.S.-Japan Agreement for R&D Cooperation in the Utilization of Natural Resources (UJNR). A program on Large-Scale Earthquake Engineering Test Projects came under this agreement.
- The 1965 agreement to establish the U.S.-Japan Cooperative Medical Science Program for research collaboration on diseases prevalent in Asian countries.
- The 1968 Agreement for Cooperation Concerning Civil Uses of Atomic Energy (later renamed the Agreement for Cooperation Concerning Peaceful Uses of Nuclear Energy).
- The 1979 U.S.-Japan Agreement for R&D Cooperation in Energy Related Areas. The Photoconversion and Photosynthesis Program that began in 1975 was ultimately placed under this agreement. So was the U.S.-Japan Fusion Cooperation Program, begun in 1979.
- The 1980 U.S.-Japan Science and Technology (Non-Energy) Agreement.

Japan also participated in some large multilateral research projects run by NSF. Blanpied and Loretz believe that the relationships built through the

Cooperative Research Program made it easier to negotiate and organize this participation. They say:

> One good indicator of the breath and flexibility of the 1961 Cooperative Science Program is that it has provided NSF with both the experience and organizational ties with the Japanese Government and Japanese research system which have proved useful in negotiating more specialized agreements, particularly those involving large scale endeavors. Japan's participation, since the mid-1970s, in two successive deep sea drilling projects managed by NSF provides a case in point.

U.S.-Japan cooperation took several different forms under these various government agreements. In some cases, cooperation between government and government-funded researchers from the two countries involved primarily research visits by collaborating scientists to each other's laboratories and information exchange seminars. This was the case, for example, in the early years of the Photoconversion and Photosynthesis Program. In other cases, U.S. and Japanese agencies would directly fund joint research projects, as was the case, for example, with large-scale earthquake engineering testing projects between 1978 and 1999. Government agencies in the two countries also used their knowledge of each other's programs to provide informal guidance to scientists interested in joint work.

3.1.2. The 1988 U.S.-Japan Agreement

In the 1980s, trade frictions arose between the United States and Japan, as the U.S. trade deficit with Japan grew and as Americans complained about a lack of access to Japan's markets. Blanpied and Loretz point out that these trade disputes spilled over into other policy areas as well, as follows:

> In particular, questions were raised about possible connections between basic research cooperation and Japan's trade advantage. There

was concern that since a larger fraction of US research facilities were open to visiting Japanese scientists than comparable Japanese facilities were open to America, the Japanese were enjoying an advantage that might be detrimental to the commercial interests of the United States.

The putative connections between research cooperation and trade and the relative lack of access to Japanese research facilities on the part of American researchers became apparent during negotiations for renewal of the 1980 U.S.-Japan Science and Technology (Non-Energy) Agreement, which was due to expire in 1985. The United States proposed, and Japan ultimately agreed, that US-Japan bilateral science and technology relations had become sufficiently complex and mature to warrant the creation of a system that would permit periodic review of the relationship both to identify fruitful areas of future cooperation and to avoid potentially destructive misunderstandings. Negotiating an agreement to accommodate this concept required a series of mutually agreed on extensions of the 1980 agreement. Finally, in 1988, a new, five-year Science and Technology Agreement was signed by U.S. President Ronald Reagan and Japanese Prime Minister Noboru Takeshita.

The 1988 agreement established a formal process for regular consultations between the two governments, and a Task Force on Access to R&D Facilities led to greater access in Japan for Americans, including graduate students. The agreement also dealt with the important issue of how to allocate intellectual property rights resulting from joint research. Several existing cooperative programs were brought under the umbrella of the new agreement, including the Ocean Drilling Program. New initiatives under the agreement included Global Change Research and the Joint Optoelectronics Project. The two governments renewed and at times revised the 1988 agreement three times: in 1993, 1999, and most recently in 2004 (a ten-year extension).[16]

[16] The English text of the 1988 Science and Technology Agreement, its annexes, and 1999 revisions is available at the following Web site: http://www.tcc.mac.doc.gov/cgi-bin/doit.cgi?204:64:bca8d21b0a80614fc6491d296ac4f27021b7782d2349a098449bbb50f2c3e8fc:119.

Not all U.S.-Japan S&T agreements signed since 1988 come under the 1988 agreement or are subject to its provisions. For example, some very specific agreements between U.S. Government laboratories and Japanese laboratories are separate from the 1988 pact.[17] But the 1988 agreement did provide a general framework and set of policy guidelines for U.S.-Japan S&T cooperation, and it did prevent trade frictions from leading to disruptions in bilateral S&T relations.

However, it is important to understand what the 1988 agreement and U.S.-Japan committees under it can do and cannot do. As discussed, the agreement provides guidelines for specific U.S.-Japan cooperative programs. And it helps agency officials in both countries who want to cooperate with each other; they can point to this high-level agreement as showing that the leaders of the two countries want to cooperate.

But the 1988 bilateral agreement by itself creates no specific programs. The U.S.-Japan meetings under the bilateral do not set specific R&R priorities or pick or fund specific R&D programs. The agreement only says that such programs are welcomed and that if agencies in the two countries agree to create bilateral programs, then certain rules apply. Moreover, the official meetings held under the 1988 agreement have not addressed practical barriers of the type discussed in chapter 4 of this report – practical problems that arise because of, for example, differences in the university research systems of the two countries. And the current official process, with its infrequent meetings and very bureaucratic discussions, is not well suited to discuss practical operational

[17] An example of this type of very specific agreement among laboratories is a 2001 pact entitled, "Cooperation Agreement between the National Institute of Standards and Technology and the National Institute of Advanced Industrial Science and Technology for Cooperation in the Fields of Metrology and Measurement Standards." This agreement functions separately from the provisions of the 1988 agreement.

problems. Moreover, the U.S. Government does *not* have single, high-level White House or State Department "Office of International Research and Development Collaboration."

Instead, most actual cooperative programs are created, funded, and implemented by mid-level officials in the R&D agencies and ministries of the two countries. These officials have actual R&D budgets and the authority to create and fund research programs, including collaborative programs.

This situation has an important implication for S&T policy-makers in Japan: while officials from NEDO, METI, MEXT, JST, and other ministries and agencies should maintain cordial relationships with the White House and State Department, if they want to create collaborative research programs they need to work with the directors and deputy directors of major U.S. research agencies, such NSF, NIH, DOE, and NASA. This is particularly true during the Bush Administration, when the White House Office of Science and Technology Policy (OSTP) is particularly small and politically weak.

3.2. U.S.-Japan Science and Technology Cooperation Today

Available data show that the U.S.-Japan S&T relationship is strong and getting stronger. At the same time, Japan is also increasing its S&T connections with other countries, particularly elsewhere in Asia. Barriers still exist that can hinder U.S.-Japan cooperation – as Chapter 4 will discuss – but today's relationship is close in several ways.

3.2.1. Data on Coauthorship

One important measure of U.S.-Japan S&T cooperation is the number of science and engineering papers that have authors from both countries. These coauthored papers can result from both official government-sponsored programs and informal collaborations between individual American and Japanese researchers.

NSF publishes some interesting data on international coauthorship. In particular, its data set on Japan examines three topics: the percentage of scientific and engineering articles published in Japan that involve one or more non-Japanese authors, whether the percentage of Japanese articles that include foreign coauthors is increasing or decreasing over time, and where these foreign coauthors come from. The data published by NSF clearly show that in recent decades more and more Japanese articles include a foreign coauthor – an indicator of growing S&T collaboration between Japanese and foreign researchers. Moreover, many of these coauthors are Americans and Europeans, although, not surprisingly, a growing percentage of foreign coauthors come from other parts of Asia. NSF provides the following summary of these trends:

> In Japan, the share of articles with international coauthors increased from 9% to 22% between 1988 and 2003, as Japan broadened its collaboration with more countries…. Japan's collaborations with the East Asia-4 [that is, China, Singapore, South Korea, and Taiwan] increased considerably during this period, especially with China….[18]

[18] National Science Board, *Science and Engineering Indicators – 2006*, Arlington, VA: National Science Foundation, 2006, volume 1, page 5-44.

The following table provides additional details.

Table 1. Science and Engineering Articles Published in Japan and the Numbers and Percentages of Those Papers That Include International Coauthors

	Total papers in Japan that year	Number of papers with international coauthors	Percentage of papers with international coauthors	Percentage of international coauthors from the U.S.	Percentage of international coauthors from China
1988	36,041	3,097	9	49.5	4.1
1996	54,614	7,973	15	41.7	4.9
2003	67,728	14,534	22	34.5	8.0

Source: National Science Board, *Science and Engineering Indicators – 2006*, tables 5-47. 5-48, and 5-49

From these data, one can make some interesting calculations. First, one can calculate the *number* of papers published in Japan that included one or more American coauthors:

- 1988: 3,097 x 0.495 = 1,532 papers coauthored with Americans
- 1996: 7,973 x 0.417 = 3,324 papers coauthored with Americans
- 2003: 14,534 x 0.345 = 5,014 papers coauthored with Americans

From these calculations, one can see that the *number* of collaborations between Japanese and American coauthors jumped by a factor of 3.27 (5,014/1,532) in 15 years. This suggests that the growth rate of U.S.-Japan coauthored papers published in Japan has been about 8.2 percent per year. This is an impressive rate of growth in U.S.-Japan collaboration.

Second, another way of looking at this situation is to calculate the *fraction* of *all* science and engineering papers published in Japan that had a U.S. coauthor. These are the calculations:

- 1988: 1,532/36,014 = 4.25%

- 1996: 3,324/54,614 = 6.08%
- 2003: 5,014/67,728 = 7.4%

In other words, over the 15-year period the proportion of papers published in Japan that involve U.S. coauthors has increased steadily and has nearly doubled over that period. And even as Japanese researchers have increased their collaborations with other Asians, the number of papers coauthored with Americans has also continued to increase.

A third interesting observation can be made by examining the data in the last two columns of this table. In 1988, we see that 49.5% of papers published in Japan with co-authors from other countries had a U.S. co-author, while only 4.1% had a Chinese co-author. That is, such papers were approximately twelve (49.5/4.1=12.1) times more likely to have an American, than a Chinese as a co-author. By 2003, this ratio had declined to only about four to one (34.5/8.0=4.3), suggesting both that the role of Americans as co-authors has declined somewhat, while the role of Chinese as co-authors has expanded very significantly.

