teachers and urges local authorities to be more flexible in setting school curricula. It exhorts them to stress moral values, to remove unfit teachers, to listen to parents, and to avoid emphasizing trivial rules. The recommendations seem unobjectionable. But implementation, when and if it begins, may meet some strong objections from *Nikkyo-so*.

At the university level, more tangible changes may be coming. The report urges universities to permit more faculty transfers. It seeks advice on how to make entrance exams "more liberal and flexible." It would like to permit credits to be transferred, especially from junior to regular colleges. It would shorten the master's and Ph.D. requirements, permit early entrance to graduate school for talented students, reexamine the existing system of academic degrees, expand postdoctoral programs, increase the use of outside lecturers, and permit more joint research projects with industry. A new national council is to be set up to deal with university problems, a subject normally left to *Monbusho* bureaucrats.

As Amaya explained, each major topic in this controversial review will require a subcommission to analyze it and recommend action. The program will forge ahead at glacial speed.

Responding to a foreigner's skepticism about the practical impact of all this, some Japanese leaders said it should be regarded as the first step in a campaign that will take more than 10 years to complete. Kida, for example, said it is important to keep in mind that this reform, unlike the others, is being made during peacetime, with no crisis looming overhead. "This time, change will develop gradually, not so drastically." He saw this gradualism as a strength. Others said privately there is more noise than substance in the whole program, and doubted that it would amount to much in the end.

Many obstacles remain in the way of educational reform. Not least is the fact that the instigator of this campaign, Nakasone, is due to leave office in October unless his party revises its rules of officeholding. That probably will not happen. Meanwhile, the teachers' union will keep up its resistance, and inertia will take its toll.

Nevertheless, it would be a mistake to underestimate Japan's willingness to change, once persuaded that change is necessary. Modern Japanese history is essentially the record of a nation remaking itself according to programs of self-reform, not once, but in several major upheavals. Based on this record, it is best to assume that Japan will accomplish exactly what it intends in the way of educational reform. At present, however, its intentions are still a bit unsettled. ■ ELIOT MARSHALL

# Japan's U.S. R&D Role Widens, Begs Attention

*Industry and university overtures, politics, and necessity have spurred Japan to enter into more American-based research*

At Brookhaven National Laboratory on Long Island a new $1-million advanced spectrometer financed by the University of Tokyo is allowing Japanese and American scientists to peer deeper into the structure of materials. On the campus of the National Institutes of Health the number of Japanese researchers receiving federal support has grown by 65% in 5 years. And at university and industry laboratories around the United States, basic and applied research is increasingly being funded by Japanese industry.

Do these situations just reflect Japan's long-term economic strategy, which calls for bolstering that country's creative skills and basic research capabilities—or is something bigger going on? A number of Japan watchers across the United States see a growing economic interdependence that is far more significant than other global trade linkages. They argue that it is being driven by a multitude of factors, including Japan's rising direct investment in the United States, political expedience, and growing ties with multinational companies based in America.

This interdependence is reflected in everyday trade between the two countries, banking, manufacturing—and in a less tangible factor known as "technology transfer." It is defined broadly as the formal licensing, sharing, or theft of ideas, research, inventions, and know-how. But contrary to public perception, rather than being a packager of Western technology, Japan is increasingly the source of new ideas and know-how in electronics, telecommunications, materials, and biotechnology. To further this economic evolution the Japanese are overhauling their university system. They are also bolstering their ties to the American research establishment through grants, collaborations, research contracts, and independent research efforts based in the United States.

Just what Japan's growing scientific and technological prowess bodes for the U.S. economy is poorly understood. There has been little effort by Congress and the government to define and comprehend the international economic forces at work and their long-term implications. Nor has there been a thorough accounting of the growing R&D linkages between the United States and our second largest trading partner, which racked up a $49.5-billion trade surplus with the United States last year. Says Charles Morrison, a research fellow at the University of Hawaii's East-West Center, "Americans are not really aware of how dependent our economy has become on the Japanese. We don't really recognize the vast technological interdependence and how much our scientists are relying on the Japanese."

Confronted with an overall $148.5-billion trade deficit in 1985, federal officials cannot help but be concerned about Japan's expanding technology and research interchanges and their effect on American society. To an extent, they see these trends as potential threats. Comments Joseph P. Allen, an analyst with the Commerce Department's Office of Productivity, Technology, and Innovation, "it is apparent that traditional policies allowing the research results of [federal laboratories] to become freely available to our international competitors are being used against us."

