TECHNICAL REPORT

Japanese Science and Technology Capacity

Expert Opinions and Recommendations

Anny Wong, Douglas Yeung, Silvia Montoya, Sarah Olmstead, Aviva Litovitz, Lisa Klautzer, Sarah Kups, Alison Raab Labonte

Sponsored by the Mitsubishi Research Institute

RAND

Transportation, Space, and Technology

A RAND INFRASTRUCTURE, SAFETY, AND ENVIRONMENT PROGRAM

This research was sponsored by the Mitsubishi Research Institute (MRI) of Japan and was conducted under the auspices of the Transportation, Space, and Technology (TST) Program within RAND Infrastructure, Safety, and Environment (ISE).

Published 2010 by the RAND Corporation
1776 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138
1200 South Hayes Street, Arlington, VA 22202-5050
4570 Fifth Avenue, Suite 600, Pittsburgh, PA 15213-2665
RAND URL: http://www.rand.org
To order RAND documents or to obtain additional information, contact
Distribution Services: Telephone: (310) 451-7002;
Fax: (310) 451-6915; Email: order@rand.org

Summary

The Japanese government places great emphasis on ensuring the country's vitality in science and technology (S&T) and remaining at the forefront of global science. It is in this spirit that Japan uses its five-year basic S&T plans, the first of which was introduced in 1996, to guide research and development (R&D) promotion (see Government of Japan, 2006).

This RAND report documents input and recommendations we received from 55 top researchers on their perceptions of the current state of Japanese S&T and priorities for improvement.

Study Objective

The current basic S&T plan—the third one—will run through 2010, and efforts are under way to develop the next basic S&T plan for 2011 to 2015. The Mitsubishi Research Institute (MRI) of Japan, which is providing research support to the Council for Science and Technology Policy (CSTP), an advisory body in the Office of the Prime Minister of Japan, in the formulation of the 2011–2015 basic S&T plan, asked the RAND Corporation to interview 50 top researchers in the United States, the European Union (EU), and Switzerland to learn from their perspective how well Japan performs in their fields and areas of research and to solicit their thoughts on what is essential to promote excellence and innovation in scientific research. The expert responses and recommendations collected would feed into analysis by MRI for the government of Japan in developing the fourth basic S&T plan, for 2011 to 2015.[1]

Study Method

Since the objective and scope of this study is the same as the 2004 RAND study for MRI, we employed the same study method used for the 2004 study. It is important to reiterate that the objective of this research is to collect qualitative feedback from U.S.- and European-based experts and to produce a summary of their responses in a final report. As such, we do not have

[1] This is the second time MRI asked RAND to provide research support toward the formulation of Japan's basic S&T plan. In 2004, RAND completed a study with the same objective and with a similar focus and approach (Wong et al., 2004). The main difference between the 2004 study and this one is that, for the former, we were directed only to interview experts based in the United States. A second difference is our inclusion of high-performing junior researchers in this 2008 study. More details on this are in the "Study Method" section.

the mandate or the time and resources to review literature on the current state of Japanese S&T or to produce a final report with anything beyond what we were tasked to do.

Our research began with the identification of experts in the designated 25 scientific fields under the four categories of life sciences, environmental science, information and communication technology (ICT), and nanotechnology and materials science (see Table S.1). These four categories and the 25 fields under them were the same as in the 2004 RAND study and provided to us by our research sponsor.

To identify and select experts for interviews, we utilized a combination of methods to draw on the strengths and mitigate the weaknesses of each to determine a researcher's prominence in his or her field. The results of searches using one method (e.g., searching databases on scientific publications and citations) were checked against the results of searches using another method (e.g., identifying recipients of major merit awards). We also cross-checked researchers recommended to us by respondents or colleagues to ascertain their professional achievements before we added them to our list of candidate respondents. In all, we identified more than 200 experts across the 25 fields.

For this study, our respondents included junior scientists who are "rising stars" in their own fields. The decision to include such junior scientists was made in consultation with our sponsor. By *rising stars*, we mean those younger and high-performing researchers who work at the cutting edge of their fields. We thought that the perspectives and experience of rising stars may well complement those of senior, more-established researchers who represent the more-conventional definition of *top expert*. With increased Japanese government efforts to expand opportunities for young international researchers to work in Japan under its current and previ-

Table S.1
Categories and Fields

Category	Field
Life sciences	Agricultural science Biology and biochemistry Clinical medicine Immunology Microbiology Molecular biology and genetics Neuroscience and behavior Pharmacology and toxicology Plant and animal science
Environmental science	Environment/ecology Energy engineering Geoscience
ICT	Computer science, basic Computer science, applied Electrical and electronics engineering Mechanical engineering Mathematics
Nanotechnology and materials science	Chemical, basic Chemical, applied Materials science, metals Materials science, polymers Materials science, ceramics Materials science, semiconductors Physics, basic Physics, applied

ous basic S&T plans, rising stars could inform us of their experience in Japan or their reasons for choosing (or not choosing) to work in Japan.

