Learning the R&D System: University Research in Japan and the United States (1989)

Pages
27

Size
6 x 8

ISBN
0309317711

Office of Japan Affairs; Office of International Affairs; National Research Council

Learning the R&D System: University Research in Japan and the United States

Prepared by the
Office of Japan Affairs

Office of International Affairs
National Research Council

NATIONAL ACADEMY PRESS
Washington, D.C. 1989

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

The National Academy of Sciences of the United States is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Frank Press is president of the National Academy of Sciences.

The National Academy of Engineering of the United States was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievement of engineers. Dr. Robert M. White is president of the National Academy of Engineering.

The Institute of Medicine was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Samuel O. Thier is president of the Institute of Medicine.

The National Research Council was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Research Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Research Council is administered jointly by both Academies and the Institute of Medicine. Dr. Frank Press and Dr. Robert M. White are chairman and vice-chairman, respectively, of the National Research Council.

Available from:
Office of Japan Affairs
National Research Council
2101 Constitution Avenue, NW
Washington, DC 20418

Printed in the United States of America

OFFICE OF JAPAN AFFAIRS

Since 1985, the National Academy of Sciences and the National Academy of Engineering have engaged in a series of high-level discussions on advanced technology and the international environment with a counterpart group of Japanese scientists, engineers, and industrialists. One outcome of these discussions was a deepened understanding of the importance of promoting a more balanced two-way flow of people and information between the research and development systems in the two countries. Another result was a broader recognition of the need to address the science and technology policy issues increasingly central to a changing U.S.-Japan relationship. In 1987, the National Research Council, the operating arm of both the National Academy of Sciences and the National Academy of Engineering, authorized first-year funding for a new Office of Japan Affairs (OJA). This newest program element of the Office of International Affairs was formally established in the spring of 1988.

The primary objectives of OJA are to provide a resource to the Academy complex and the broader U.S. science and engineering communities for information on Japanese science and technology; to promote better working relationships between the technical communities in the two countries by developing a process of deepened dialog on issues of mutual concern; and to address policy issues surrounding a changing U.S.-Japan science and technology relationship.

Staff

Martha Caldwell Harris, Director
Donna J. Audritsh, Research Associate

COMMITTEE ON JAPAN

The Committee on Japan has been established to advise the Office of Japan Affairs on its programs, and to assist in defining the contribution that the Academies can make in enhancing U.S. interests through science and technology exchange with Japan.

Harold Brown, *Chairman*
Johns Hopkins Foreign Policy Institute

Daniel Okimoto, *Vice-Chairman*
Stanford University

Justin Bloom
Technology International, Inc.

Lewis Branscomb
Harvard University

Mac Destler
University of Maryland

Ellen Frost
United Technologies Corporation

Lester Krogh
3M Company

James Merz
University of California, Santa Barbara

Yoshio Nishi
Hewlett-Packard Company

Terutumo Ozawa
Colorado State University

Susan Pharr
U.S.-Japan Relations Program, Reischauer Institute

John D. Rockefeller IV
U.S. Senate

Richard Samuels
MIT-Japan Science and Technology Program

Roland Schmitt
Rensselaer Polytechnic Institute

Hubert J. P. Schoemaker
Centecor, Inc.

Ora Smith
Rockwell International

Susumu Tonegawa
Massachusetts Institute of Technology

Ex Officio Members:

Gerald Dinneen, Foreign Secretary, National Academy of Engineering
William Gordon, Foreign Secretary, National Academy of Sciences

U.S.-JAPAN DIALOG ON THE WORKING ENVIRONMENT FOR RESEARCH IN UNIVERSITIES
Beckman Center
January 9-10, 1989

U.S. PARTICIPANTS

Roland Schmitt
(Cochairman)
Rensselaer Polytechnic Institute

Joseph Ballam
Stanford Linear Accelerator Center

Frank Carrubba
Hewlett-Packard Company

Marvin Cohen
University of California, Berkeley

William Cummings
Harvard University

Gerald Dinneen
Honeywell, Inc.

Marshall Edgell
University of North Carolina

Alan Engel
International Science and
Technology Associates, Inc.

James Merz
University of California,
Santa Barbara

Tom Owens
National Science Foundation

Howard Schneiderman
Monsanto

Nam Suh
Massachusetts Institute of Technology

JAPANESE PARTICIPANTS

Sogo Okamura
(Cochairman)
Tokyo Denki University

Jun-ichi Baba
Mitsubishi Electric Corporation

Masao Doyama
Nagoya University

Yoshihiko Ichikawa
Nagoya University

Hiroshi Inose
National Center for Science
Information System

Ken Kikuchi
National Laboratory for
High-Energy Physics

Fumio Kodama
National Institute of Science and
Technology Policy

Tsuneo Nakahara
Sumitomo Electric Industries, Ltd.

