Japan Unveils Ambitious Plan for Science and Technology, with Large Boost in R&D Spending

If the great era of scientific discovery is over, as John Horgan's recent book *The End of Science* proclaims, then nobody told the Japanese.

In July the Japanese government unveiled an ambitious plan of reforms aimed at creating a more flexible and competitive environment for R&D in Japan. To support such efforts, the so-called Science and Technology Basic Plan calls for a vast increase in government spending on science and technology, amounting to 17 trillion yen (about $155 billion) over the next five years. That represents a 50% increase over the ¥11.3 trillion spent during the 1991–96 period. Private-sector investment in R&D, which accounts for 80% of total R&D spending in Japan, has been declining since 1992, the plan notes.

Compared to past reform attempts, this latest initiative is notable for its broad base of support. It has the blessing of Japan's Council for Science and Technology, whose chair is Prime Minister Ryutaro Hashimoto. The plan also has the backing of Japan's parliament, which last November approved a law designating the promotion of science and technology "a responsibility of the nation." Even the Ministry of Finance, which has been looking to cut public spending to ease Japan's growing budget deficit, is said to be reluctantly cooperating.

Larry Weber, who recently completed a five-year tour as head of the National Science Foundation's Tokyo office, sees the new plan as "solidifying a trend" of increasing government support for science. Government investment in R&D has grown annually by 4–6% over the past decade. And so, despite Japan's current fiscal problems, Weber believes the plan's funding target will likely be met. More difficult to implement will be the other reforms designed to overhaul the research environment throughout Japan's public universities and national laboratories; many of the suggested changes challenge long-held traditions, such as lifetime employment.

In terms of science and technology policy, "this may be the most significant initiative that the Japanese have introduced in the post–World War II era," says Gerald Hane, a special assistant in the White House Office of Science and Technology Policy (OSTP) who monitors Japanese science policy. "It also bears major implications for the US. We must be sure that we are prepared to cooperate as partners."

The Japanese government seems committed to overhauling the country's R&D system. Will the plan work?

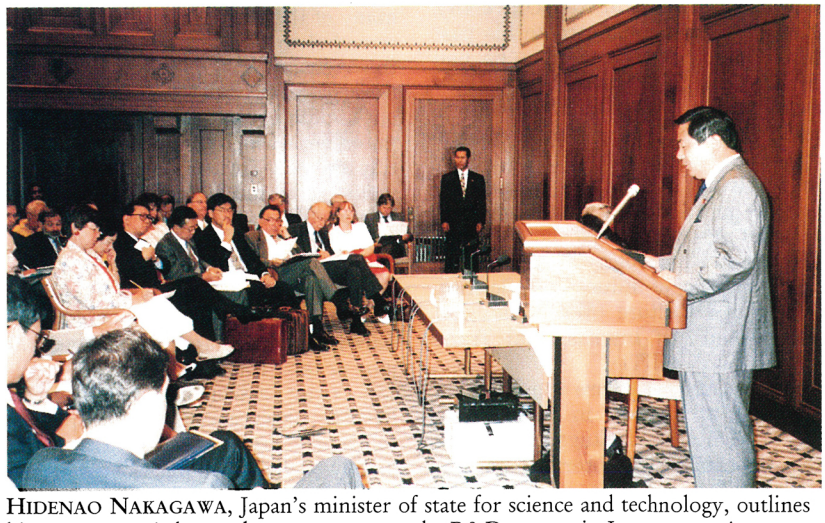
Big physics to come

The results of Japan's recent investments in research can already be seen in several major physics projects that are nearing completion or are under development.

One is the $1 billion Super Photon Ring-8 GeV (SPring-8), which will be the world's most brilliant synchrotron radiation source when it comes on line in late 1997, two years ahead of schedule. SPring-8 is being built by the Japan Atomic Energy Research Institute and RIKEN (the Institute of Physical and Chemical Research), and the light source is expected to attract an international cadre of users. A special law is now being drafted to ensure that the facility remains open to non-Japanese researchers.

Nuclear physicists are awaiting the final go-ahead for the Japan Hadron Project (JHP), a multipurpose, high-intensity proton accelerator comprising a 50 GeV proton synchrotron, a 3 GeV booster ring (which will replace the 12 GeV KEK-PS) and a 200 MeV linear accelerator. The 50 GeV synchrotron will provide high-intensity kaons, pions and antiprotons, and will also shoot a beam of neutrinos to the Super Kamiokande experiment, located some 250 km away (see PHYSICS TODAY, February 1996, page 17). The booster is to serve as a neutron spallation source and will also be used for muon physics studies. In anticipation of the project's approval, the University of Tokyo's Institute for Nuclear Study is relocating to Tsukuba next spring and will merge with the National Laboratory for High Energy Physics (KEK), where the JHP is to be built.

Another project being contemplated by high-energy physicists in Japan, the US and Europe is a next-generation linear collider. Called variously the Japan Linear Collider or the Next Linear Collider, this electron–positron collider would have a center-of-mass energy of 500–1500 GeV and would complement the Large Hadron Collider (LHC) at CERN. Kaoru Hagiwara, a theorist at KEK, notes that "the next important step toward the linear collider is to obtain support from the Science Council of Japan and . . . from our fellow scientists in other fields." At an estimated cost of $3 billion, however, such a machine would also require international support.