On the whole, these data suggest that the U.S.-Japan relationship in science and technology remains strong but that the U.S. is increasingly "competing" with a resurgent China for partnerships with Japanese researchers.

3.2.2. Collaborations between Government Laboratories in the Two Countries

While many U.S.-Japan cooperative projects involve researchers from universities, government laboratories in the two countries also have a long tradition of collaboration. No single list of such projects or the agreements under which these projects take place exists in the United States. But laboratories such as NIST and the large national laboratories of the Department of Energy have entered into many agreements with laboratories in Japan and conducted many specific joint projects under these agreements. For example, NIST researchers have long worked with colleagues in Japan on metrology issues.

In general, cooperation among laboratories appears to be smooth, with few legal or procedural barriers. At one major U.S. government laboratory with a long history of cooperation with Japanese entities, the legal office reported to us that there have not been any significant legal issues in coming to agreements for cooperation with Japanese groups.

U.S. research institutions, including universities and government laboratories, have had a long history of collaboration with Japanese government laboratories, including those under the auspices of the former Agency for Industrial Science and Technology (AIST). Owing to the recent "privatization" of the AIST laboratories and their conversion into non-governmental administrative agencies, U.S. laboratories and agencies have found it necessary to re-negotiate all of their pre-existing agreements with AIST, which no longer are in force. According to our interviews, this has been a resource consuming exercise but has not resulted in any major difficulties in continuing to work together.

3.3. Factors Likely to Affect U.S.-Japan Cooperation in the Future

3.3.1. Trends in U.S. Attitudes Towards International S&T Cooperation

In recent years, U.S. Government officials have spent less time on formal meetings with Japanese S&T officials. For example, the 1999 amendments to the

1988 Science and Technology Agreement replace the requirement for "annual meetings" of the Joint High Level Committee and the Joint High Level Advisory Panel with the term "regular meetings" – so that meetings may occur less frequently. And clearly the U.S. has spent much time recently on new S&T agreements with countries such as India.

Is this decline in official meetings and attention causing worrisome? Is it a bad thing that is damaging S&T cooperation between the two countries? Interviews conducted by TPI for this study suggest that this decline in official attention may not be a problem.

First, today the U.S. Government is spending less time on formal meetings with Japan because U.S.-Japan S&T relationships are going well and are not a day-to-day problem. The U.S. focuses significant policy-level attention on its bilateral S&T relationship with other countries for two reasons: either to use S&T agreements as a way to improve overall relations, or because some problem exists in S&T relations (such as problems of access or intellectual property).

Second, actual scientific and technical cooperation between the two countries seems strong. Opportunities may exist for even more cooperation and for reducing barriers that hinder further cooperation, but the current level is impressive. In both bilateral and multilateral projects, the U.S. and Japan work together. The International Thermonuclear Experimental Reactor (ITER) is one of the largest examples.

Third, the U.S. Government continues to propose new initiatives when those initiatives serve the political interests of key American officials, especially the President. The Bush Administration – like other administrations before it – has used S&T projects to as a way to advance its foreign policy objectives. For example, many Americans and non-Americans have criticized the Bush Administration for rejecting the Kyoto Protocol and its requirement to reduce emissions that contribute to global warming. Partially in response to this criticism, the Bush Administration has proposed research and development (R&D) projects that one day may help reduce world dependence on fossil fuels. On January 9, 2004, for example, the U.S. Department of Energy and METI signed a joint statement of intent to pursue pre-competitive R&D in the field of fuel cells and hydrogen technology. Over the next few years, one should expect that the Bush Administration will continue to advocate bilateral and multilateral S&T energy and environmental initiatives, and perhaps some initiatives in important medical areas such as avian flu.

3.3.2. How Trends in Global R&D May Affect Bilateral Cooperation

The changing nature of global R&D will also affect the U.S.-Japanese S&T relationship, by changing the kinds of projects the two nations want to undertake and the ways in which they will want to organize and fund them.

First, investments under Japan's First and Second S&T Plans have strengthened Japanese basic research, increasing the reasons for Americans to want to work with Japanese researchers.

Second, the cost of major research projects continues to climb, and that fact has affected U.S. attitudes toward international cooperation. In earlier years, the U.S. often would simply create its own large program (such as its own particle accelerators) or design its own programs and then ask other countries to join (as was the case with the International Space Station). Today, however, the U.S. gradually is joining truly international R&D projects, such as ITER and the Large Hadron Collider. (Of course, Japan is also a major contributor to both

ITER and the LHC.) It is likely that the U.S. and Japan, along with other countries, will continue to cooperate and share costs on expensive projects.

Third, however, it is also possible that in the future many more international S&T projects will be multilateral rather than bilateral. The growing costs of projects, the fact that many research questions are global ones (for example, global climate change and the need for alternative energy), and the increasing globalization of R&D (meaning that many countries have significant R&D capabilities and invest substantial funding in R&D) suggest that many future projects involving the U.S. and Japan may be multilateral. There may be fewer large bilateral projects and more in which America, Japan, and other countries work together.

A fourth trend in R&D is the increasingly interdisciplinary and inter-sectoral (i.e., government-university-industry) nature of R&D, whether it is in new fields such as nanotechnology or more established fields such as energy. These trends in how R&D is organized and performed suggest that both the U.S. and Japan may need to adopt more flexible rules for international cooperation that will enable researchers from many different disciplines and sectors to work together effectively. In energy, for example, the two governments may want to invite company researchers to participate in R&D projects, along with researchers from universities and government laboratories.

Finally, as China, India, and other developing countries increase their R&D, both Japanese and U.S. researchers have new opportunities to partner with scientists and engineers in these countries. One would expect, therefore, that over time Japanese researchers would continue to increase their research collaborations with colleagues in these other countries.

4. BARRIERS TO EFFECTIVE U.S.-JAPAN COOPERATION IN SCIENCE AND TECHNOLOGY

4.1. Chapter Introduction

The U.S. and Japanese governments have now cooperated in science and technology since at least 1961; individual collaborations have gone on even longer. The data on coauthorship presented in the last chapter show that research collaboration between the two countries is strong and still growing. But of course problems can arise in bilateral S&T projects. What has been learned about the barriers that can hinder effective U.S.-Japan S&T cooperation? What problems can arise? Understanding these barriers will help both Americans and Japanese design more effective S&T programs in the future.

To answer these questions, TPI conducted a series of interviews with American experts engaged in scientific and technical cooperation with Japanese counterparts, either currently or in the past. TPI interviewed a dozen experts, including university professors, senior administrators at U.S. universities, and U.S. Government officials. The interviews were informal and were not numerous enough to allow statistical analysis, but they did include in-depth discussions with these very knowledgeable people. Through these interviews, TPI has drawn empirically based conclusions about the major barriers that have arisen in the past – and learned what they recommend to reduce these barriers and to enhance U.S.-Japan S&T cooperation. TPI has promised not to provide the names of these anonymous experts, but we greatly appreciate their time and valuable insights.

Before we began the interview process, we thought about the barriers that *might* exist. We considered barriers that *might* exist both in Japan and in the United States – barriers that would prevent or hinder cooperation between

Japanese and American researchers. In the interim report submitted to NEDO in March, we listed the following potential barriers.[19]

- *Financial Barriers*

  Insufficient Funding on One or Both Sides

  Restrictions on Using National Funds to Support Activities Overseas

  Costs of Project Coordination

- *Legal and Administrative Barriers*

  Differences in Project Funding Mechanisms

  Timing and Commitment Issues Related to Different Governmental Decision-Making Processes

  Contractual and Legal Issues

  Dispute Resolution

  Indemnity

  Intellectual Property and Other Ownership Rules

  Export Controls

  Human Subjects Protections

- *Cultural and Professional Differences*

  Language Barriers

  National Preferences Regarding International Partners

  Effects on Career Opportunities for U.S. Researchers

  Entrepreneurial and Other Differences in Style

[19] The exact words used here are slightly different than the words we used in the March report, but the list is essentially the same.

Flexibility of Project Execution

Roles of Students

Authorship and Attribution

Pacing and Timing of Research Projects

Then, during the interviews, we listened to see whether the Americans we interviewed in fact mentioned specific items from our list of potential barriers. We also listened to see if they mentioned any barriers that were not on our initial list. From the interviews, we gathered a picture of what these American leaders think about science and technology cooperation with Japan.

From the interviews, three main points emerged:

First, several of the Americans interviewed said that they believe that the quality of Japanese research is uneven – world-class in some areas, less good in others. One senior American university official added that current uncertainty about the future of Japanese university research also could deter Americans from wanting to work with Japanese colleagues, because Americans are not yet sure what kind of Japanese research universities will emerge from the reforms now underway in Japan. On the other hand, one U.S. Government official pointed out that Japan now has some incredible new research equipment, such as the Earth Simulator supercomputer, and that many Americans have an outdated view of Japanese research capabilities. And another observer pointed out that the Japanese university research system is improving rapidly and, equally important for Americans, becoming more like research systems in other countries. For example, Japanese agencies increasingly use competitions to award research funding. This slow "convergence" in research systems is likely to make U.S.-Japanese collaboration easier in the future.

Second, of the five types of collaborations discussed in Chapter 2 of this report – official government-created collaborations, seeking money from the other government, informal individual collaborations, collaborations among U.S. and Japanese university research groups, and personnel exchanges – we found that barriers are relatively minor in the first, third, and fifth categories. However, major barriers do deter collaborations in the second and fourth categories.

Third, while many of the Americans interviewed for this project said that research collaborations with Japanese colleagues can be very rewarding, in general they see negotiating and conducting research collaborations with the Japanese as more difficult and taking more time than collaborations with colleagues from other nations. Language problems, cultural differences, and bureaucratic rules cause special difficulties. One senior academic at a major public university noted that there are "no general incentives" for U.S. academics to collaborate with Japanese colleagues, so "special circumstances" are necessary if collaboration is to happen.

4.2. General Features of the Japanese and U.S. Research Systems That Can Affect Cooperation

Before discussing specific barriers that hinder S&T cooperation between the U.S. and Japan, it is worthwhile to mention some general features of the two nations' research systems – features that affect the willingness and ability of researchers to collaborate with each other.