In the end, 55 experts out of nearly 100 contacted spoke with us. We gave priority to contacting those with the highest professional qualifications (e.g., top scientific prize winners and those regarded as the most influential in their fields) for interviews. We also tried to collect data from experts in each of the 25 fields. Since participation was strictly voluntary and research had to be completed within a time frame and with the resources available, we could not have, say, one expert each from the United States or Europe for each of the 25 fields or have one expert each who is male or female for each of the 25 fields. All interviews were conducted via telephone, and all the information we received was treated as confidential. Table S.2 shows the number of respondents for each field and some attributes of our respondents.

First, in terms of the number of respondents for each category, the largest number is in the life sciences, followed by nanotechnology and materials science, environmental science, and ICT. By location, 19 of our 55 respondents are U.S.-based, 24 are EU-based, and one each is in Switzerland and Russia. By category, an even number of respondents in the life sciences and ICT are based in the United States and Europe, while, in the environmental science and nanotechnology and materials science categories, the number of European-based respondents significantly outnumbers the U.S.-based ones. (Although our sponsor did not name Russia as

Table S.2
Number of Respondents, by Key Attributes

Category/Field (number of respondents)	Location	Career Point	Gender	Professional Experience in Japan or with Japanese Research
Life sciences (18)	U.S. (9)	Senior (14)	Male (12)	Low (7)
Agricultural science (3)	EU (9)	Junior (4)	Female (6)	Moderate (6)
Biology and biochemistry (4)				High (5)
Clinical medicine (1)				
Immunology (1)				
Microbiology (1)				
Molecular biology and genetics (1)				
Neuroscience and behavior (3)				
Pharmacology and toxicology (1)				
Plant and animal science (3)				
Environmental science (11)	U.S. (2)	Senior (8)	Male (9)	Low (8)
Environment/ecology (6)	EU (8)	Junior (3)	Female (2)	Moderate (2)
Energy engineering (2)	Switzerland (1)			High (1)
Geoscience (3)				
ICT (10)	U.S. (5)	Senior (7)	Male (8)	Low (6)
Computer science, basic (0)	EU (5)	Junior (3)	Female (2)	Moderate (3)
Computer science, applied (4)				High (1)
Electrical and electronics engineering (2)				
Mechanical engineering (1)				
Mathematics (3)				
Nanotechnology and materials science (16)	U.S. (3)	Senior (13)	Male (15)	Low (7)
Chemical, basic (2)	EU (12)	Junior (3)	Female (1)	Moderate (3)
Chemical, applied (2)	Russia (1)			High (6)
Materials science, metals (3)				
Materials science, polymers (1)				
Materials science, ceramics (0)				
Materials science, semiconductors (2)				
Physics, basic (3)				
Physics, applied (3)				

a location, our effort to identify top experts pointed to a few Russia-based scientists, and one accepted our request for interview.)

By career point, 42 senior and 13 junior researchers spoke with us. Among the senior researchers, 14 are in the life sciences, eight in environmental science, seven in ICT, and 13 in nanotechnology and materials science. For the junior researchers, their numbers for these categories are four, three, three, and three, respectively. Further, by career point and location, senior European-based researchers are the largest subgroup, followed by senior U.S.-based researchers (15), junior European-based researchers (nine), and junior U.S.-based researchers (four).

In terms of gender alone, there were 44 male and 11 female respondents. Female researchers made up half of all respondents in the life sciences, but they were in far smaller numbers in the other three categories. Combining gender and career point, senior male researchers lead (37), followed by junior male (seven), junior female (six), and senior female (five) researchers.

As for their level of professional experience in Japan or with Japanese research, we designated 28 respondents as low, 14 as moderate, and 13 as high. The greatest number and share of respondents with high designations are found in the life sciences and nanotechnology and materials science. These designations are based on a combination of respondent self-assessment and the content of their responses. *Low* means that one has had little or no current or prior collaborations with Japanese researchers and institutions, few or no visits to Japan, and minimal awareness of Japanese research in their research areas. *Moderate* means that one has had had some prior collaborations with Japanese researchers or institutions, some visits to Japan and interactions with Japanese researchers at professional forums in Japan or elsewhere, and some awareness of Japanese research in their research areas. *High* means that one has had or has current or recent collaborations with Japanese researchers or institutions; multiple visits to Japan; experience teaching, doing research, or participating in advisory panels in Japan; and in-depth awareness of Japanese research in their research areas.

