

Will Japanese Science Reinvent Itself?

It is common knowledge that the United States and Japan lead the world in science and technology (S&T) development. Using the amount each spends on research and development (R&D) as a percentage of their gross domestic product to judge their strength, Japan was number one with 2.78% in 1995; the United States followed with 2.52%, according to the National Science Foundation's (NSF's) 1998 *Science and Engineering Indicators*. Both nations have an array of governmental policies aimed at fortifying their S&T base and their technological competitiveness, and Japan recently instituted broad reforms in its S&T policies that will have a lasting impact on the country's public and private sector research.

One key change is the promotion of programs linking researchers from industry and academia (I/A) in joint R&D. The government intends for these I/A programs to help foster a greater spirit of innovation and entrepreneurship among Japanese scientists and engineers, resulting in more patents, more technology transfer, and the creation of high-tech start-up companies. These everyday events in the United States have not traditionally been part of Japan's culture of research and, in some cases, have even been prohibited by law.

Historical perspective

Japan's achievement since World War II in creating wealth, including a formidable S&T base, has been remarkable. In 1945, the country began rebuilding an economy leveled by war. Backed by an influx of U.S. dollars, Japan adopted a policy of high-quality engineering to improve on existing technologies. In the 1960s and early 1970s, concerns about energy and the environment prompted Japan to build up its S&T base.

In the 1970s and 1980s, its high-tech industries became world leaders in areas such as microelectronics, heavy machinery, and automobiles. The government funneled

money into programs for innovative research, redirected its national laboratories towards long-term basic R&D, and started new programs to fund creative young scientists. In the early 1990s, however, the economy began to falter, competition

in Japan remains unclear. Three years is a short time to see results in a culture as traditional as Japan's. Many observers think that true reform will require a change in Japan's science culture, which, for example, means increasing the number of people trained to do research.

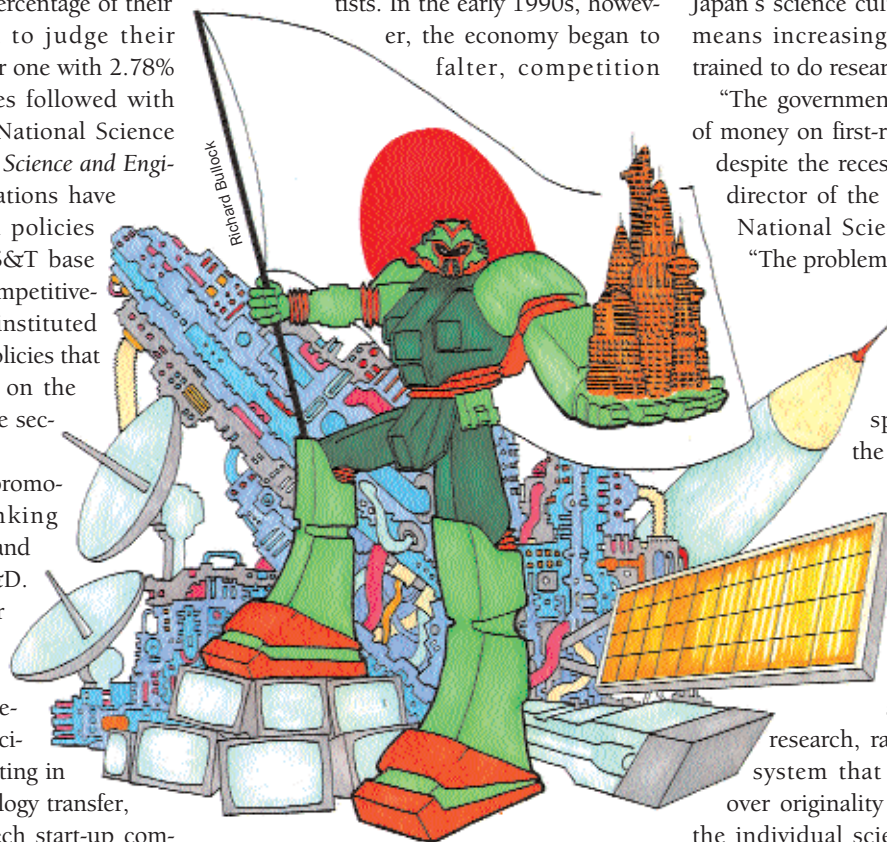
"The government is spending large sums of money on first-rate scientific institutions, despite the recession," says Bill Blanpied, director of the Tokyo office of the U.S. National Science Foundation (NSF).

"The problem is finding adequate numbers of trained young people to staff these institutions. That's why schemes of special appointments for the top young scientists and engineers have been instituted."

Other reforms focus on creating an R&D culture that is more inventive, more competitive, and more subject to peer-reviewed research, rather than the traditional system that emphasizes experience over originality and the institution over the individual scientist. Moreover, having realized the economic value of high-tech spin-offs, the Japanese government now encourages the scientists and engineers it funds to think more about the commercial potential of their work and even assists them in obtaining patents.