Shigefumi Nishio
University of Tokyo

Tamiya Nomura
Shibaura Institute of Technology

Michiyuki Uenohara
NEC Corporation

Justin Bloom of Technology International assisted with preparations for the meeting and the report and contributed to the discussion.

Learning the R&D System: University Research in Japan and the United States

The United States and Japan are now approaching a relationship of comparative strength in fields of science, as well as technology. Japan's success in the market reflects Japanese capabilities, particularly in engineering, that contribute to the development of and commercialization of high technology products. While the strength and depth of American scientific research remain unmatched anywhere else in the world, new efforts will be necessary to maintain leadership in many fields of science and to improve U.S. capabilities to develop, produce, and market high technology products and services.

This new context presents both challenges and opportunities for American and Japanese researchers, businessmen, and policymakers. A central question is how to improve foreign access to Japanese science and technology. Improved access and expanded collaboration in research and development (R&D) should ultimately benefit Japan as well as the United States. There is a special urgency associated with the question of access because of the very real prospect that frictions and restrictions could result if it is not effectively addressed soon enough.

Many explanations can be given for why there are many more Japanese researchers in U.S. labs than vice versa. Differing degrees of researcher independence, different approaches to funding, language barriers, differing perceptions of what constitutes "basic" research—all of these factors can be understood in the context of differences in the way the R&D systems are organized. This list of factors highlights the need to know more about how the Japanese R&D system works. "You have to know the system" in order to work it and work in it—this is the basic rationale for a series of bilateral meetings organized by the National Research Council's Office of Japan

Affairs in cooperation with the Japan Society for the Promotion of Science and other organizations in Japan.

The value of a U.S.-Japan dialog on R&D systems is clear for Japan as well. For years, Japanese researchers have experienced first-hand the working environment for research in the United States. Today, however, Japan is attempting to improve basic research. A number of factors, such as a tradition of central funding and the dominance of senior professors, tend to perpetuate a hierarchical university research system seen by many as inimical to path-breaking, independent research. It is in this context that Japanese research leaders still find much to learn from American university research.

This report covers major insights gained from a two-day bilateral meeting held on January 9-10, 1989, at the Beckman Center. The participants included senior scientists, engineers, and research managers from the United States and Japan who met to explore differences and similarities in the "working environment for research in universities" in the two countries. The two chairmen were Dr. Roland Schmitt, president of Rensselaer Polytechnic Institute and formerly chief scientist at General Electric, and Dr. Sogo Okamura, professor of Tokyo Denki University and former dean of the school of engineering at Tokyo University. This meeting was the first of three organized with the support of a grant from the U.S.-Japan Foundation.

Prepared by the Office of Japan Affairs, this report highlights parts of the discussion that shed light on the way research is done in the two countries, and on the broader implications for research collaboration between the United States and Japan. It is not a consensus document or a conference proceedings.

UNIVERSITY RESEARCH IN JAPAN AND THE UNITED STATES: STANDARD IMAGES AND NEW TRENDS

Universities in Japan and the United States play key roles in the conduct of *basic* research. They are more open and accessible than other research organizations, serving as the gate through which all young, aspiring scientists and engineers move.

A comparison of the U.S. and Japanese university research systems, however, reveals some striking contrasts and some obstacles to foreign access. Few of these differences are consciously erected barriers to foreign access. In many instances, they reflect divergent traditions and national priorities for research. Economic, political, and cultural factors in each country have produced quite different organizational environments for research. These differences in most instances do not present insurmountable obstacles to a foreign researcher who has the desire and the needed preparation to work abroad, but they must be understood and taken into account if meaningful research collaboration is to be pursued. Better knowledge of how the Japanese research and development system works can also assist those monitoring events in Japan from afar.

In Japan, universities are often called the weakest part of the research system.[1] Japanese universities are hierarchically organized on the basis of seniority, oriented toward group effort that creates lifelong ties, and funded on the basis of a rigid system that leaves only small leeway to reward individual excellence on the part of younger researchers. Compared to corporate laboratories, the equipment and facilities of many Japanese university labs leave much to be desired.

Japanese universities, however, have special strengths. Despite the fact that its population is half that of the United States, Japan awards about the same number of bachelor's degrees in engineering. Three-quarters of the total research expenditures in Japan's national universities are in engineering fields, and Japan produces many more engineers than scientists at the undergraduate level.[2] At the master's and especially the Ph.D. levels, the contrasts to the United States are striking. American universities award many more degrees in science and engineering at these levels than do Japanese universities.