HIDENAO NAKAGAWA, Japan's minister of state for science and technology, outlines his government's latest plan to restructure the R&D system in Japan, at an August meeting at the National Academy of Sciences in Washington, DC.

Government Funding for Selected R&D Programs in Japan, FY 1996 and 1997 (in billion yen)

	FY 1997 (request)	FY 1996 (actual)
Ministry of Education, Science, Sports and Culture		
Grant in Aid for science research	114.1	101.8
Research for the Future Program	22.0	11.0
Science and Technology Agency		
Promotion of science research	26.0	21.5
Core Research for Evolutionary Science and Technology	25.0	15.0
Ministry of International Trade and Industry		
Innovative Industrial Technology R&D Promotion	4.9	2.7
Local cooperation of government and industry	2.0	0
Special competitive research	2.2	0
Other ministries	13.9	6.1
Total	210.1	158.1

Source: *Nihon Keizai Shimbun*, 2 September 1996.

Seeking a US commitment

The new science and technology plan calls for unspecified "boosts" to existing international projects, including the International Space Station, the International Thermonuclear Experimental Reactor (ITER) and the LHC. Indeed, Japan now seems the most likely host for ITER, and the country's unwavering enthusiasm for the project in general lies in stark contrast to the ambivalence displayed by the US (see PHYSICS TODAY, June, page 21).

A month after the basic plan was issued, Japan's minister of state for science and technology, Hidenao Nakagawa, visited the US to discuss the plan's implications with officials and scientific leaders. A one-time journalist who studied law at Keio University, Nakagawa was appointed to his post last January. Prior to that, he had been responsible for maintaining harmony within Japan's ruling coalition, and in that role he proved a capable diplomat. Such skills will be necessary in resolving turf battles among the various ministries and agencies that support research—most notably, the Science and Technology Agency (STA), the Ministry of Education, Science, Sports and Culture (Monbusho) and the Ministry of International Trade and Industry (MITI).

In an address before the National Academy of Sciences in Washington, DC, on 8 August, Nakagawa stressed the importance of international research efforts, and he made it clear that his country would welcome further US–Japan collaborations. Speaking through an interpreter (whose English he corrected several times), Nakagawa said, "When you look at mega-science projects, such as in space, ocean and energy, you have to have collaboration. One nation cannot achieve anything on its own."

"Our vision is to create a country based on creative science and technology," Nakagawa told the NAS audience. No doubt that vision includes more Nobel Prizes in science being awarded to Japan, which thus far has garnered a mere 5, compared to the US's 175. When politicians in Japan discuss science policy, he said, that disparity inevitably comes up.

Remedial measures

Japan has long been criticized for investing too little in basic R&D, and many of the new plan's provisions are remedial measures designed to bring the research system up to par with those of the US and Europe. Replacing out-of-date equipment, installing computer networks and developing scientific databases are among the improvements to be made to the research infrastructure.

The number of research assistants and technicians will be increased as well. At present, Japan has only one assistant for every three researchers, and in the universities it's more like one for every nine or ten. Karen Leighly, an American x-ray astronomer working at RIKEN, observes that her Japanese colleagues are "expected to be completely proficient in all aspects [of the research] and therefore end up overextended." A recent PhD who presented some interesting results in his 1995 thesis has since become involved with another project and has no time to write up those results for publication, Leighly says. "It seems to be almost universal in Japan—everyone is too busy."

The plan also calls for increasing the number of, and the financial support for, graduate students and postdocs, including foreign researchers. But it is silent on the issue of where, or whether, these new scientists will later find work.

To promote the mobility of researchers between academia and other sectors, the plan suggests replacing the traditional "lifetime employment" with limited-term contracts, and also allowing professors to accept consulting or other temporary positions at government and private labs. According to a report by the environment, science and technology affairs section of the American embassy in Tokyo, a US-style tenure system is also being considered. Such reforms would first require changes in national laws, not to mention cultural attitudes.

Several measures in the basic plan are designed to encourage greater international exchange among researchers. The government no doubt would be happy to have more physicists like Makoto Oka, a professor at the Tokyo Institute of Technology who spent eight years at MIT and then the University of Pennsylvania before returning to Japan in 1991. Despite his example, Oka says he has trouble convincing students to work overseas. "They feel uneasy taking temporary positions abroad because there is no guarantee that they will be able to come back and find work in Japan."

Basic research will also see some increased funding in the coming years. For example, the proposed 1997 budget for Monbusho's competitive Grants in Aid program is about ¥114 billion, up ¥13 billion from this year's appropriation (see the table). A newer initiative jointly launched this year by six of Japan's ministries and agencies is also promoting basic research. Called the New Systems for Promoting Basic Research, it received a total of ¥32 billion (about $300 million) in FY 1996. The STA's Core Research for Evolutionary Science and Technology, Monbusho's Research for the Future program and MITI's Innovative Industrial Technology R&D Promotion program are among the new "systems" within this initiative.