Finally, all questions in our telephone interviews were open-ended, and respondents could choose to answer all or none of them as they pleased. Our questions focus on these areas provided by MRI and CSTP:

- competitiveness of Japanese S&T institutions, especially how Japan compares with other scientifically advanced nations
- important scientific research accomplishments in Japan, with a particular focus on the past five years
- quality of Japanese science education
- ideas for Japan or lessons learned from experience on how to increase excellence in national S&T capacity.

Expert Responses and Recommendations

Considering the small sample size and that the expert comments we received are subjective and may be more reflective of individual experiences, observations, and impressions than any collective truth about Japan or Japanese S&T, we appreciate the need for caution in interpreting their responses. We recognize that other research and data (e.g., citations and patent data) can provide a useful context to interpret the responses we collected. However, it is not within the scope of this study to assess the validity of the viewpoints or the appropriateness of the recommendations provided by our respondents.

Overall, 22 of our 55 respondents reported that Japan is at the forefront, among the top five leaders, or has demonstrated significant improvement in their specific research areas. Another dozen reported that Japan is doing very well, produces high-quality research, or is among the ten leaders in the world. This compares well with the responses received in our 2004 study. Similarly, though, respondents frequently qualified their assessments that Japan's excellence is in technology development, applied research, or areas in which expensive equipment is required rather than in theoretical or fundamental research.

Consistent with a major observation from experts interviewed for the 2004 study, too, is the widespread view that significant institutional and cultural problems hinder excellence in Japanese S&T. More than two-thirds of our respondents across all fields and other attributes made comments to this effect. Also, despite observations of improved performance (e.g., more Japanese research articles published in major international academic journals, more substantive Japanese participation in international conferences and seminars, more opportunities for international researchers in Japan, and positive changes, such as special grants for young scientists and less hierarchical environments at places like RIKEN), our respondents generally emphasized that Japan has to do more and hasten the speed of change. In this regard, about one-quarter of all respondents highlighted, in particular, their perception of rapid improvements in S&T in China and India overall or within their own fields, and several commented that Chinese and Indian researchers were more independent and bold in their approach to research than Japanese researchers. These traits, in their view, will help to propel Chinese and Indian researchers to the forefront of global science.

Also, our respondents did not generally characterize Japanese research as creative or innovative, even though it was invariably described as good or on par with the top one, two, or three leaders in the world. About one-fifth of the respondents attributed their perception of lack of creativity and critical thinking in Japanese research to rigidities in Japanese culture.

On research funding in Japan, respondents in general perceived Japan to provide a high level of R&D support. Their criticisms lie in how the funds are allocated. About half a dozen respondents explicitly criticized the bias in funding for older, established researchers, and about half spoke of a need to move away from top-down–driven funding in R&D and the need for merit-based awards and urged special grants to support young researchers.

Finally, more than half of our respondents saw the general absence of female researchers in Japan and low proficiency in English and communication skills as serious weaknesses in any effort to improve Japan's S&T performance.

Feedback from our 55 respondents does not appear to differ by location or career points. As for gender, both male and female respondents across all fields, locations, and career points spoke of the need to expand opportunities for female and junior researchers in Japan. Generally, those respondents identified as having a high level of experience in Japan or with Japanese research have a more positive opinion of Japanese research (e.g., lauding the achievements of a particular Japanese research team or noting the success of special programs that target young researchers). Yet, they were no less critical of perceived shortcomings and weaknesses in the Japanese S&T institutions and communities.

Recommendations from our respondents focused on six points (presented by frequency with which they were mentioned and not in order of sequence or hierarchy). They are consistent with those recommended by the experts we interviewed for our 2004 study.

1. Prioritize proficiency in oral and written English to improve communication and interactions with the international scientific community at meetings, submissions to academic journals, in online dialogues, and the like.
2. Emphasize merit in research funding, promotion, hiring, and all else to mitigate social and institutional barriers that permeate research organizations and management bodies in Japan.
3. Increase the number of short-term visits by international scientists (e.g., to attend conferences and through fixed-term fellowships in Japan), and fully integrate foreign students, faculty, and researchers into the Japanese system.
4. Increase the number of students, faculty, and researchers Japan sends overseas for education, exchanges, and short-term stays (e.g., one- to two-year postdoctoral fellowships and yearlong sabbaticals).
5. Emphasize critical, independent thinking skills in Japan's secondary and tertiary education systems.
6. Continue to fund research, including more support for international R&D, and to improve research facilities and workplace quality.