"One of the principal challenges to changing the path of innovation in Japan is the rigidity of the employment system," says Gerald Hane of the White House's Office of Science and Technology Policy. "The expectation of lifetime employment is still strong, and there is little midcareer mobility. As a consequence, entrepreneurs who fail cannot easily reenter the mainstream of corporate Japan, so they are reluctant to pursue ventures such as high-tech start-ups."

Formula funding has been the norm for S&T funding in Japan, with three government agencies primarily responsible for overseeing



from Korea and Taiwan increased, and the United States assumed the lead in areas such as biotechnology, software, and the Internet. Many politicians and scientists saw the need for new policies to address these challenges.

In 1996, the government drew up the S&T Basic Plan, which stressed technological innovation, improvements in facilities and equipment in public research institutions, and more funding for a competitive grants system. (Most government-sponsored research in Japan is funded by a formula based on tradition and the size of the institution, which rarely changes.) The plan also called for I/A collaborations, provisions to facilitate patents, and lessening limits on university faculty to receive funds from any source other than the government.

Whether the plan has been effective at improving the quality of research and inno-

it. The Ministry of Education, Science, Sports and Culture (Monbusho) supports research at universities, affiliated laboratories, and national interuniversity institutes. Its budget totaled \$13.4 billion in FY 1998, about half of all government R&D funding. Another one-quarter of Japanese S&T money goes to the Science and Technology Agency (STA), which supports several national laboratories and large-scale R&D projects in nuclear energy, space, ocean development, and synchrotron radiation. The third agency, the Ministry of International Trade and Industry (MITI), receives about one-eighth of the government's S&T funds. MITI oversees industrial technology policy, subsidizes some industrial R&D, runs 16 national laboratories, and organizes collaborations between its laboratories and industry. The remaining one-eighth of government funding is spread among other agencies.

STA and Monbusho are slated to merge in the next few years. "This merger will have a big impact on Japanese scientific institutions. Faculty members at national universities are government employees, and as such, have had certain restrictions on their professional activities," says Kasuke Takahashi, director of the Washington liaison office of the Japan Society for the Promotion of Science. "With pending reforms, they will have more freedom, including being allowed greater access to industrial R&D activities and vice versa."

The proposed changes have not yet been approved, and faculty at national universities are still prohibited from consulting or holding positions with private companies. However, many expect that the government will move soon to lift all the restrictions, which hinder the creation of start-up companies based on technologies developed in university laboratories. The selection of physicist Akhito Arima as Minister of Science, the first scientist to hold the post, also illustrates the commitment to change, Blanpied says.

Industrial research

Private-sector industrial laboratories perform about 75% of all Japanese R&D and employ 70% of the country's engineers and scientists, according to a 1997 NSF report.

Companies tend to hire at the bachelor and master's degree level, and they provide life-long training for their employees, including Ph.D. degrees.

Creating programs that allow industry, government, and academic researchers to work together has been another priority of

the Japanese government. Although formalized I/A programs are a relatively new phenomenon in Japan, informal networks linking the two sectors have existed for years. These usually form between a professor with a special expertise and an industrial laboratory that carries out similar work.

“Japanese companies usually prefer to receive university technologies informally, without having to limit their ability to control intellectual property rights,” explains Robert Kneller, a visiting research professor at the University of Tokyo who specializes in intellectual property. “They’ll donate funds or equipment to a particular university lab or create an endowed chair. If an invention occurs in the area, the academic scientist typically retains the right to apply for a patent, but usually shares the information with the collaborating company on an informal basis and leaves the company with the discretion to apply for patents and to develop the invention. The professor will usually hold off publishing until the company gives him the go-ahead.”

To better organize and increase the flow of knowledge between academia and industry, and to facilitate technology transfer, the Japanese government has begun to sponsor joint I/A research programs.

“One motivation for the formation of I/A programs stems from the severe recession in Japan. Industrial R&D needs to be restructured and revitalized, particularly in areas such as biotechnology and information technology,” Takahashi says. He believes I/A collaborations will prosper, and he cites the example of Nichia Chemical Industries, Ltd., in Tokushima Prefecture. Nichia has created a thriving global business in light-emitting diodes by establishing a working relationship with the local university in engineering, design, and testing.

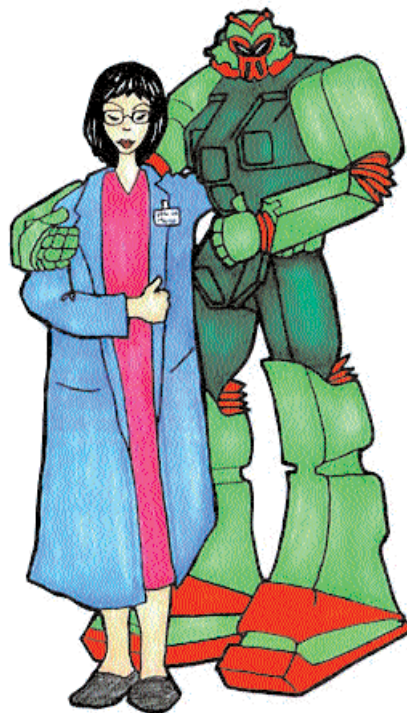
Research centers

One important venue for I/A collaboration is Monbusho’s University–Industry Cooperative Research Centers (CRCs), which numbered 49 in early 1998. These CRCs provide laboratory space on campus for cooperative research, offer technical training for private-sector employees and academic consulting services, and hold special conferences, lec-

tures, workshops, and so forth.