---

[1] For a discussion of the role of universities in basic research, see especially, *Kagaku Gijutsucho* [Science and Technology Agency], *Kagaku Gijutsu Hakusho* [Science and Technology White Paper], 1988.

[2] Fumio Kodama, paper on "The Culture of Academic Research," shows that Japan had more than 97,000 undergraduate students in engineering in national universities in 1986 ascompared with 23,000 students in natural sciences. Research expenditures per science student were 1.5 times greater, however.

U.S. university research is usually described as rewarding individual excellence: outstanding young researchers quickly gain recognition and resources; senior experts become entrepreneurs. Almost everyone moves a number of times during a professional career. The working environment for research is dynamic, open, and a magnet for students and scholars from around the world. In the United States the natural sciences make up a comparatively larger share of R&D expenditures in universities, and the high quality of scientific research is well recognized.

Another important contrast to the Japanese university system is the large percentage of foreign students, particularly graduate students, in U.S. universities. The number of Japanese researchers in scientific and engineering fields working in the United States dwarfs the number of similarly trained Americans in Japan.[3]

These standard images go far to explain why some of Japan's most outstanding scientists and engineers have found it necessary to go abroad to do the kind of path-breaking research that brings worldwide acclaim. They also explain why so few Americans have gone to work in Japanese university laboratories, despite the fact that they are more accessible to foreigners than any other part of the Japanese research system.

These contrasting images of U.S. and Japanese university research are generally accurate, but it would be dangerous to overlook exceptions or to ignore changes under way. *One assumption that deserves careful review is that there is not much world-class research under way in Japanese universities.*[4] Judged by commonly used indicators such as numbers of Nobel laureates or path-breaking discoveries, Japan lags behind the United States and Western Europe in many fields of basic research. Japanese policy-

---

[3] Tsusho Sangyosho [MITI], *Sangyo Gijutsu no Doko to Kadai* [Trends and Topics in Industrial Technology], Tokyo: MITI, 1988, p. 95. During 1986, there were 26,334 Japanese researchers in scientific and technical fields in the United States, and 3,633 Americans with technical backgrounds in Japan, according to Ministry of Justice statistics (*Shutsu-nyukoku Kanri Nenpo*). According to the same source, there were 43,686 foreign researchers in Japan (most from developing countries), while there were 55,869 Japanese researchers overseas in 1986. These data include students.

[4] See, for example, comments by Jiro Kondo, chairman of the Science Council of Japan, as reported in *Nihon Keizai*, February 25, 1989. The *Nihon Keizai* conducted a survey of Japanese leaders in science and technology that indicated they agree that Japan has taken a "free ride" on Western basic research. See report in February 21, 1989, edition. See also report of Science Council of Japan, *Nihon no Gakujutsu Doko* [Trends in Japanese Science and Technology], April 1988.

makers accept this judgment, and the government has responded with a plan to boost "basic research,"[5] but the role of universities in meeting this objective still remains uncertain.

The fact is that significant numbers of U.S. researchers will be attracted to Japanese university labs only where they offer the opportunity for world-class research. American interest in Japanese research and development today focuses on the work going on in Japanese corporate labs, which are well equipped and where cutting edge research is under way in developing and applying technology.

In considering possibilities for improved access it is, therefore, important to note the areas where Japanese university research excels. Japanese research in the fundamental aspects of controlled nuclear fusion and high-energy physics are well known to U.S. researchers in these fields. The Institute for High-Energy Physics (known as KEK), which is an interuniversity research institute under the Ministry of Education, operates on an annual budget of more than $100 million (19 billion yen in 1988) and attracts many foreign researchers.[6] Cooperation and exchange between the United States and Japan in these areas have been long term, extensive, and successful. Even the most stubborn cultural and institutional barriers have been overcome in these fields because scientists have seen value in cooperation.

In addition to such fields of *basic* research, which are generally viewed as "more noble" in Japan, Japanese university researchers have achieved excellence in many applied research areas, such as in electronics, communications, and new materials. Japanese university curricula in manufacturing engineering and applications-oriented research in fields such as advanced materials may interest Americans who want to learn more about Japan's approaches to manufacturing process technology.

Over the past 100 years, the Japanese have successfully applied their own brand of "creativity" in the relentless pursuit of improving and adapting technologies and producing products. This incremental R&D approach is

---

[5] Use of such terms as "basic" and "applied" research for comparative purposes can lead to confusion. Much of what Japanese authorities report as "basic" research would be considered "applied" research in the United States. Japanese "basic" research includes several categories, one termed "goal-directed" basic research.