4.2.1. Some Features of the Japanese Research System

Japan and the United States have very different R&D systems, particularly differences in how university research is funded and conducted. From the perspective of senior American professors and university administrators, the quality of Japanese university research is uneven. Certainly in many research areas, Japanese research professors are among the best in the world. Americans interviewed for this project specifically mentioned electronics, earthquake engineering, oceanography, and energy. In such fields, top American researchers often work with their Japanese colleagues.

But Americans interviewed for this project also say that, in their view, in the past and even today much of Japan's university research has not been world-class. Americans who know Japan well say one important reason is the way in which the Japanese government traditionally funded university research.

One senior U.S. university administrator noted that until recently the Japanese government did not award many research grants on a competitive basis, and that other practices also hindered the quality of Japanese university research. For example, rules limited the number graduate students any one professor could have. So even if a professor received a large competitively awarded research grant, he or she could not hire additional graduate students to help carry out the research. This same administrator, who likes Japan very much, added that many of the current generation of senior Japanese professors are not motivated to conduct world-class research and, even if they were, they do not have the funding or administrative freedom to do so. As a result, he said, he believes American professors should try to work primarily with younger Japanese professors, who may have more interest in conducting high-quality research and working with foreign colleagues.

A senior professor at a major Midwestern U.S. university – himself born in Japan – made similar points. This professor feels that there are ample possibilities for collaboration between Americans and Japanese in his field. However, they are not coming to fruition for a variety of reasons. Most have to do with a mismatch in the research systems in the two countries. The first impeding structural difference is what this professor calls a "vertically divided system" in Japan. That is, the older professors/researchers control money and decision-making, and the younger "are not empowered." In effect, younger researchers have little freedom to choose what they will work on, and the older people have little interest in having their protégés go abroad or work on someone else's research projects. Second, this professor feels further that the main venue to uncover fruitful cooperation is a "strong age-group network." This is difficult to achieve outside of one's home institution in Japan, and even harder across countries. Publications are definitely not enough. He says that even though he went to school in Japan, he does not "know enough people in Japan" to yield a framework for collaborations. Most Americans suffer even more from this, as there are definitely not enough opportunities to meet with Japanese researchers. Third, another big barrier is the difference in research funding practices. "Overhead" is not normally funded in Japan, which creates problems if Japanese money were to cover American-based research. In addition, Japanese universities do not normally have "Offices of Sponsored Programs" to administer and solve practical problems in research funding. This professor is "hopeful" that with privatization of Japanese universities, these problems will be ameliorated – he is in favor of Japanese sponsored programs offices – and that collaboration may increase.

An additional perspective on the Japanese research system came from another senior professor interviewed for this project. He added that the Japanese university system is now changing rapidly, but that Americans do not yet know what kinds of Japanese universities will result. Will the new organizational freedom enjoyed by national universities and the new emphasis on competitively awarded grants lead to universities that conduct more high-quality, world-class research? And will Japanese universities have adequate funding to pursue international collaborations with foreign colleagues? Until the answers become clear, he said, many Americans are reluctant to consider new partnerships with Japanese professors.

However, as briefly mentioned earlier, one U.S. Government official knowledgeable about Japan said U.S. researchers sometimes did not understand how much good research equipment Japan has added in recent years and the research opportunities that equipment provides to both Japanese and foreign scientists and engineers. He specifically mentioned the Earth Simulator supercomputer, one of the largest in the world devoted to climate modeling, and a massive "shake table" for earthquake engineering experiments that is capable of holding a simulated eight-story building. And of course as the number of competitively awarded grants in Japan increases, one would expect research quality to improve and Japan's university research system to become more like that of other major countries.

Finally, one American expert interviewed for this study suggested that it is also possible that recent changes in Japan's universities have reduced Japanese interest in collaborations with the United States. This expert said that the recent growth in Japanese research budgets and the improving quality of research in Japanese universities has provided better research opportunities in Japan. As a result, he said, Japanese researchers appear less interested in coming to the

United States than they were when funding and equipment within Japan was not as good as today.

4.2.2. Some Features of the U.S. Research System

Americans acknowledge that some features of the U.S. research system may hinder the ability of Japanese researchers to work with Americans. Three features deserve attention.

First, the U.S. Government's budget process can create uncertainty for international partners. U.S. funding for large international projects may be cut suddenly, as happened with in the mid-1990s when Congress abruptly cut money for U.S. participation in the International Thermonuclear Experimental Reactor (ITER) project. The termination of the Superconducting Supercollider after a number of years of construction and international negotiations over funding and collaboration also serves as a reminder of the somewhat mercurial nature of big science funding in the United States.

Second, the U.S. Government generally funds individual professors through competitively awarded grants or contracts that run for only a few years. Americans believe that this system of competitive, short-term awards encourages quality proposals and research, but it also means that a Japanese professor can never know whether his or her American partner will still have research funding in five years.

Third, the U.S. university research system depends heavily on what Americans call "soft money" – grants, contracts, and gifts – rather than guaranteed annual funding ("hard money"). As a result, if any Japanese researcher or research group wants to work with an American university laboratory, that laboratory usually requires that researcher or group provide funds. Japanese companies usually can provide money; Japanese university groups often cannot. This feature of the American research system can hinder U.S.-Japan cooperation.

4.2.3. Some Features of the 1988 U.S.-Japan Bilateral Agreement

As mentioned in chapter 2, the 1988 bilateral S&T agreement and the official governmental committees associated with it have specific capabilities and weaknesses. In particular, the bilateral agreement and its committees are *not* a good forum for discussing and dealing with specific operational barriers. This bilateral process does provide high-level support from the two governments for collaboration, but the committees meet so infrequently, require so much formal discussion, and so lack detailed technical knowledge that they do not have the time, expertise, or resources to understand or resolve specific operational barriers.

This observation is not a criticism. The bilateral process works very well for its intended purposes, which are to demonstrate high-level support for the bilateral relationship and to establish general rules for topics such as intellectual property. But a formal meeting once every two or three years cannot do more than allow a general discussion or ratify a specific agreement reached in other discussions.

The structure of the U.S. Government makes this situation even more complicated. There is no White House or State Department office whose job is to talk with Japan about the barriers discussed in this chapter. Instead, Japanese officials must discuss any such barriers with individual U.S. research agencies, such as NSF, NIH, DOE, and NASA. In one sense, this situation is frustrating: no one office in the U.S. Government can help resolve these issues. But on the other hand, mid-level officials in U.S. research agencies have the expertise, motivation, and resources to work out any problems.

4.3. Specific Barriers to U.S.-Japan S&T Cooperation

Americans interviewed for this study emphasize several sets of barriers that hinder U.S.-Japan S&T cooperation. In general, these barriers create less difficulty for researchers in official government-sponsored collaborations or in informal individual partnerships than they do for researchers in other kinds of cooperative activities.

4.3.1. Financial Barriers

With the exception of a few programs such as NEDO Grant, neither the Government of Japan nor the U.S. Government provides much grant money for foreign researchers, which means that people who want to cooperate with each other must each find their own funding, usually from their own governments. This is not a surprising fact, but it may be difficult for two professors in two different countries with very different systems of research support will be able to obtain funding for their proposed cooperative research activity at the same time unless there is a coordinated bi-national program in the area of their interest. This unpredictability can cause uncertainty.

Two people interviewed for this study added that a minor but still real problem is that the Japanese and U.S. governments have different fiscal years, which also can complicate planning since grants in the two countries start and end at different times.

In general, individual researchers in official government-sponsored collaborations in "big science" fields such as high-energy physics, oceanography, earthquake engineering, or ITER feel little financial uncertainty – unless the U.S. Congress decides to cut U.S. funding in any particular year. Individual Japanese and U.S. professors involved in informal research partnerships will tend to continue their collaborations as long as each professor has some funding.

4.3.2. Legal and Administrative Barriers

Interviews conducted for this study identified several types of legal and administrative barriers. This section of the paper discusses five such barriers: two from the Japanese side, two from the American side, and a fifth general barrier.

First, in the few cases where a professor in the U.S. directly receives Japanese government research money, that professor must of course comply with Japanese government regulations. However, because the two countries have such different financial, administrative, and legal rules, compliance can be difficult and time-consuming. One person interviewed for this study said it is not worth having a grant of less than $100,000 from the Japanese government, because administrative costs are so high. A later section of this chapter provides more details on this type of situation.

Second, administrative problems arise when American researchers or graduate students are invited to work in Japanese laboratories. According to an administrator who works with a professor who sends graduate students to Japan, Japanese universities require each student to submit a resumé in Japanese, obtain a physical examination in Japan, and other steps. All of these steps are reasonable from the Japanese point of view, since visitors should comply with

Japanese regulations. But the practical effect is to deter American students from coming to Japan, since these steps are often difficult for Americans.

The interviewees also mentioned two sets of U.S. policies that potentially could hinder U.S.-Japan cooperation, but which in practice actually do not seem to be significant. First, as mentioned in Chapter 2, the U.S. Government does not usually provide grant funding to foreign institutions.[20] (Of course, foreign-born graduate students and post-docs in U.S. universities may receive funds from U.S. grants.) However, NIH and even NSF occasionally allow U.S. Government funds to be used to provide direct support to a foreign researcher.

The second set of U.S. policies consists of U.S. Government visa regulations and export control regulations. TPI asked the American experts whether these policies significantly hinder the ability of Japanese researchers to visit and work in the United States. In recent years, a major debate has developed in the U.S. over these two issues; university groups worry that new visa requirements adopted since September 11, 2001, deter foreign students and researchers from coming to the U.S., and that export control rules can require American universities to obtain government licenses before certain foreigners are allowed to use certain types of high-tech research equipment. However, the people interviewed for this project told TPI that they did not know of any incidents in which U.S. visa and export control issues caused significant problems for Japanese researchers. One senior administrator at a major U.S.

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[20] When NSF is considering funding a proposal from a foreign institution, it sends the proposal to the U.S. Department of State for its review, pursuant to provisions of the NSF Act that require coordination with that department. The State Department does not pass judgment on the intellectual merit of the proposal, but only on whether foreign participation is generally consistent with any overall S&T agreements with that foreign country. TPI discussed this review process during our interviews and found no evidence that the State Department review process slows or prevents U.S.-Japanese research collaborations.

research university said that Japanese students and professors usually get visas within three weeks of applying. Given that Japan is America's close ally and friend, perhaps this fact is not surprising.