The research efforts at a CRC are usually geared to the strengths of its host university. Most commonly, projects are related to materials, machinery and equipment-related projects, software, civil engineering, biotechnology, electronics, and energy. Most projects last from 6 to 12 months. Patent rights arising from these ventures are shared by the government or faculty member and the participating company, unless the invention is clearly the product of one person.

NSF’s Win Aung has studied the Japanese CRCs and suggests that their success depends on surmounting age-old barriers. These obstacles include Japan’s traditionally low level of I/A research, due in part to the well-developed in-house R&D capabilities of industrial laboratories; laws prohibiting faculty at national universities from receiving funding from sources other than Monbusho; and “a certain apparent disdain university faculty have for applied research.”



"I think CRCs, and Japanese I/A collaborations in general, will have a long learning curve," Aung says. "Based on what I have seen, many centers are almost just shells, set up in response to available funding."

Larry Weber, former director of NSF's Tokyo office, argues that one should judge Japanese CRCs within their cultural context. "If you measure success by the U.S. model, maybe CRCs haven't done so well," he says. "However, in Japan, the goals may be different—for example, employment for all students. The CRC may help establish close ties between a professor, his department, and a company, which will recruit students from the lab. So for this purpose, they do work."

Another government initiative involves the formation of Venture Business Laboratories (VBLs). With an initial budget of about \$200 million, 24 VBLs were established in 1995 at national universities. The VBLs focus on advanced technologies such as microelectromechanical systems and nanotechnology and help train graduate students to be more independent and entrepreneurial.

Another Silicon Valley

The VBL at Kyoto University is particularly active, and director Kasume Matsushige attributes its success to a committed management, involvement with local venture businesses, team spirit, and an energetic group of young scientists. The region is now home to more than 200 small technology start-ups, and local Ritusmeikan University offers courses in how to launch a small business and what it means to be an entrepreneur. *Business Week* recently termed the Kyoto area "Japan's next Silicon Valley."

However, "VBLs were supposed to be a place where creative researchers could create the seeds of new industries through

entrepreneurial ventures," says Hane. "There's still little precedent for this career path in Japan, the uncertainties are high, and financing is difficult to obtain." In Japan, venture-capital firms are few, and the stock market typically doesn't give much market value to new high-tech start-ups if they go public.

As part of its effort to promote innovation, the Japanese government has recently established Technology Liaison Offices at six national universities. Historically, there is little precedent for formal technology transfer from universities or national laboratories to industry because of the high cost of patent applications (typically around \$8,000 in Japan), red tape, and Japan's tradition of informal networking.

A third government effort to promote R&D, including greater I/A partnerships, is the plan for more than 20 planned science cities. Conceived in the 1960s, the first one built was Tsukuba Science City, located 40 miles northeast of Tokyo and home to Tsukuba University, 88 national laboratories, and more than 160 private firms (see *The Industrial Physicist*, 9/96, pp. 20–21).

Stimulating start-ups

The Japanese government is also trying to cultivate the formation of start-up companies or venture businesses. "Start-ups in the U.S. are typically made by kids who drop out of school because they love to tinker and end up starting their own company, or those who leave the academic research world because they want to form their own firms," Blanpied says. "Both situations are quite unique to the United States and are not the norm in Japan."

There are exceptions to the norm, however. Yoko Imazu of Nagoya formed Think Forest Corp., a multimedia firm, in 1996, while a student in health sciences at Chukyo University. She began the company by scouring Nagoya offices and collecting business cards, eventually getting enough clients to start the business. Her company was recently nominated for an award by the Japanese multimedia industry association.

Hence, a sea change is taking place in the Japanese research culture. For the transformation to succeed, however, the government may have to take a more active part in promoting it. The time-honored traditions of experience, teamwork, precision, and extreme attention to detail have helped make Japan a world leader in S&T. One big future challenge for its R&D community will be to learn how to augment these qualities with independence and imagination. ■

I/A Collaborations: Here and There

Both the United States and Japan support their S&T base with public-policy initiatives. Yet significant differences mark the research cultures and technology-transfer processes of the two nations.

UNITED STATES

Universities account for about half of the nation's basic R&D efforts.

Federally funded faculty can and often do consult with industry on the side.

Faculty commonly file for, and receive, patents.

Spin-off technologies commonly result from I/A collaborations.

High-tech start-up companies often emerge from I/A collaborations.

Venture capitalists seek out I/A-developed start-ups to offer funding.

JAPAN

Private-sector industrial laboratories perform 75% of all R&D.

Government-funded faculty are prohibited from formally consulting with industry.

There is no tradition of faculty filing for or receiving patents.

Spin-off technologies rarely emerge from I/A collaborations.

High-tech start-up companies rarely result from I/A collaborations.

Few venture-capital companies exist; stock markets don't value start-ups.