Indeed, the response of Congress and the Reagan Administration is largely a firefighting action directed at the predatory information-gathering practices of industrialists in Japan and other countries. The thrust of Administration discussions centers on (i) protection of intellectual property, especially where federal government funding of research is involved; (ii) reciprocity, particularly being assured equal access to Japanese university and government research facilities; and (iii) federal laboratory management, specifically striving to better manage and transfer intellectual property to American industry.

The flow of information and benefits, however, is not all one way. Justin Bloom, a Washington, D.C., consultant who served in Japan for 6 years as the State Department's science attaché, notes that AT&T, IBM, and Burroughs have established or are building their own research facilities in Japan. DuPont is constructing a $60-million electronics research facility to support 200 research-

ers. This activity is a recognition, says Bloom, that Japan is on the cutting edge of technology in many areas and that American companies must have more than just listening posts there. "I don't think there is any question about it. There is no bilateral relationship that is more high-tech oriented," says Richard J. Samuels, an associate professor of political science at the Massachusetts Institute of Technology (MIT).

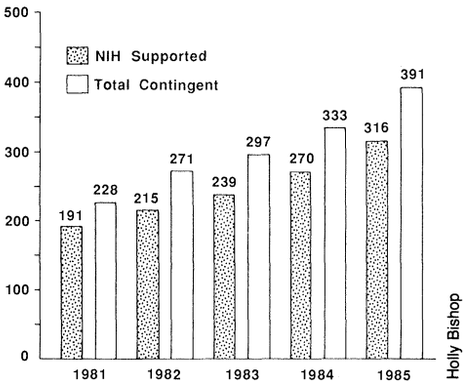
Japanese industrial involvement and financial support for research conducted in the United States is expanding in part because of fund-raising efforts by American universities. MIT, for example, has $3.5 million annually in Japanese research contracts and 12 endowed chairs. Industrial research efforts involving the Japanese also are multiplying because American high-technology ventures are turning to Tokyo for capital, entering into joint research pacts, or conducting contract research for Japanese firms.

"The R&D interchange is enormous. There are thousands of cross-licensing agreements," Bloom observes. The "network is complex," but not necessarily one-sided or all bad for the United States, he adds, noting that "a lot of people have made a lot of money out of this relationship with Japan."

The growing high-technology ties between the United States and Japan are illustrated by the rising volume of microelectronic technology licenses issued by Japanese firms to American electronics companies, says Herbert I. Fusfeld, director of New York University's Center for Science and Technology Policy. Over a 5-year period (1979–84), he notes, there appears to be rough balance in cross-licensing of microelectronic technologies between the two nations, an indicator that the United States continues to lead in many areas.

In his book, *The Technical Enterprise*, Fusfeld concludes that economic efficiency is often best attained through licensing. As long as a nation maintains "technical competence" at the forefront of key industrial sectors, Fusfeld says, relying on outside technology need not pose a threat. Japanese support of American research does not represent vulnerability, he adds, so long as U.S. research institutions remain competitive.

Licensing agreements alone, however, do not begin to reflect the outflow of information from the United States to Japan, says James J. O'Connell, director of government affairs and policy analysis at Control Data Corporation. "We believe there is a very clear correspondence between present technology flows and future trade in goods and services." This stream of information is likely to intensify in the absence of a government response, he says, citing Japan's growing support for research conducted at American industrial facilities, national laboratories, and universities.




**Japan's contingent** *of researchers at NIH has increased steadily in recent years.*

Michael Borrus, deputy director of the University of California's Berkeley Roundtable on the International Economy, echoes O'Connell's concerns. "It is very clear that the Japanese are looking to technology to carry them into the next century on top of the industrial heap," he says. "So, they are buying into U.S. technology in a much more organized fashion than they have in the past . . . at the level of basic research."

The extent to which this is actually occurring is not really known, but such assertions cannot be readily dismissed. Six years ago, Japan began a major push to expand its basic research activities in both the university and the industrial sectors. Furthermore, Japan's Ministry of International Trade and Industry has proposed an international research effort covering artificial intelligence, alternative energy, and biotechnology. It is estimated that this effort will cost $140 million annually over 20 years, and Japan would pick up more than half the cost.