Finally, several people interviewed for this study identified intellectual property issues as a significant and time-consuming problem when negotiating U.S.-Japan research collaborations. Two senior administrators who run research centers at two major U.S. universities said that negotiating intellectual property issues with Japanese companies and universities takes much more time than most negotiations with groups from other countries.

4.3.3. Cultural and Professional Barriers

The American experts interviewed for this study said that cultural and professional barriers are very significant and hinder science and technology cooperation between the United States and Japan. They particularly mentioned four barriers that deter American students and professors from working in Japan.

First, for Americans cultural barriers remain significant, especially for American researchers who might consider living and working in Japan. The barriers here are well known: difficulties learning Japanese, differences in style (for example, many Americans like to ask direct questions but some Japanese might consider that impolite), the expense of housing, spouses and children who may not want to live in a foreign country with such an unfamiliar language, and the general bureaucracy involved in living and working in Japan. One Japanese-born administrator who works for a Japanese professor now at a major U.S. research university told TPI that American-born graduate students in her laboratory are often reluctant to move to Japan for a year or more, even though the professor can help find positions.

The high cost of living can be a problem for U.S. researchers or graduate students visiting in Japan. Having special housing facilities set aside for foreign visitors in Japan can help, but can also lead to isolation from the larger culture, which one faculty member we interviewed suggested would not be a good outcome.

Families of visiting researchers can face serious adjustment problems coping with Japan's quite different culture. Conversely, of course, some families find that life in Japan is very stimulating and opens new vistas for them. S&T exchanges have left many scientists and engineers and their spouses with life-long passions for Japanese arts, language, culture and so on. One senior professor we interviewed was deeply influenced by his experience in Japan as a young scholar and has gone so far as to write books on Japanese for English speaking scientists and engineers.

One of our interviewees mentioned that it can be difficult for American women researchers to work with men in Japan or with male Japanese researchers in the United States owing to what was characterized as the attitudes of some Japanese men toward professional women. The problem seemed to this person to be more a matter of ignoring women colleagues than of harassing them.

Many American graduate students and young post-docs are married. Given the contemporary prevalence of two-career marriages in the United States, extended study abroad is often not an option for younger American scientists and engineers.

Foreign language training has been in decline in U.S. universities for decades. Up until the 1960s, most leading universities required doctoral graduates to have developed at least a reading knowledge of two major foreign languages, which often meant German and Russian and, for a few, Japanese. Today, however, nearly all doctoral programs have eliminated foreign language requirements completely, so many fewer U.S. students are prepared to study abroad. According to one of our interviewees, who is very familiar with foreign language training at a major public research university, about 75% of all of their undergraduate students who study abroad as undergraduates go to countries like the United Kingdom, Canada and Australia where English is the dominant language. Another large fraction go to Spanish-speaking countries. Very few choose to go to countries with languages more challenging to Americans, such as Japan.

Second, differences in the two nations' university systems can be an issue. Historically, professors in Japanese national universities worked in a system with fixed research budgets for each professor and fixed numbers of graduate students. So it was difficult for American professors to send their graduate students to Japanese national universities when Japanese professors were not allowed to have extra students. There is also a perception, perhaps unfair, that many senior professors in Japan have few resources or little motivation to pursue world-class research. This perception leads some American graduate students, post-docs, and professors to think that Japan is not the best place to conduct research. This perception contributes to the third barrier.

Third, many American students and researchers have preferences regarding foreign research partners. Some Americans very much want to work with Japanese colleagues. This is especially true of Americans involved in "big science" collaborations or individual informal collaborations based on friendships and shared interests. But according to the American experts interviewed for this study, U.S. researchers generally prefer collaborations with Europeans, Australians, or others in East Asia (Korea, Taiwan, China). Americans believe that the top universities in these countries are active in interesting research areas, eager for partners, and easier culturally for people from the United States.

Fourth, the people interviewed for this study believe that American students and young professors are often told by senior U.S. professors that working in Japan will not help them in their careers. Of course, in some S&T fields Japan is a world leader, so if an American person studies earthquake engineering or oceanography or some fields in energy and electronics then experience in Japan helps one's career. But in general senior professors tell students and young professors that time spent learning the Japanese language and working in Japanese laboratories will not help them advance professionally. Administrators in U.S. government laboratories often give the same message to their young researchers. The message is this: time spent learning Japanese is a diversion, not something that helps one's career.

Fifth, one senior professor told us that, in the United States, each faculty member, no matter his or her rank or age, has very wide discretion over the conduct of his or her own research. The faculty member is "in charge." Any external collaborative activity implies being willing to share the responsibility and authority for conducting research, and this does not always come easy to individualistic American faculty members. Younger U.S. faculty, in particular, do not generally operate in research groups headed by more senior faculty, as is common in Japan.

What about the American view of Japanese researchers who come to the United States? In general, the Americans interviewed for this study welcome Japanese graduate students, post-docs, and professors into American laboratories. Japanese researchers work hard and generally are well trained. The ones who succeed often know English well, are well trained in their fields, and can understand America's culture and its emphasis on asking questions and exploring new ideas.

4.4. How These Barriers Affect the Five Different Types of Collaborations

The barriers described in the previous section affect different types of U.S.-Japan collaborations in different ways. This section provides some additional details about this situation that emerged from TPI's interviews.

4.4.1. Official Government-Sponsored Collaborations

Agreements on many issues must be negotiated at the beginning of an official government-sponsored bilateral or multilateral project: funding, intellectual property, indirect costs, how students will participate, and so forth. However, once government agencies in the U.S. and Japan reach agreement on these issues and secure funding, then the barriers faced by individual Japanese and American participants are relatively low, according to American experts interviewed for this study.

Examples of successful collaborations include the Joint Optoelectronics Project, ITER, and continuing U.S.-Japanese cooperation in the fields of earthquake engineering, oceanography, and energy (including hydrogen fuel research).

One of the American experts told TPI that official bilateral programs benefit greatly from the fact that senior government officials want these programs to exist and will help negotiate the necessary agreements about details.

4.4.2. Government Money from One Country Supporting Researchers in the Other Country

As mentioned in Chapter 2, NEDO's International Joint Research Program allows foreigners to coordinate individual research projects. It also requires an accounting coordinator for each project – an important step that helps the research team comply with NEDO administrative requirements.

The interviews indicated some concerns about accounting requirements associated with grants from MEXT and MEXT-affiliated independent agencies. A Japanese-born administrator gave TPI insights into the difficulties of U.S.-based researchers have in working with Japanese government agencies. She works for a Japanese professor who is now at a major U.S. research university and has received direct funding from the Japanese government.

She emphasized that if an American-based professor accepts funding from a Japanese agency, then of course that professor must comply with Japanese rules. She focused on a different topic: *if* a Japanese agency believes that Japan benefits from research it funds in foreign universities, *then* the agency should be flexible in how it administers its rules so that the professor and the university can carry out the research successfully and will want to continue to work with Japanese officials. She believes that Japanese agencies unnecessarily cause difficulty for the professors that the agencies themselves want to fund.

She pointed to several problems that could, she think, be easily solved. They include:

- "Paperwork is the headache," she told TPI. Japanese government agencies require many reports each year, more than is really necessary, and all of these reports must be in Japanese, which is time consuming for her but would be very difficult for any professor who does not know the language.

- Japanese agencies require that a U.S.-based professor spend all funding for a given year by the end of the Japanese fiscal year (March 31). However, American universities operate on a different fiscal year as well as a different academic year schedule, and forcing a U.S. university laboratory to spend all money by March 31 complicates payments to graduate students and others.[21]

- When a professor in the United States is asked to submit a proposal to a Japanese government agency, the agency requires the proposal to list the names of all graduate students who will work on the project. In the American system, a professor usually does not know which students will work on a particular project until he or she gets funding and begins recruiting students. The person interviewed said this is another example of how Japanese agencies do not understand the differences between Japanese and U.S. research universities.

- MEXT is one Japanese ministry that will not allow its research grants to be used to pay graduate student stipends. This approach is sensible in Japan, where students receive money separately from research projects. But of course many U.S. graduate students are paid through research assistantships. And since a professor in the United States

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[21] TPI agrees with this point made by the Japanese-born administrator. When Japanese agencies insist that a U.S.-based professor spend all funds by March 31, this policy causes considerable problems for U.S. universities. U.S. research grants and contracts are not usually tied to fiscal years at all, but can start and end at any time. They often run for several years. The U.S. academic year typically runs from September until May or June, and it is the period to which graduate student stipends are tied, while the summer is the time when most work gets done and expenditures happen. Even universities supported by state governments are allowed to maintain this September-May fiscal year. If the Japanese agencies that fund professors in the United States want good research, then Japanese grants to U.S. researchers should not be tied to any concept of a fiscal year.

needs graduate students to carry out research, MEXT's rule makes it difficult for the professor to carry out the research that MEXT itself wants performed.

- All equipment bought with Japanese government funds must have a Japanese inventory number and sticker. That is reasonable. But it is nearly impossible, this administrator says, to get permission from Tokyo to sell or dispose of obsolete equipment. This is a problem in the United States because U.S. universities aggressively seek to dispose of unused or obsolete research equipment as quickly as possible, in order to create room for new equipment.

- Japanese R&D agency officials (grant administrators and auditors) are typically not familiar with the standard American practice of including "indirect costs" and "indirect-cost payments" in research project budgets – that is, using a percentage of a grant to a university to pay for administrative and facility costs (utility costs, building rent, and other costs the university incurs when it provides laboratory space to professors).

- In most cases, the Japanese government officials supervising a grant in the United States do not speak English, do not understand the research being performed, and require all reports in Japanese. Then just as they begin to understand the U.S. research system, they are transferred to other government jobs. She contrasts these Japanese supervisors with American grant supervisors, people she feels are technically knowledgeable, have long experience in their jobs, want the professors to succeed, and are willing to try to be flexible when administrative rules cause problems.

- In her laboratory, the Japanese funding agency encourages the professor to send his graduate students – who are some of the world's best young researchers – to work in Japanese university laboratories. Yet in her view Japanese national universities make this process unnecessarily difficult. Students must submit their resumés in Japanese, which means that American students must find and pay for a translator. Their physical/medical examinations must be done at the Japanese university; a physical examination in the United States is not acceptable. Students must register with the government, which is appropriate, but universities sometimes do not help foreign students with this process. National universities require that foreign graduate

> students be physically present on their campuses on March 31, the end of the fiscal year, which may not fit the students' schedules.