[6] In 1987, the total number of man-days of use at KEK was 65,000, of which 30 percent was foreign visitors. (Man-days are calculated by multiplying the number of users by the period of stay.) Ken Kikuchi, vice-director and general research coordinator, KEK, "High-Energy Physics in Japan."

perfectly suited to successful industrial evolution. As a result, Japan has moved new ideas into the marketplace even without a great deal of truly "pioneering" basic research.

But Japanese leaders have set their sights on stepping out of a catch-up mode and into a position of leadership in science as well as technology. Thus they are emphasizing the importance of building capabilities in basic research. This will require new vision in setting goals and directions, as well as encouragement of independent, pioneering research that breaks new ground in science and in fundamental technology development. It is important to note that the basic research push is seen to complement and accelerate, rather than substitute for or detract from, continuing leadership in product and process innovation.

To summarize, there is truth in the view that the quality and breadth of Japanese university research lags behind that of U.S. universities in many fields. In order to address the need for improved foreign access in these fields, Japan will have to take bold steps. Improving the university research environment to promote path-breaking research will be an extremely difficult undertaking, as discussed more fully below. But it is the only sure way to establish a sound basis for meaningful collaboration with foreign researchers at Japanese universities. What should not be overlooked, however, are the programs of research in some Japanese universities where productive research collaboration can take place now. More information about those programs and institutions could help U.S. researchers identify promising partners and places for research collaboration.

Standard images of Japanese rigidity and immobility versus U.S. flexibility and mobility also deserve careful consideration. When the U.S. and Japanese university research systems are compared, the standard perceptions hold much truth: The Japanese university research environment system *is* more rigid and hierarchical and its researchers are less mobile than American counterparts. The *koza* (chair) system is normally seen as the key element in Japanese university organizational context. The fundamental unit of organization in a traditional Japanese national university, the "cozy *koza*," grants automatic lifelong tenure to the chaired professor. Students and subordinates (usually a relatively small group of assistant professors, lecturers, assistants, technicians, and graduate students) are chosen by the professor and work in his general field of research. To move their careers forward, they follow the lead of the chaired professor.

Reinforced by the channeling of most university research funds through it, the *koza* has been seen to stifle creativity among young researchers and to restrict mobility. Although the early stages of a researcher's career can

be the most creative and productive, the seniority-based system makes funds most plentiful in what may be the researcher's least productive, later years. In addition, proposals for government-funded research must be accompanied by some form of "prediction" about research results, a requirement that has led experienced researchers to conduct preliminary, unpublicized research before applying for funds.

Not *all* Japanese universities are organized along the chair system, however. Private universities created after World War II are organized less hierarchically, with the chairs functioning more like American university departments. Some newer national universities, such as the one at Tsukuba, do not even have chairs; faculty at Tsukuba are chosen by a personnel committee and are assigned to more than one organizational unit to encourage interdisciplinary research.

Those universities that continue to operate formally under the *koza* system may not always follow traditional *koza* rules. Engineering schools in particular cannot adhere to such a rigid system because the nature of their research requires that it be in tune with the needs of the "real world." Traditional disciplinary lines are sometimes broken or bridged to pursue the type of research required. While it is true that automatic lifelong tenure ties a chaired professor to one field, in some cases the *koza* system permits flexibility in choice of research topic. This has allowed Japanese university researchers to pursue new fields, such as biotechnology and new materials, without changing the formal system. Members of "Iron and Steel" *koza* are today more likely to be active in new materials than in iron and steel research.

The standard images of Japanese university rigidity contrast sharply with the images of the free and open U.S. university research environment. That these perceptions of the U.S. system are generally true is evidenced by the fact that it attracts hundreds of thousands of foreign students. Individual researchers in the United States have more freedom to choose a research topic (subject, of course to funding constraints) than their counterparts in Japan.

Qualifications to this general picture are, however, necessary. The U.S. system can exhibit inflexibility at the departmental level, where competition for funds and traditional evaluation mechanisms are increasingly challenged by the need for multidisciplinary research. Young researchers trying to pursue cross-disciplinary research within a department-based U.S. system may find that there are no mechanisms for evaluating and thereby recognizing the quality of their work. They also face a problem similar to their young Japanese counterparts in that U.S. government proposal review

procedures also encourage applicants to emphasize predicted research results.

Mobility and diversity are often seen as stimulants for American "creativity," and their absence in Japan is often seen as an inhibiting factor. American universities bring together researchers with different views from different organizations and backgrounds, who work on cutting-edge research, and then move on to other organizations. In contrast, the Japanese university research system produces research groups made up of researchers with similar research training who pursue methodical, incremental research. Japanese researchers have found it more difficult than Americans to switch their institutional affiliation, but there are signs of change.