There are numerous signs of an expanded Japanese role in research conducted in the United States, as well as conflicting data that make analyzing the matter difficult. National Science Foundation records show that the number of doctoral degrees awarded annually by American universities in science and engineering to Japanese citizens jumped 54.5% between 1980 and 1984. Similarly, the number of Japanese "guest" researchers—those funded by the Japanese government and/or industry—working at NIH has increased by 102% since 1981. But in sheer numbers, the largest increase in Japanese researchers—228 to 391 in the past 5 years—stems from the NIH's federally funded "visiting" researcher program.

This upswing, says Samuel K. Coleman, associate director of the Japan Center at North Carolina State University, should not necessarily be viewed with alarm. "In most cases they are working with top American scientists because we have identified them as being very good," says Coleman, noting that Japanese researchers have a reputation for "working with enviable zeal."

In a survey conducted recently by the National Science Foundation (NSF) of 128 top academic and nonprofit institutions, 43 schools reported some foreign funding, chiefly in the form of grants, research contracts, and in limited instances endowed chairs such as those established with Japanese funding at MIT. In fact, the Japanese government and Japanese companies were cited most often as the foreign sponsor.

At the industrial level, the Department of Commerce calculates that annual expenditures for research conducted in the United States by American affiliates of Japanese companies rose from $23 million in 1977 to $169 million in 1983. Martin Goland, president of the Southwest Research Institute and chairman of the National Research Council's commission on engineering and technical systems, finds the number hard to accept. "That figure seems exceptionally low," says Goland, whose company had about $8 million in Japanese research contracts in 1983. No matter what the correct figure is, Goland is sure that expenditures by Japanese industry and government on R&D conducted in the United States will rise steadily. "I think it is the wave of the future," says Goland, "it's uncontrollable."

Besides providing new windows on American science and technology, Japanese research in the United States will aid Japanese companies in developing products for international markets. But just as important is the political motivation, says Susan Farr, holder of the Toyota-endowed Japan chair at Georgetown University's Center for Strategic International Studies. "It is part and parcel of their massive direct investment effort," adds Farr, noting this strategy is aimed at securing market niches and fending off trade protectionism.

Japan's push in basic research does not necessarily mean more Japanese researchers studying at U.S. educational institutions, or working in industrial and national laboratories, says Robert J. Fujimura, Commerce's Tokyo-based analyst for biotechnology. There are already 13,000 Japanese students studying in the United States, 7% studying engineering and 5% studying physical and health sciences. In fact, the total number of Japanese students has soared from the 1973–74 level of 4745. Statistics compiled by the Institute for International Education in New York, however, show that the actual percentages of Japanese students enrolled in engineering and various science curriculums have declined from 11.1 and

9.4%, respectively, as compared to 1973–74.

NSF's representative in Japan, Charles T. Owens, expects that Japanese matriculation in American universities will hover near present levels because of budget constraints and efforts to encourage more foreigners to come to Japan. Consistent with this goal of creating an international research climate at home, Fujimura notes that many Japanese students are starting to feel they do not have to go overseas. Although the country is moving rapidly to upgrade its university and industrial capabilities in basic research, Japanese officials admit that change takes time.

"They don't have a good basic research infrastructure, so they are going to use ours while they try to build up their own system," observes Clyde Prestowitz, a fellow at the Smithsonian Institution's Wilson Center for international studies. Many of Japan's brightest students and researchers, in fact, will continue to tap the American universities because of Japan's slowly changing hierarchical academic setting, which still has trouble accommodating students with new ideas. Concedes Commerce's Fujimura, "the best way for young people to get recognized is to go overseas."

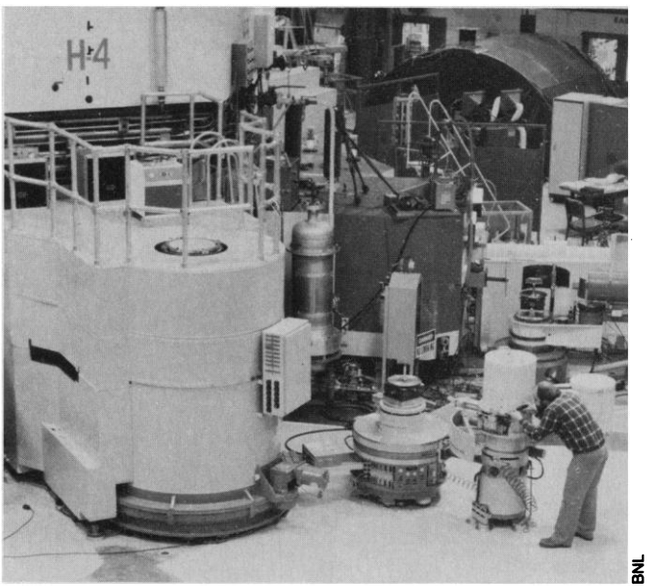
This explains in part why for decades Japanese scientists have sought work at U.S. national laboratories. In recent years their research activities, including Japanese funded contract work and joint research with the United States, have intensified. The Japanese are heavily involved in nuclear and high-energy physics research and materials testing programs at Argonne, Brookhaven, Oak Ridge, and elsewhere. Besides funding a portion of research projects and sharing data, the Japan Atomic Energy Research Institute has supplied Oak Ridge with an electron microscope for materials research.