Again, both this university administrator and TPI understand that Japanese government agencies have rules that are appropriate for Japan. These certainly are not bad rules. However, this Japanese-born administrator feels that if the Government of Japan wants to fund some foreign-based researchers in order to advance and then access their research, then these steps unnecessarily alienate the Americans that the government wants to work with. Doing research in the United States with Japanese government money, she says, "is like playing a card game with two different sets of rules." And whenever she tries to persuade Japanese government officials to be flexible and reduce the administrative burden they place on U.S.-based researchers, she gets little help. "They ask more for paperwork than for research results," she told TPI.

4.4.3. Informal Collaborations between Japanese and American Researchers

American professors interviewed for this project often have long and rewarding friendships and research partnerships with colleagues in Japan. And as long as professors each have separate funding for their home governments, few of the barriers listed earlier in this chapter cause problems for them. Some difficulties can arise. For example, if the Japanese professor comes to work in the American's laboratory for a period of time, or if the American goes to Japan, then agreements must be reached about the ownership of any resulting intellectual property.

While these informal partnerships run into few barriers, two senior American professors interviewed by TPI pointed out several factors that limit the number of informal American-Japanese partnerships.

One of the professors, a senior electrical engineering professor who has worked at several major U.S. research universities, pointed out that friendships and partnerships usually form when two people who respect each other's work decide to collaborate. He mentioned a long-term friendship he had with a senior Japanese electrical engineering professor, which lasted until the Japanese professor retired. The American has great respect for the work of his Japanese colleague and also appreciated the opportunity to learn about the research his colleague conducted with his unique, world-class equipment. In short, they had something to learn from each other. The implication is that if Japan would like to encourage more informal collaborations with top American professors, then it must enable more of its professors to conduct world-class research. The American professor also added that gift money that his Japanese colleague had received from companies helped the collaboration. His Japanese colleague could invite him and his students to visit Japan and give talks, using gift money to pay expenses and modest honoraria. Japanese government grants apparently did not allow the Japanese professor to pay the travel expenses of his American colleague.

The second American professor, who has long experience in Japan, made another point – one mentioned briefly earlier in this report. This professor pointed out that historically most Japanese professors had limited research money, limited training in English, and little motivation to conduct world-class research. All of these factors limited their ability and willingness to meet and work with American researchers. Of course, reforms in Japan have increased the number of competitive grants and brought more Japanese into the world research community. But when asked what more Japan could do to encourage and help its professors meet and work with the very best foreign researchers, he offered blunt advice: forget about the current generation of senior Japanese professors, he said, and concentrate on sending the best young Japanese professors to international scientific and engineering conferences where they will meet other scientists and engineers and, one hopes, build lasting friendships. Then provide these young Japanese professors with enough research funding and travel funding so that they can perform and share world-class research.[22]

4.4.4. Collaborations between Japanese and American University Research Centers

As part of this project, TPI interviewed two senior U.S. university administrators, each of whom manages a large electronics research center. The two centers are at two of America's best research universities. TPI interviewed these two administrators because potentially one new form of U.S.-Japanese S&T collaboration is between university research centers in the two countries. At least in the United States, much of the most important new interdisciplinary research is conducted in groups and centers, which involve multiple professors and many graduate students. How easy it is for U.S. and Japanese research centers to cooperate with each other?

Both of the senior administrators gave the same answer, and it was not encouraging. So far, this kind of cooperation is difficult and rare, and for three reasons. First, with a few important exceptions, the quality of Japanese university equipment and research does not equal that in the United States. So,

[22] In fairness, we should note that the United States does no better in addressing these matters.

American centers do not see mutual benefits from simply exchanging researchers and students. This leads to the second point. Because American universities support most of their research through "soft money" – grants, contracts, and gifts – they would be willing to work with Japanese universities if those universities could pay to send Japanese professors and students to work and learn at the American centers. But Japanese government policy limits the ability of Japanese researchers to use their government grants in this way. Third, and related, these prestigious American centers find it much easier and beneficial to work with European universities and governments. Trying to work with Japanese universities is just too difficult.

Both centers do work with Japanese companies. The companies contribute money in exchange for early access to research results, and in some cases they also pay the cost of company researchers who work for a year or so in the American centers. In short, Japanese companies can contribute money while Japanese universities usually cannot. Even so, both administrators told TPI that working with Japanese companies is more difficult and time-consuming that working with U.S. or European or Taiwanese firms. One of the administrators said negotiations with a Japanese company typically take six to eight months, much longer than with a U.S. firm. Intellectual property negotiations consume much time, but so do negotiations over whether to contribute grants or gifts and other topics. And it appears that it takes longer to build trust than it does with companies from other countries, a cultural barrier. Both of these administrators want to work more with Japanese companies and in fact have visited Japan to discuss possible partnerships. But they say that negotiating with Japanese companies is hard.

Both administrators also pointed out another barrier to greater cooperation between their researchers and Japanese colleagues: when the American researchers in their two centers want to visit other countries or work temporarily in other countries, they prefer Europe or even China. These other countries provide research funding. And the Americans find these other countries more comfortable.

4.4.5 Visits by Researchers from One Country to Labs in the Other Countries

A professor at a large Midwestern public university pointed out the critical importance to continued effective collaboration of long-term relationships between faculty from the United States and Japan if such collaboration is to be truly fruitful. Just an occasional visit or a one-time interaction is not likely to bear much fruit or to be particularly cost effective. People from different countries need to be not only S&T collaborators but to develop real friendships and trust relationships to do good work together. Reinforcing this, a senior NSF official deeply knowledgeable about Japan told us that in order for NSF to fund the international aspects of a proposed project, the project must hold out the promise of being “catalytic;” that is, it should lay the ground work for a continuing pattern of collaboration and not just be a one-time project.

TPI had the opportunity to discuss in depth the experience of one major U.S. federal laboratory in hosting visiting researchers from Japan and, less frequently, in posting American researchers to Japanese institutions. A number of important points were made regarding trends in and the success of such programs.

First, the department to which the laboratory is attached has a priority list of a half-dozen countries with which it wishes to encourage international cooperation. It includes China, India, and Brazil, among others, but not Japan. It is not clear whether this list reflects the desire to build new relationships, sustain existing ones, or both.

The number of visitors to the lab from Japan has declined over the past few years, while the number from China has increased substantially. In addition, the Japanese visitors are tending to be younger, and are more typically graduate students enrolled in U.S. universities. Interestingly, if visitors from overseas are not paid enough by their home governments to live in the United States, the laboratory will sometimes supplement their salaries to help with housing costs. It is not clear whether any of the Japanese visitors have this problem.

The laboratory at one time offered Japanese language instruction to its own staff owing to the high interest in communicating with and understanding Japan. The lab recently discontinued instruction in Japanese, but maintains it in Chinese and Spanish.

The areas of interest of Japanese visitors have shifted from, for example, earthquakes, structures, and fire research to nanomaterials, quantum computing, and MEMS (micro electro-mechanical systems). Japanese researchers in the latter fields are quite competent, it is reported.

The lab has had to arrange a new MOU for cooperation with AIST laboratories since AIST is no longer a government agency and is not covered by the U.S.-Japan bilateral S&T agreement.

When asked, the interviewee checked with the laboratory general counsel and determined that there are typically no legal barriers to effective collaboration with Japanese universities and government laboratories. In cooperating with Japanese companies, the lab requires that any intellectual property developed during the collaboration is made available to U.S. companies as well.

5. MAJOR FINDINGS AND POLICY OPTIONS

TPI's interviews and other data lead to certain major findings. And based on those findings, this chapter contains an analysis of several steps – several policy options – that might reduce or offset barriers to U.S.-Japan S&T cooperation.

5.1. Major Findings

The evidence presented in this report leads to several major findings.

First, since at least 1961 the United States and Japan have built a strong and lasting partnership in science and technology. That partnership has led to both informal friendships and strong official bilateral agreements and programs in areas such as earthquake studies, space, oceanography, high-energy physics and fusion, and electronics. These bilateral programs include both university professors in the two countries and researchers in government laboratories in both nations. Moreover, data on Japanese science and engineering articles indicates that an increasing percentage of these articles include foreign coauthors, and, even as Japanese researchers cooperate more with China and other emerging countries, almost a third of all these coauthors today are Americans. In fact, 7.4 percent of *all* science and engineering papers published in Japan in 2003 involved one or more American coauthors. To use an American phrase, U.S.-Japan S&T cooperation is "alive and well."

Second, however, our interviews show that barriers do exist that appear to hinder additional S&T cooperation between the two countries. Outside of the research fields mentioned above, many of America's top researchers prefer to work with colleagues in countries other than Japan. So the U.S.-Japan S&T relationship is not as strong as leaders in the two countries might want. For many American researchers – but certainly not all – Japan is seen as a "difficult" country, friendly but with a difficult language, a very different culture, many bureaucratic rules, and many universities that are not world-class research institutions. Many Americans would rather work with people from countries other than Japan. One set of statistics, not mentioned earlier in this report, is that in 2003 25 percent of all scientific and engineering articles published in the United States had one or more foreign coauthor; of those foreign coauthors, 44.4 percent came from the European Union (then 15 countries), 10.7 percent from the East Asia-4 (China, Taiwan, Singapore, and South Korea), and 8.4 percent from Japan. This 8.4 percent is significant, but not as high as some other parts of the world.[23]

Third, Japanese government rules sometimes make it difficult for Japanese to gain access to some of America's best research. Japanese university professors are having particular difficulty gaining access to America's growing number of interdisciplinary academic research groups and centers. Japanese companies, which have more freedom to contribute financially to these centers, have had more success. And when Japanese government agencies decide it is in Japan's interest to fund university professors in the United States and gain access to the resulting research, Japanese rules place an enormous administrative burden on these professors and probably deter other Americans from wanting to work with the Japanese government.

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[23] *Science and Engineering Indicators – 2006*, volume II, Table 5-4 9.