Japan is experimenting with programs that simulate mobility. Programs like the Exploratory Research for Advanced Technology (ERATO) represent an attempt to improve Japan's basic research capabilities by allowing researchers from various fields and institutions to do joint exploratory research on broad topics for a specified period of time, without leaving their home institutions. Time will tell whether this experiment in creating research networks without new institutions will have a real impact.

More specifically related to universities are national interuniversity research institutes. Since 1971, 12 such institutes have been created in fields as diverse as biology, space, and high-energy physics. Plans have been announced for a new institute for fusion research scheduled to open later in 1989. Established in fields that require large, expensive facilities, or large teams of researchers, these institutes are open to all university researchers as well as to foreign researchers. The High-Energy Physics Institute received more than 320 foreigners in 1987, 70 percent of whom were from the United States and about 90 of whom stayed for a month or more.[7] Facilities in these institutes are far superior to those in regular university labs and interuniversity research institute faculty reportedly receive as much as five times the funding received by their counterparts in university labs.

Despite the comparative immobility of the Japanese university system, on at least one dimension Japan's system is more flexible. Some believe that Japanese university professors find it *easier* than their American counterparts to travel abroad—despite the absence of an established sabbatical system. While abroad, they are able to maintain a tenure base in

[7] Ken Kikuchi, vice-director and research coordinator, National Laboratory for High-Energy Physics, "High-Energy Physics in Japan."

their home university without fear that promotion will be jeopardized. Japanese professors may even draw *two* salaries—one from their home base and one abroad. In contrast, a sustained period abroad for a U.S. university professor (especially if he or she is young and not yet tenured), can sidetrack his academic career. American universities have few effective mechanisms for tenure-related decisions concerning the individual who is working abroad, nor is there any guarantee that he or she will return. A sojourn abroad may also be a financial loss for professors who depend on outside consulting income in the United States.

The standard image of close cooperation between universities and industry in Japan requires further study. While national university professors have in the postwar period been prohibited from direct contract work for industry, *indirect* lines of communication and cooperation between Japanese universities and industry are usually seen as strong and effective. It is also important to note that the prewar pattern was one of much closer industry-university cooperation in Japan. There are a plethora of professional societies and other information exchange organizations through which university and industry researchers can informally exchange views and research results. Professors have often received small sums of money from industry when their research was of interest, and Japanese professors can work for industry under the auspices of nonprofit agencies, such as the Industrial Research Institute in Tokyo. Finally, *private* Japanese university professors have never been subject to the same legal restrictions that national university professors face on direct consulting.

There are many informal channels of communication between universities and industry in Japan, but the result is not always to guarantee effective research collaboration. In both the United States and Japan, the degree and effectiveness of industry-university cooperation depends to a great extent on the field. True research collaboration with industry seems to be a viable option only for the most well known professors in first class universities. The Japanese government is, however, making a determined effort to promote university-industry cooperation by eliminating regulations that discourage such cooperation.[8]

[8] National university professors still cannot act as consultants for private companies, although they can "consult" for free, and sometimes do. In addition, they can accept grants from industry through two primary mechanisms: (1) contract research, under which industry gives money to the government, which passes it on to the university, or (2) donations (whether or not there are "strings attached" depends on university policy).

In some ways *U.S. university-industry cooperation* can be likened to *Japanese industrial cooperation.* Perhaps in part because U.S. antitrust laws have set constraints on direct cooperation among companies, universities have become the site of many cooperative research activities in the United States. Precompetitive research cooperation of interest to industry occurs at U.S. universities in a relatively inexpensive, open environment. In Japan, such precompetitive research results are sometimes pursued through industrial research cooperation, which often does not involve universities. Japanese cooperative industrial research programs, however, offer a sharp contrast to the inexpensive, open environment of U.S. academic research programs. The Very Large Scale Integration program, for example, was closed to outsiders, and the International Superconductivity Technology Center, while open to foreigners, requires a substantial financial contribution in order to participate in cooperative research.

CHALLENGES

Universities in both the United States and Japan face challenges in adjusting to what is likely to be a much less benign environment in the years ahead. Resource constraints, and the growing need for multidisciplinary research, and the trend toward more university-industry cooperation are issues that universities in both countries must deal with. Both countries must work harder to encourage young researchers. As mentioned earlier, Japan's major challenge is to build its basic research capability. The United States, meanwhile, is giving increased attention to improving technology applications and upgrading the production process.

After generations of Japanese success in importing and improving technology and exporting high-quality products, *Japan will face severe challenges in efforts to upgrade basic research.* From a political perspective, the perception that Japan has benefited from free access to science abroad while lagging in scientific research could result in the construction of barriers that would work to the disadvantage of scientific communities of both nations, particularly Japan's.