Increased cooperation with the Japanese, says John R. Mallott, special assistant to the under secretary of state for economic affairs, does not put us at a disadvantage. "Technology does not become the exclusive property of any one company or country," he notes. "Look at the whole history of technology. It does not take very long for technology to be diffused." Oak Ridge officials say that Japanese contracts and broadening scientific collaborations are actually permitting U.S. research to advance at a faster pace.

Although strongly supported by the academic and scientific communities, such collaborations, while increasingly productive, may pose some risks. Japan has moved steadily over four decades from being an importer and copier of technology to being an exporter and technological innovator. The large number of patents being registered by Japan, notes Martha C. Harris, an analyst with Congress' Office of Technology Assessment, suggests that not only is Japanese industry enlarging technology exports, but companies are also seeking to strengthen their bargaining positions.

**Spectrometer**

*This $1-million polarized-beam spectrometer was built at Brookhaven National Laboratory's High Flux Beam Reactor under a cooperative agreement with the University of Tokyo. In exchange for providing the state-of-the art instrument, Japanese researchers get 50% of the machine's operating time.*

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Thus, American companies probably will encounter stiffer competition in high-technology export markets. And, to the extent that the Japanese can convert research to technology patents ahead of U.S. companies, accessing Japanese technology through licensing agreements may become more costly. Overall, the number of U.S. patents granted yearly to Japanese from fiscal year 1978 through 1985 has jumped 80% to 12,783 while the number of patents granted annually to Americans over that period has remained flat at around 42,000.

These trends, says Harris, pose complex questions for U.S. policy-makers about how to promote the competitiveness of American companies while limiting the potential damage of technology exchange on the domestic economy. Says Farr of the Center for Strategic International Studies, "It is tremendously important to be looking at the implications of what is happening."

But to the dismay of many trade analysts and economists, the amount of data collected by the U.S. government on foreign support for R&D conducted domestically is virtually nonexistent. Comments Borrus of Berkeley, "no one has the slightest clue about how extensive and widespread it [foreign support for research conducted in the United States] is and the U.S. government does not care."

Both universities and national laboratories keep data on nationalities, and on academic and research pursuits of foreign students and scientists. National laboratory security offices also record data on the activities of overseas visitors. There is no systematic effort, however, to obtain annual reports from these institutions for analysis.

Federal data gathering in this area suffers from a fragmented system and inadequate funding. And efforts to address statistical deficiencies, federal officials say, have been stymied by jurisdictional disputes between the principal agencies—the Commerce and State departments and NSF. "It's par for the course," comments MIT's Samuels. "We are just coming to understand what is going on pretty late in the game."

The White House's Office of Science and Technology Policy is attempting to come to grips with issues of foreign-funded research and technology transfer through its Committee on Industry, Science, Engineering and Technology. As part of that effort, NSF has instituted a survey of 1300 Japanese companies to determine their plans for future R&D investment, including joint research and contract research conducted in the United States. This follows their recently completed poll covering foreign support of universities and academic research.

The two studies are but snapshots of current activity, not endeavors that will examine past activity or regularly monitor future action. Federal and private economists hope the White House task force will recommend upgrading statistical analysis related to U.S.–Japanese scientific and technical ties. "We have got to have the demographic, economic, and technical data with which to make decisions," asserts Bruce Merrifield, acting under secretary for economic affairs at Commerce. But putting the federal government's statistical house in order will not be done overnight. Says Merrifield glumly, "the pace of change is such that we are going to lose ground before we catch up." ■ MARK CRAWFORD