Fourth, it is not yet clear how the U.S.-Japan S&T relationship will change in the future. On the one hand, Japan has greatly increased its investments in basic research and in research facilities and now awards more of its research funding through competitive processes. These steps are likely to increase the quality of Japanese research and make the Japanese research system more like those of other countries – which may in turn make Japan a more attractive research partner. On the other hand, both Japanese and American researchers now have many opportunities for collaborative research, including not just Europe, Canada, and Australia but also China, India, and other Asian countries. In the future, will both Japanese and American researchers prefer to work with Chinese colleagues than with each other?

Fifth, the interviews suggest that many of the most successful U.S.-Japan collaborations are based on close personal friendships between Japanese and American researchers. In many cases, these friendships began when the researchers met each other at international conferences or during visits to each other's laboratories. Young researchers often form the closest friendships.

5.2. Policy Options for Strengthening U.S.-Japanese Bilateral S&T Cooperation

As part of this study, the Washington, D.C., office of NEDO asked TPI to provide ideas, based on our interviews and analysis, about what steps Japan might take to improve the U.S.-Japan S&T relationship. We were not asked to comment on what steps the U.S. Government might take, although that is certainly a subject worth considering at another time.

If Japan would like to increase U.S.-Japan S&T cooperation, the analysis in this study suggests several steps may be particularly valuable. In particular, many of the U.S. experts interviewed for this study said that Japan could increase collaboration by taking two sets of policy steps.

First, Japanese ministries could encourage and enable young researchers in Japan and the United States to meet each other, work together, and form lasting friendships. The U.S. experts believe that the best opportunity for expanding U.S.-Japan S&T cooperation is to help young Japanese researchers to conduct world-class research with American colleagues. The experts and our own analysis suggest that several specific policy steps by the Government of Japan and the U.S. Government might help:

- Continue Japan's current policy of awarding more government research money through competitive processes. This policy can help good young researchers and will improve the overall quality of Japanese research, making Japan an even more attractive research partner than it is today.
- Support international conferences and other meetings that are targeted to young researchers, as a way to build social networks among young researchers.
- Create a database of researchers by field, including young researchers, and disseminate to American researchers looking for international collaborators.
- Provide additional long-term fellowships for Americans and Japanese to study in each other's country, including language training. Short sessions, such as the eight-week language courses supported by NSF, are too short to make a difference. One model is the existing U.S. Fulbright program, which provides money for Americans to study in other countries and for foreign students to come to the U.S.
- Japan could create special programs, in English, for young foreign Ph.D. researchers who are interested in learning more about research

in Japan. The international degree program at the National Graduate Institute for Policy Studies (GRIPS) might serve as a model.

Second, *if* Japan would like to have greater access to research and research findings in the United States, then the following policy steps might help:

- When Japanese government agencies evaluate research proposals, they could give special consideration to proposals that include international collaboration (with Americans or with foreigners in general).
- When funding researchers in the United States, Japanese agencies could establish special accounting rules and procedures that ensure good oversight but also fit with the American research system and reduce the administrative burden on the American researchers. For example, the awards to professors in the United States could include funds for "overhead" (indirect cost payments to universities) and for graduate student research fellowships. NEDO Grant provides one valuable model: when an American (or other foreigner) leads a NEDO Grant project, NEDO names one of the Japanese participants as the accounting coordinator, thus relieving the American of having to spend a great deal of time understanding and following Japanese accounting rules.
- Japanese universities, with support from MEXT, could create "collaboration offices" – special administrative offices – to work with foreign researchers. When a Japanese professor wants to work with an American colleague (or a colleague in China or another country), experts in these offices could help that professor enter into a cooperative agreement.
- The Government of Japan might want to provide special funds to Japanese universities that allow professors at those universities to participate in interdisciplinary research centers in the United States and other countries.

Some of the experts suggested that the U.S. Government could take steps to encourage and facilitate additional U.S.-Japan S&T cooperation. In particular, some observers believe that the U.S. Government should provide special funds to support collaborative research between American and Japanese scientists and engineers. In TPI's judgment, this is an interesting idea, but in the American political system it would be very difficult for NSF or another U.S. agency to provide funds for cooperation with one country, such as Japan, and not for collaborations with many other countries. So the amount of funding that would help cooperation with any one country, such as Japan, would be low. However, the Bush Administration has shown great interest in multi-national Asia-Pacific research programs, particularly in environmental and energy fields. It is possible that the American government would welcome a proposal to expand these Asia-Pacific programs, although more study would be required.

5.3. Concluding Observations

As both Japan and the United States consider what steps might further strengthen their relationship in science and technology, TPI believes that three basic points should be kept in mind.

First, S&T cooperation will not occur unless there is reason to cooperate. So, for the relationship to stay strong, science and technology in the U.S. and Japan has to be excellent, at the state of the art, and relevant to each other's needs. What this suggests is that the top priority for countries that want to maintain a strong S&T relationship with other nations is to keep the quality of their research high.

Second, S&T cooperation is also – always – a matter of people cooperating with other people. Institutions may facilitate it, but they do not carry it out. Our view, therefore, is that policies to promote person-to-person, bottom-up mechanisms are the most powerful. As mentioned earlier, our analysis suggests that policies to encourage meetings and cooperation among young researchers may be particularly valuable.

Finally, the level and visibility of S&T cooperation between the U.S. and Japan is a function of more than S&T. It depends greatly on the health of economic ties and cultural affinity. The apparent great surge in U.S.-Japan interaction, during the 1980s, had a great deal to do with the new perception of Japan as an economic and technological power, as well as a measure of cultural attraction. Today, on the one hand, emerging economies like China and India are in the limelight, and cannot be ignored. On the other hand, the depth of the U.S.-Japan relationship gives a constancy between these two countries that does not exist elsewhere. It nevertheless needs continuing nourishment.

APPENDIX. PROJECTS IN 2000 PURSUED UNDER THE U.S.-JAPAN COOPERATIVE AGREEMENT IN SCIENCE AND TECHNOLOGY AND WITH SUPPORT FROM THE JAPANESE MINISTRY OF INTERNATIONAL TRADE AND INDUSTRY (MITI)

Over the years, Japan and the United States have engaged in many cooperative research projects, and several Japanese sources list many of the joint projects that have received some funding from Japanese government ministries and agencies.

For example, Japan's Ministry of Foreign Affairs (MOFA) maintains a Web site that lists some 160 joints projects under the 1988 Japan-U.S. Science and Technology Agreement. (Please see: http://www.mofa.go.jp/region/n-america/us/q&a/science/Science.html?adc6cc28.) Several Japanese ministries and agencies have participated in these joint projects with Americans.

Another useful document, presented in this Appendix, lists 79 specific cooperative projects that received financial support in 2000 from what was then the Japanese Ministry of International Trade and Industry (MITI), through its funding of national laboratories in Japan. This table was compiled by MITI as of March 2000. It does not contain any information about the status of these projects in 2006. The table illustrates the wide range of U.S. research institutions involved in cooperative research with Japan.

It should be noted that reorganizations in the Japanese government subsequent to the date of the table have resulted in the renaming of MITI as METI (Ministry of Economy, Trade and Industry), and the "privatization" of the national laboratories referred to in the table that were supported by the AIST (Agency of Industrial Science and Technology). These ex-national laboratories are currently operated under the independent administrative agency, the "National Institute of Advanced Industrial Science and Technology."

This table – as well as its translation into English -- was provided to the authors of this report by Hideo Shindo, Chief Representative of the Washington, D.C., office of NEDO (New Energy and Industrial Technology Development Organization).

No	Project Title (Sector)	Japanese Agency	US Agency	Outline (Existing/New)	Future Prospect
1	Analysis of Nucleation and Growth of Nanometer-sized Aerosol Enhansed by Ion (Earth Science and Global Environment)	Mechanical Engineering Laboratory	Yale Univ. Mechanical Engineering dept.	To demonstrate electric charge's impacts on nanoparticle-generating mechanisms in suspension in the air (Existent)	Continue
2	In-situ asessment of CFC mitigation by Solar Power-driven High Altitude Platform (Earth Science and Global Environment)	Mechanical Engineering Laboratory	UCLA	To experimentally make a demonstration airplane with long endurance in the stratosphere, which would contribute environmental protection (Existent)	Continue
3	Sensor Based Robotics (Production Engineering)	Mechanical Engineering Laboratory	Purdue Univ.	To establish a technology to control robots well based on information from sensors, through exploring a visual-oriented sensor technology and through its application to multi-finger robotic hands as well as to full-arm robotic arms	Continue
4	Research on Advanced Robotics and It's Industrial Applications (Production Engineering)	Mechanical Engineering Laboratory	Purdue Univ.	To explore practical robotic technologies by analyzing application needs of robotic technologies	New
5	Future Technology for Improved Highway Operation (Production Engineering)	Mechanical Engineering Laboratory	UC Berkeley	To exchange information on the Intelligent transportation System (ITS) and vehicle-control technologies at &D stages (existent)	Continue
6	Robotic Assistant (Production Engineering)	Mechanical Engineering Laboratory	Stanford Univ.	To establish a technology to construct a semi-autonomous 'robotic assistant' which is to support humans' various object-manipulating operations in manufacturing/service industries (existent)	Continue
7	Smart structure with integrated active control of structural acoustic radiation (Information Science and Technology)	Mechanical Engineering Laboratory	Virginia Institute of Technology	To research a smart-structure which contains a function to actively control vibration radiation (existent)	Terminate
8	Determination of Metabolic Using Novel NMR Techniques (Life Science)	Mechanical Engineering Laboratory	Radiation Imaging Lab (UCSF)	To establish a technology to enable non-invasive measurement and imaging of functions of living organisms such as metabolism and activities using nuclear magnetic resonance (NMR) (existent)	Continue
9	Light-tissue Interaction and Technologies for Optical Diagnostics (Life Science)	Mechanical Engineering Laboratory	Univ. of Arizona	To conduct basic research on light-tissue interaction mechanisms from theoretic and experimental viewpoints, in the context of R&D of an optical diagnostic technology, which would contribute to gain optic cross-section images of human bodies (existent)	Continue
10	Research on MR-compatible Surgical Manipulator (Life Science)	Mechanical Engineering Laboratory	Harvard University, Medical School	To develop a surgical manipulator which is compatible with surgical magnetic resonance imaging (MRI), and to conduct research for its application (existent)	Continue
11	Analysis on Generation Process of Nanostructured Materials by Laser-induced Plasma (Advanced Materials including Superconductivity)	Mechanical Engineering Laboratory	UC Irvine	To theoretically and experimentally elucidate, and solve, generation processes of nano-structured materials by laser-induced plasma (existent)	Continue
12	Study on the Accurate Characterization of Dynamic Characteristics for Displacement Related Sensors using High Impact (Production Engineering)	National Research Laboratory of Metrology	NIST	To conduct a collaborative research on acceleration-characterization techniques which is necessary for accurate characterization of dynamic forces, which is extremely important to balance two conflicting goals between energy efficiency of vehicles and safety protection of passengers (existent)	Terminate
13	Development of calibrated filters to improve the accuracy of a Fourier transform infrared spectrometer (Others)	National Research Laboratory of Metrology	NIST	To conduct an R&D to improve the accuracy of a Fourier transform infrared spectrometer which is used in various industries such as semiconductor, medical and pharmaceuticals, food and cosmetics, pollution measurement, etc.	New