Knowledgeable observers, however, question whether domestic forces in Japan pushing for change are strong enough to overcome bureaucratic inertia that perpetuates rigid funding mechanisms. Despite almost a decade of Japanese government exhortations about the need to promote basic

research, growth in government funding for basic research has declined.[9] While the most comfortable and politically feasible approach may be to continue to build interuniversity research centers, the question is whether this approach will promote truly outstanding research in other areas of basic research where Japanese universities lag today. Those who call for the creation of "centers of excellence" in Japan are attempting to reverse a tradition of "democratic" funding that supports geographically dispersed but sometimes lower quality university research.

A related challenge for Japan is to open its research system to really meaningful foreign participation. Japanese universities are more open than other Japanese research environments, but the flow of U.S. scientific and technical researchers to Japanese universities is still minuscule compared to the flow in the opposite direction. If Japan's university research system is not upgraded, the result could be to exacerbate resentments over what some perceive to be a "closed" research system in which the best work is carried out in industry labs that are much less accessible to foreigners.

Encouraging foreign participation will also require efforts to overcome cultural and organizational differences. Japanese "politeness" can exclude a foreign researcher from the central work of a laboratory or research institute. An American researcher may find himself or herself inhibited by the Japanese tendency to treat foreign researchers as "guests," rather than "colleagues."[10] Sometimes in an attempt to provide good treatment, foreigners are given "better" office space—far away from Japanese colleagues with whom they should be interacting. A foreign researcher may also find that group-oriented research limits his or her ability to pursue a new (but

---

[9] According to the National Science Foundation, *The Science and Technology Resources of Japan: A Comparison with the United States*, p. 42, the Japanese government increased basic research performance by less than 1 percent a year from 1980 to 1985, compared with 3 percent from 1975 to 1980. The higher education sector, which performs about half of Japan's basic research, increased its basic research expenditures by 10 percent annually from 1975 to 1980, but from 1980 to 1985 this rate declined to about 4 percent per year. In addition, the Japanese government's share of total national R&D expenditures has been consistently lower than the corresponding share of the U.S. government's, even when defense R&D is excluded.

[10] Alexander DeAngelis, who heads the National Science Foundation's office in Tokyo, has noted the "sense of distance and separateness toward outsiders which is . . . a longstanding motif of Japanese society." Alexander P. DeAngelis, "Guest or Colleague? Accepting Foreign Scientists into Japanese Research Institutes," *Frontier Research Program Newsletter*, Vol. 1, No. 4, March 1988.

related) research topic and the way in which he or she gains recognition through publications and public presentations.

U.S. universities have a long history of openness and international participation. But there is also cause for concern: the numbers of college freshman interested in science and engineering have dropped significantly in recent years. The United States has actually become increasingly dependent on foreign nationals in graduate schools. Half the engineering faculty members under 35 years of age are foreign born. The United States has come to depend on foreign researchers, particularly those from the Pacific Rim, in industrial labs as well. Meanwhile, the U.S. minority population is a reservoir of virtually untapped talent that the country can ill afford to exclude. *One way for the United States to address this issue is to encourage minorities—blacks, Hispanics, and women—to enter science and engineering fields.*

The increasingly expensive, complex, and cross-disciplinary nature of scientific research in both nations has generated *a need for new mechanisms for conducting multidisciplinary research.* In American universities, however, departments are often reluctant to pool resources unless their survival is threatened. In Japan, the creation of a new institution does not imply the dissolution of the old ones and resources are increasingly strained. The reality of multidisciplinary research needs and constrained budgets challenge both nations to seek new ways to encourage cooperation between existing *koza* and departments.

One example of an American effort to bring researchers from various disciplines together without removing them from their home departments is the still young Program in Molecular Biology and Biotechnology at the University of North Carolina. Unlike the standard approach to multidisciplinary research, this center is not a stand-alone research organization, but one with widely dispersed functions. Strong leadership is required to deal with departmental competition for resources, and new mechanisms must be created to evaluate research that crosses traditional disciplines.

Many of these issues are closely related to the challenge that both nations face in *the need to encourage young researchers.* In Japan there is concern that there will not be enough Ph.D. graduates to meet the challenges of basic research. Programs to encourage young researchers have been established in both nations by government institutions—Japan's Ministry of Education and Science and Technology Agency and the National Science Foundation

in the United States. In Japan, however, there has been a reluctance to increase faculty because of an expected decline in the number of college-age students. In the United States, there is a need for departments and faculty to take responsibility for making internal changes needed to encourage young researchers, rather than putting all of the onus on government programs. For Japanese universities, where traditions of hierarchy and seniority are more entrenched, encouraging younger researchers will be a particularly significant challenge.

Both countries are attempting to *increase or improve the effectiveness of university-industry research cooperation*. The root of the challenge in this area lies in differing expectations about cooperative research. Tensions are created in some university-industry relationships in both countries because universities and industry enter them for very different reasons.

Companies in Japan, for example, continue to see the role of universities primarily as one of educating future employees. They seek cooperation with universities primarily for purposes of information exchange and human contacts (mainly for employee recommendations). In addition, when they do engage in joint research, they seek to exclude other companies from access to their potentially proprietary research results, because they perceive that university researchers are insensitive to their technology transfer concerns. Japanese universities, on the other hand, would prefer to gain financial support for long-term basic research from their cooperation with industry. In addition, they prefer to keep their labs open to many companies.[11]

Many of the tensions between U.S. industry and universities are similar to those in Japan. U.S. companies, like those in Japan, emphasize the importance of the educational role of universities. Unlike Japanese companies, however, U.S. companies base this preference on the argument that they do not have the time or resources for significant postgraduate training. They also seek research cooperation that will keep technology in the pipeline for future product development; technology transfer and university research that can spur more effective research within industry is very important. U.S. universities seek industry support for long-range basic research and many could not maintain their research programs without industry support. While it might sound logical to promote a division of labor

[11] Based on a workshop presentation of the results of a 1988 survey, prepared by Tomo Ishihara. Answers to questions regarding university and industry attitudes toward cooperation and expectations were solicited from national, public, and private university as well as industry researchers.

between basic research in universities and development and applications research in industry, there must be enough overlap in the work of the two sides to enable meaningful communication. It would be a mistake for American industry to abandon basic research, even if it is "inefficient" as measured in short-term return on investment terms.

Despite the very real problems that can result from differing expectations about university-industry cooperation, there have been many examples of successful cooperation in both the United States and Japan. Hewlett Packard, for example, is involved in various types of relationships with about 30 universities all over the world, including the University of Tokyo and the University of Osaka in Japan. Monsanto, which has a long history of involvement with university research, spends $15 million to $20 million annually on university research cooperation. This amounts to about 3 percent of the company's total research and development budget, but this is 15 percent of the company's "discovery" budget.

Efforts in both countries to improve university-industry relations, combined with the increasing globalization of industry, have created yet another challenge as contacts between foreign companies and domestic universities grow. Some companies have begun to express concerns about the possibility that industry-supported research will flow freely through universities to the hands of international competitors. As both the United States and Japan strive to improve university-industry relations, their challenge will be to do so without destroying the openness of universities. American universities now receiving more funding from foreign sources will need to consider which mechanisms best ensure academic freedom.

NEXT STEPS

In efforts to improve foreign access to the Japanese research system, the importance of improving Japan's basic research capabilities cannot be overstated. The recent establishment by the Japanese government of more fellowships for American scholars is laudable, but if foreign participation in Japanese research is to be expanded, foreigners will have to have sound scientific reasons for going to Japan. While the weakness of basic research may be seen as a "Japanese problem," it will also affect the degree of meaningful U.S.-Japan research collaboration in the years ahead.

Within Japan, there are different interpretations of what it means to create "centers of excellence." The idea of creating "total" centers of excellence—universities with excellent people, facilities, and equipment in a broad range

of scientific fields—if achievable, would certainly attract significant numbers of foreign researchers.

A less ambitious approach could also prove effective and would certainly be easier to achieve. The unit of "excellence" could, for example, be interpreted to apply to specific university departments. Because researchers are much more concerned about the quality of work in their field than about the state of the rest of the university, improvements in departments and research projects could, in theory, expand meaningful opportunities for foreign access. But smaller units of excellence might be less visible internationally, therefore requiring greater efforts by Japan's research and policy leadership to make information available to foreigners about the research under way and the available laboratory facilities.

While long-term efforts are made to improve university research in Japan, shorter-range measures can be taken. *Increased attention in both nations to the quantity and quality of researchers* exchanged can contribute to better prospects for R&D collaboration. For example, the American research community would benefit without going to Japan if more *senior*-level researchers came to the United States from Japan.[12] Junior researchers come to the United States to garner knowledge and develop personal networks that are invaluable in later years. Senior-level Japanese researchers can make more significant contributions to research collaboration in the foreign setting. Another issue concerns the researchers sent abroad purely for orientation to a foreign culture or as a reward. Leaders in both research communities would be wise to be sensitive to the resentment that results when researchers are sent abroad who are unlikely to contribute to meaningful research exchange.

In view of growing U.S. interest in research useful to industry, Japan could *focus efforts to expand opportunities for U.S. researchers on engineering and high technology fields.* These are areas that may be of particular interest to American researchers. Encouraging foreign participation in these fields may require new approaches, however. In some engineering fields, graduate student fellowships would have a greater impact than postdoctoral fellowships because the customary practice in those fields is to bypass postdoctoral research.