14	Aerosol Particle Mass Spectroscopy and It's Mathematical Modeling (Earth Science and Global Environment)	National Research Laboratory of Metrology	NIST	To develop a mass spectroscopy technique regarding aerosol particles which are considered to have a big impact on global warming as well as ozone hole formation (existent)	Continue
15	Molecular Biological Studies on the Oncogenic Chromosome of Skin Cancer (Life Science)	National Institute of Bioscience and Human-Technology	UC Berkeley	To analyze oncogenic chromosomes of skin cancer by molecular biological techniques, which would contribute cancer diagnosis and treatment (existent)	Continue
16	Peptide Products targeting on Tumors (Life Science)	National Institute of Bioscience and Human-Technology	Univ. of Pittsburgh	To develop a technique of peptide targeting on tumors, through temporarily inactivating bio-active peptide by chemical modification, and then through reactivating it by removing those modified parts by enzymes located within tumors (existent)	Continue
17	Structural Control of Enzyme Function (Life Science)	National Institute of Bioscience and Human-Technology	Pennsylvania State Univ.	With a goal of development of a system to control enzyme functions using structural changes of enzymes, to produce kinds of variant proteins with different structure development mechanisms through modifying enzyme proteins, and to research their reactions to formulate higher level structures and their structural changes by various ligands (existent)	Continue
18	Mechanism of Growth Signaling (Life Science)	National Institute of Bioscience and Human-Technology	Maine Medical institute	To elucidate a mechanism to control cell-growth (mechanism of growth signaling), which would contribute to solve cancers as well as heart and vascular diseases (existent)	Continue
19	Structure and function of Molecular Motors (Biotechnology)	National Institute of Bioscience and Human-Technology	UCSF	To understand movement of living bodies at the level of protein molecules (existent)	Continue
20	Elucidation of the Molecular Mechanism Concerning the Regulation of Glycolytic Genes Expression in Yeast (Biotechnology)	National Institute of Bioscience and Human-Technology	Harvard University, Medical School	To elucidate a mechanism of controlling factors which integrally regulate a series of glycolytic genes, and to elucidate the molecular mechanism concerning the regulation of those genes expression (existent)	Continue
21	Studies on intercellular lipid metabolism and transport (Life Science)	National Institute of Bioscience and Human-Technology	Mayo Clinic and Foundation	To elucidate an intercellular mechanism of lipid metabolism and transport by studies on related enzyme systems and by using fluorescent lipids, and to realize visualization of an inter-cellular structure formation mechanism (existent)	Continue
22	Study on the quarry method harmonized with the environment (Earth Science and Global Environment)	Natural Institute for Resources and Environment	New Mexico Tech.	To develop a quarry method harmonized with environment concerning transformation and greenization of mountainous area (existent)	Continue
23	Evaluation of immunotoxic potential of industrial pollutant a using advanced instrumentation and biochemical methods (Life Science)	Natural Institute for Resources and Environment	Murray State Univ.	To elucidate immunotoxic potentials of industrial pollutants such as dioxins, and to evaluate their risks	New
24	Research on Characterization of Novel Activated Carbons and Activated Carbon Fibers (Advanced materials including Superconductivity)	Natural Institute for Resources and Environment	Univ. of Kentucky	To elucidate microporous structures of unique novel carbon materials, and to develop a quantitative characterization method concerning them (existent)	Terminate
25	Neutral mechanism of ocular following eye movements (Life Sciences)	Electrotechnical Laboratory	NIH	To elucidate a neural mechanism in brain regarding ocular following eye movements	New
26	Neural mechanism of visual recognition (Life Sciences)	Electrotechnical Laboratory	NIH	To elucidate a neural mechanism in brain regarding pattern recognition under the existence of visual noises	New
27	Evaluation of odor discrimination of mammals from mammals from receptor cells to behaviors (Life	Electrotechnical Laboratory	Monell Chemical Senses Center	To elucidate a general principle and a mechanism of odor discrimination of mammals such as rats, by combining physiological data and behavioral data (existent)	Continue

	Sciences)				
28	Intelligent Robot System (Automation, Process Control and Production Engineering)	Electrotechnical Laboratory	Carnegie Mellon Univ.	To conduct collaborative researches regarding advanced manipulation technologies, environmental model achievement utilizing robot vision, hand-eye systems, automatic programming functions of robots, etc. (existent)	Terminate
29	Joint Optoelectronics Project (Information and Telecommunication)	Electrotechnical Laboratory	NIST	To promote R&D activities on and effective commercialization of optoelectronic technologies for computers in both Japan and the US (existent)	Continue
30	Measurement of Supercomputer Performance (Information Science and Technology)	Electrotechnical Laboratory	DOE	To cooperate with each other regarding standardized measurement techniques of high-speed computing systems such as supercomputers and parallel computing systems (existent)	Continue
31	Collaboration of NbN-based digital-to-analog converters for programmable Josephson voltage standard (Others)	Electrotechnical Laboratory	NIST	To develop NbN-based digital-analog converters which have a critical temperature for superconductivity, and to contribute their application to digital circuits	New
32	Characterization of Organic Superconductors (Advanced materials including Superconductivity)	Electrotechnical Laboratory	Florida State University	To characterize organic superconductors and related materials, through accurate measurement of the effect of there magnetic resistance and their magnetization status under strong magnetic field, extremely low temperature and high pressure. Characterization includes Fermi phase of organic metals as well as their low-temperature electron status (temperature v.s. magnetic field and pressure phase chart) (existent)	Continue
33	Research on Amorphous and Microcrystalline Semiconductors (Advanced Materials including Superconductivity)	Electrotechnical Laboratory	Princeton University	To develop amorphous and microcrystalline semiconductors with new functions, through development of a method to control microscopic structure of materials in use of diagnosis and control techniques of reacting gas (existent)	Terminate
34	Thin film materials processing in high gravity field (Advanced materials including Superconductivity)	Electrotechnical Laboratory	Clarkson Univ.	To establish a new material processing technique based on the experimental and theoretical considerations on effects of various types of gravities - from zero gravity to high gravity - on thin film materials processes, including diamond thin film process (existent)	Continue
35	Microscopic structure and electronic properties of transition metal oxides (Advanced Materials including Superconductivity)	Electrotechnical Laboratory	UC Berkeley	To study, through isotope-labeling effects, etc., the electron status of the clean surface of transition metal compounds, and the involvement of lattices concerning phenomena observed there, such as atom redistribution, and to contribute to establish a method to control functions of transition metal compounds as electronic materials, as well as a method to combine and formulate metal oxides including high-temperature superconductivity materials. (existent)	Continue
36	Evaluation of Earthquake Potential Using Geologic Methods (Earth Science and Global Environment)	Geological Survey of Japan	US Geological Survey	To conduct R&D on and to establish strategies of studies on earthquake time-series and dislocation movement patterns in order to mitigate damages by earthquakes (existent)	Continue
37	Study on earth's crust using deep boreholes (Earth Science and Global Environment)	Geological Survey of Japan	Stanford Univ.	To develop a technology to analyze the status of stresses, fractures, and various fluids in the deep earth crust, through various collaborative measurements and analyses in deep boreholes (existent)	Continue
38	Joint research on the development of the accurate and precise K-Ar and 40Ar/39Ar dating of Quaternary tephras (Earth Science and Global Environment)	Geological Survey of Japan	US Geological Survey	To collaborate each other to develop a technology to know accurate and precise timinsg of eruption concerning Quaternary tephras (existent)	Continue

39	Research on investigation of the three-dimensional structure of the active volcanoes (Earth Science and Global Environment)	Geological Survey of Japan	US Geological Survey	To develop a methodology to investigate the three-dimensional structure of the active volcanoes, by sharing data on scientific boring of volcanoes and surveys on active volcanoes (existent)	Continue
40	Study on Deep Crust Using Seismic Reflection Method (Earth Science and Global Environment)	Geological Survey of Japan	US Geological Survey	To develop a methodology to analyze the structure of the deep crust using seismic reflection method (existent)	Continue
41	Resource assessment methods for deep-sealed mineral deposits (Earth Science and Global Environment)	Geological Survey of Japan	US Geological Survey	To develop a method to assess natural resources of deep-seated mineral deposits (existent)	Continue
42	Major mineral deposits, metallogenesis, and tectonics of eastern and Southern Siberia, Northeastern China, Korea, Japan (Earth Science and Global Environment)	Geological Survey of Japan	US Geological Survey	By collecting and analyzing themes concerning major mineral deposits, metallogenesis, and tectonics of eastern and Southern Siberia, Northeastern China, Korea, Japan, to elucidate formulation factors and characteristics of locations of mineral deposits in those area (existent)	Continue
43	Crustal structural studies using electromagnetic induction methods (Earth Science and Global Environment)	Geological Survey of Japan	Washington Univ.	To collaborate in study on crustal structure in the volcanic areas in Japan and the US, using electromagnetic induction methods (existent)	Continue
44	Quantitative evaluation of relationship between groundwater system and crustal deformation (Earth Science and Global Environment)	Geological Survey of Japan	US Geological Survey	To quantitatively evaluate relationship between groudwater system and crustal deformation through data-exchange, analysis and simulation methods (existent)	Continue
45	Monitoring and Imaging of Fractures in Geologic Materials by Seismic waves and Acoustic Emission (Earth Science and Global Environment)	Geological Survey of Japan	Colorado University of Mines	To develop monitoring and imaging methods of fractures underground (existent)	Continue
46	Long-term chemical observatories at seafloor hydrothermal fields (Earth Science and Global Environment)	Geological Survey of Japan	Washington Univ.	To design and experiment observatories and thus to establish an observation system of long-term trends and changes of chemicals at seafloor hydrothermal fields, in order to explore basic factors to control seafloor hydrothermal activities and to understand chemical environments surrounding the living things at seafloor hydrothermal field.	New
47	Research on geological/geochemical role on mining and the environment (Earth Science and Global Environment)	Geological Survey of Japan	US Geological Survey	To research on geological/geochemical role on mining and the mining-related environmental issues	New
48	High-Resolution Airborne Geophysical Surveys for Volcanic Hazards (Earth Science and Global Environment)	Geological Survey of Japan	US Geological Survey	to establish high-resolution airborne geophysical surveys as a method to evaluate inner-volcanic structures, in order to mitigate volcanic disasters (existent)	Continue
49	Seismic stratigraphy in Antarctic offshore area (Earth Science and Global Environment)	Geological Survey of Japan	US Geological Survey	To establish detailed and integrated geological stratums in several sea areas off the Antarctica (existent)	Continue
50	Studies on Liquid-liquid Counter Current Chromatography (CCC) (Production Engineering)	National Institute of Materials and Chemical Research	NIH and State Univ. of NY, Buffalo	To develop a highly energy-efficient and resource efficient mass separation system using liquid-liquid counter current chromatography methods	New

51	CO2 ocean disposal process in the form of CO2 hydrate particles via a submerged CO2 hydrate crystallizer (Earth Science and Global Environment)	National Institute of Materials and Chemical Research	University of Hawaii	To propose a "CO2 disposal process in the form of CO2 hydrate particles via a submerged CO2 hydrate crystallizer" as an option for CO2 ocean disposal processes, which are considered the most effective way to address the global warming issues. To evaluate its technical potential and potential impacts on ocean environment. (existent)	Continue
52	The development of macromolecular fractionation method (Others)	National Institute of Materials and Chemical Research	University of Polytechnique	To develop an efficient macromolecular fractionation method based on molecular weight and/or composition	New
53	Photo & Electronic Properties of Coordination Polymers (Advanced Materials including Superconductivity)	National Institute of Materials and Chemical Research	Virginia Institute of Technology	To develop coordination polymer materials with advanced photo & electronic functions (existent)	Continue
54	Studies of photo electronic molecular devices (Advanced Materials including Superconductivity)	National Institute of Materials and Chemical Research	Univ. of Texas, Austin	To develop a next generation photo electronic molecular devices and to control properties of them, using electron control techniques (existent)	Continue
55	Fabrication and Application of the nanostructures materials using nanoparticles and nanotubes (Former title: Quantum-Dot Arrays of Silicon Nanocrystallines) (Advanced Materials including Superconductivity)	National Institute of Materials and Chemical Research	State Univ. of NY, Buffalo	To develop a technology to prepare for functional nano-structured materials using nanoparticles and nanotubes (existent)	Continue
56	Nanostructured materials with Photo and Chemical Functionality (Advanced Materials including Superconductivity)	National Institute of Materials and Chemical Research	Univ. of Florida	To develop a novel nano-structured material system with photo and chemical functionality such as optic electrodes and chemical sensors	New
57	Laser ablation for preparation of nanostructures materials (Advanced Materials including Superconductivity)	National Institute of Materials and Chemical Research	Pacific-Northwest National Laboratory (PNNL)	To prepare for nanostructured materials such as nanoparticles using laser ablation, and to analyze the nanostructure formulation mechanism	New
58	Evaluation of Biocompatibility of High-Functional Biomaterials (Life Science)	National Institute for Advanced Interdisciplinary Research (NAIR)	Univ. of Florida	To establish a technology to evaluate bio-compatibility of high-functional biomaterials for medical use such as artificial joints and inplant material for dentists (existent)	Continue
59	Characterization of mutant myosins with optical tweezers (Life Science)	National Institute for Advanced Interdisciplinary Research (NAIR)	Stanford Univ.	To elucidate a molecular mechanism for energy transformation of myosins, which are molecular motors to efficiently transform chemical energy to kinetic energy (existent)	Terminate
60	Ion Separation Chemistry (Advanced materials including Superconductivity)	National Institute for Advanced Interdisciplinary Research (NAIR)	Texas Tech	To develop a career for synthesis of highly selectional ionophores, collection and concentration of useful ions, and removal of hazardous ions	Continue
61	Studies on gas hydrate occurrence and stability in ocean sediments (Earth Science and Global Environment)	Hokkaido National Research Institute	Univ. of Hawaii	To study on gas hydrate occurrence, resolution and stability as well as properties in ocean sediments, in order to estimate the amount of hydrate and gas in the hydrate in ocean sediments	New
62	Studies on natural gas mining from methane hydrates by CO2 substitution (Earth Science and Global Environment)	Hokkaido National Research Institute	Colorado School of Mines	To consider an environment-friendly technology to mine next generation natural gas from methane hydrate deposits which abundantly exists at various areas under the sea floor of continental shelves, etc, by replacing natural gas in the methane hydrate deposits with CO2, which has global warming effects, (existent)	Continue

63	Study of Control of Process Parameters for the Thermal and Mechanical Properties of Intermetallics (Advanced Materials including Supercobductivity)	Tohoku National Research institute	Oak Ridge National Laboratory	To exchange information on R&D on intermetallics	New
64	Developing of novel thermo-mechanical processes (Production Engineering)	Nagoya National Research Institute	Northeastern Univ.	Japan to prepare for novel metallic materials composed of ultra fine crystalline particles through a newly developed thermo-mechanical process. The US to evaluate those materials	New
65	Study on the development of acid rain monitoring system (Global Environment)	Nagoya National Research Institute	Iowa State Univ.	Japan to develop an ion chromatography for negative/positive ions in the acid rains, as an automatic measurement method regarding acid rain constituents. The US to develop the most appropriate ion-exchange resins to separate acid rain constituents, and to utilize them to acid rain and related environmental water (existent)	Continue
66	Study on processing and properties of ferroelectric thin films for semiconductor memory chips (Advanced materials including Superconductivity)	Nagoya National Research Institute	Arizona State Univ.	To explore materials appropriate for high inductance film materials for DRAM which would be a breakthrough for development of next generation highly integrated semiconductor chips (with over 1 G Byte capacity) as well as strong inductance film materials for nonvolatile FRAM, to develop a technology to integrate these materials into thin film, and to evaluate film characteristics as memory chips. (existent)	Continue
67	Grain-boundary evaluation of superconducting ceramics for the improvement of Jc (Advanced materials including Superconductivity)	Nagoya National Research Institute	MIT	To develop a bulk material for superconducting materials in order to improve Jc (critical current density) (existent)	Continue
68	Tensile Creep Behavior of Engineering Ceramics (Advanced materials including Superconductivity)	Nagoya National Research Institute	NIST	To deepen understanding of high-temperature creep destruction behavior in order to establish high reliability of structural ceramics at high temperature. (existent)	Continue
69	Improved Reliability and Low-Cost Fabrication of Ceramic Components (Advanced materials including Superconductivity)	Nagoya National Research Institute	NIST	To improve reliability, such as durability, and to reduce fabrication cost of ceramic components such as functional ceramics (existent)	Continue
70	Study on control of the microstructure of nano-particles in solid prepared by ion implantation (Others)	Nagoya National Research Institute	Univ. of Michigan	To prepare for nanoparticles in solid through ion implantation, to elucidate its preparation process, and to control microstructure of those nanoparticles by controlling ion implantation conditions. Finally, to develop an optical device which would realize radiation and nonlinear optical characteristics through controlling microstructure of nanoparticles.	New
71	Study on the development of acid rain monitoring system (Earth Science and Global Environment)	Nagoya National Research Institute	Texas Tech	To co-develop a automatic system to monitor ionic water pollutants in various acid-rain related environment water (existent)	Continue
72	Development and evaluation of functional biodegradable plastics (Production Engineering)	Osaka National Research institute	Univ. of Connecticut	To develop and evaluate functional biodegradable plastics, in order to enable wide application of biodegradable plastics which is studied as a solution to the environmental problem caused by disposed plastics.	New
73	Study on the Microscopic Designing Technology of Ceramic-Metal Interfaces (Advanced materials including Superconductivity)	Osaka National Research institute	Washington Univ.	To elucidate microscopic structure and characteristics of ceramics/metals interfaces through close connection between experimental observation and theoretical computing, and thus to establish a reliable designing technology regarding ceramics/metal interfaces. (existent)	Continue

74	Research and Development on Wear resistant Ceramics and their Evaluations (Advanced Materials including superconductivity)	Osaka National Research institute	University of Alabama	To develop ceramic materials with wear resistant and scraping properties, and to establish a technology to evaluate tribological properties. (existent)	Continue
75	Research on optical properties of heat-resistant polymeric materials (Advanced materials including superconductivity)	Osaka National Research institute	Case Western Reserve univ.	To elucidate optical properties of novel heat-resistant polymetric materials, to research on non-linear optical properties of dye-molecular-spread materials, and to understand the relationship between molecular structure and nonlinear optical properties, which would provide important suggestions for synthesis of new chemical compounds. (existent)	Continue
76	Study on nonclassical metal carbonyls and their catalytic activities (Advanced materials including Superconductivity)	Osaka National Research institute	Colorado State Univ.	To develop a catalyst for organic synthesis using nonclassical metal carbonyls (existent)	Continue
77	Production and utilization of useful substances by photosynthetic microorganisms (Life Science including Biotechnology)	Chugoku National Research Institute	Stanford Univ.	Exchange information concerning utilization of functions of photosynthetic microorganisms (existent)	Continue
78	Research and Modeling of Pollution-transport in and through Semi-Enclosed Seas (Earth Science and Global Environment)	Chugoku National Research Institute	Univ. of Maryland	To study on transportation mechanisms of pollutants in and through semi-enclosed seas, and to research on a common method for environmental impact analysis of them. (existent)	Continue
79	Study on processing and properties of metal/oxide artificial super lattice (Advanced Materials including Superconductivity)	Chugoku National Research Institute	Oklahoma State Univ.	To collaboratively evaluate optical properties of artificial super lattice composed of metal/oxides, which would contribute to a development of novel functional materials (existent)	Continue