[12] Roland Schmitt, president, Rensselaer Polytechnic Institute, "Keynote Address—U.S.-Japan Dialog on the Working Environment for Research in Universities."

At the same time, Japan in particular can enhance researcher exchange by *disseminating English-language information about programs of research excellence* that now exist and by allowing ample time to implement new fellowship programs. In addition, there are a number of ways to improve and expand international scientific exchange and communication. Scientists who take advantage of *international communication media,* such as electronic mail, international teleconferencing, and on-line databanks, can transcend barriers to international communications.

There is also a need for more *previsit preparation and postvisit debriefing* for American researchers who go to Japan. The National Science Foundation has plans to establish a new position in Tokyo for a "facilitator" who will help American scientists. It seems axiomatic that scientists who have already visited Japan can encourage more exchange and make exchanges easier by circulating information about their experiences more broadly.

Responsibility for *learning the Japanese language* in preparation for a visit to Japan remains for the most part with the American researcher, although both the U.S. and Japanese governments are making efforts to increase opportunities for technical personnel to study the Japanese language. Language skills are not necessarily the most important prerequisite for a foreign researcher going to Japan, but some Japanese language facility can be a tremendous asset in taking advantage of one's time there. Language ability is important for various aspects of laboratory life abroad, from reading equipment instructions to evaluating research results, from participation in formal meetings to the informal discussions and social events that make up the fabric of human networks among Japanese researchers.

Sister university arrangements and other student exchange mechanisms can also be developed to increase research cooperation. Research collaboration is often built on the basis of personal ties created between two individuals. Ties created between researchers during their student days can be long lasting and the experience abroad often influences later decisions. Students, especially graduate students, play a role in transferring knowledge about the foreign research setting. While many sister university relationships exist only on paper, those that are already in place could be reinvigorated with a special emphasis on science and engineering exchange. The creation of foreign student offices in Japanese universities could also improve assistance to foreign students.

The many *professional societies and international scientific organizations* are other channels that could be better used to support expanded access and meaningful collaboration. The importance of professional societies in international exchange and collaboration has been explicitly recognized by

Japan's Ministry of Education. Joint efforts by U.S. and Japanese organizations to establish procedures to disseminate written documents, to enlarge reciprocal memberships, and to create a program focus on the question of how access can be improved could contribute to stronger roles for these societies in supporting international R&D collaboration.

SUMMARY AND CONCLUSION

Resentment over the perceived imbalance in the flow of scientists and researchers between the United States and Japan, if left unaddressed, threatens to spill over into political and economic arenas. The result could be to limit the flow of scientific and technological information and personnel between the United States and Japan. For this reason, it is important that the United States and Japan not only have an accurate picture of the similarities and differences between their working environments for research, but that leaders in both countries work to bridge those that inhibit foreign access.

Japan faces a long-term structural challenge in its efforts to improve its basic research capabilities. For reasons mentioned above, this raises significant challenges for Japanese universities. If Japan's efforts to improve basic research are to improve foreign access, the result must be to stimulate research in a freely accessible environment like that of the university research lab. To accomplish this goal, structural changes must be made: changes in funding mechanisms, new incentives for younger researchers, and policies to promote cross-sectoral and multidisciplinary research.

If Japan's universities cannot respond, they will not attain the goal of improving basic research capabilities. Potential negative implications for international cooperation could result if the major initiative for improving basic research is taken up by industry rather than universities. The result would probably be a quite different approach to basic research, one less accessible and more oriented to industrial needs than to "knowledge for knowledge's sake."

The United States needs to encourage young researchers, improve multidisciplinary research, and promote industry-university cooperation. The United States also faces a longer-term structural challenge in learning to think more globally, and learning to take advantage of the offerings of the

rest of the world.[13] Improved access to Japanese R&D depends on the availability of adequate information about opportunities there, as well as the motivation of individual U.S. researchers to take advantage of them, and adjustments in organizational incentives to encourage such actions.

Cognizant of the potential political, economic, and scientific dangers of scientific protectionism, leaders in both countries will have to talk frankly about differences and similarities in their R&D systems. Such dialog, as well as concrete moves to respond quickly to the criticisms and suggestions for improving access, are necessary if the United States and Japan are to define a viable relationship in science and technology in the twenty-first century.

It should be emphasized, however, that universities make up only one part of the R&D system, and opportunities for research collaboration must be expanded in other institutions—national labs, professional societies, corporate labs and consortia. These important organizations will be the focus of further bilateral discussions on the working environment for research during the next year.

[13] National Academy of Engineering, *Strengthening U.S. Engineering Through International Cooperation*, 1987.