Physicists will wait and see

The basic plan contains "echoes of many proposals we've heard before," says Richard Samuels, director of the MIT Japan Program and vice chairman of the National Research Council's Com-

mittee on Japan. "Whether it will result in creating an innovative venue for research and development is not assured."

For now, physicists in Japan have adopted a cautious attitude. "There is plenty of disagreement among Japanese physicists concerning the value of these changes," observes Victor Rehn, a physicist who is director of the Office of Naval Research's Asian Office in Tokyo. "While there is unanimity in the feeling that the science bureaucracy is overgrown and inefficient, there is no unanimity in what to do to fix it."

Hiroshi Ezawa and Fumiko Yonezawa, the outgoing and incoming presidents of the Physical Society of Japan, told PHYSICS TODAY that "we have to wait [and] see how the Science and Technology Basic Plan affects physics and physicists in Japan in general." They point out that although the proposed increases for basic research in FY 1997 are large, "the number of projects to be benefited is not." And this year, they add, "the extra funding was distributed hastily, by a top-down strategy."

Shuji Abe, head of the fundamental physics section at the Electrotechnical Laboratory, a MITI-run facility in Tsukuba, worries that new research will be funded at the expense of existing programs. And because the new funding schemes are mostly "project oriented," Abe says, they tend to favor scientists "in some currently fashionable areas. . . . I'm afraid that within a few years, there will be a few 'rich' researchers and many 'poor' researchers in Japan."

For all its faults, the Japanese government's centralized approach to R&D does have at least one advantage: stability. Yoichi Okabe, a neural networks expert at the University of Tokyo, recalls that in the 1980s, a number of Japanese companies leapt into neural networks development, only to retreat once "the big wave had passed in the US." Government-funded research, on the other hand, has continued and will likely expand, with sizable efforts at RIKEN (which next year will open an Institute for Brain Science), the University of Tokyo and Kyushu Institute of Technology.

Robert Lewis, associate director of the Tsukuba Research Consortium, calls the government's increased support "quite natural and even desirable considering [Japan's] low level of government funding compared to the West." But what will happen, he wonders, when the new science begins to pay off in new technologies and then new products? Most likely, he says, "the West will begin a new series of complaints that Japan is unfairly using government funding to promote business."

It may take some time for the basic plan to work itself out, but OSTP's Gerald Hane believes there is reason for optimism. "If you look at Japan's history, you see that things change very slowly," he says. "But they do change."

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Recommended Reading On-line

NSF's Tokyo office maintains a World Wide Web site at http://www.twics.com/~nsftokyo/home.html. The Asian Office of the Office of Naval Research also has a Web site, http://www.itd.nrl.navy.mil/ONRA. Both sites contain reports on Japanese R&D efforts as well as links to other sources of information on Japan. An unofficial English translation of the Science and Technology Basic Plan can be found on the STA's Web site, http://www.sta.go.jp/welcome-en.html.

Caltech Hands Its Solar Observatories to NJIT

A changing of the guards is occurring in ground-based solar physics: While some university programs are on the wane, others are stepping in to fill the gaps.

Caltech's decision last year to put its efforts wholly behind nighttime astronomy, thereby abandoning its strong solar physics program, left solar physicists worried. But most are satisfied with the outcome: Since July, Caltech and the New Jersey Institute of Technology (NJIT) have been collaborating on programs and proposals while they finalize an agreement for NJIT to take over Big Bear Solar Observatory (BBSO) and the solar array at Owens Valley Radio Observatory (OVRO) next summer. During this transition year, NJIT is setting up a consortium of universities to participate in running and financing the observatories.

For more than 25 years, Caltech has operated these outstanding solar observatories—two of only a handful run by US universities. Both BBSO and the solar array at OVRO are dedicated (rather than shared) facilities, and observe the Sun all day, every day, thereby making it possible to study unpredictable phenomena. The image quality, or seeing, at BBSO is exceptionally good. The observatory sits on a causeway in the middle of Big Bear Lake in the San Bernardino Mountains in California (see photo on page 62). The lake acts as a heat sink, stabilizing the local temperature and thus minimizing atmospheric turbulence due to solar heating of Earth. And, at OVRO, an array of five antennas images and analyzes spectra of small regions of the Sun's corona at radio frequencies (86 frequencies in the 1–18 GHz range). Both observatories—individually and in collaboration—emphasize magnetic structure and activity of the Sun. They are also used as ground-based observation support for space-based studies, and BBSO is the US mainland site of the Taiwan Oscillation Network (TON) and of the Global Oscillation Network Group (GONG) for helioseismology (see PHYSICS TODAY, October 1995, page 32).

The driving force behind Caltech's solar observatories has always been Harold Zirin, director of BBSO. Now Zirin is approaching retirement, and many in the solar physics community are surprised and disappointed by Caltech's decision not to hire another solar physicist to replace him. They see it as symbolic of a more widespread neglect of the field: "The perverse reality is that solar does best when it's not part of an astronomy department," says Barry LaBonte, a solar physicist at the Institute for Astronomy at the University of Hawaii at Manoa. NJIT solar physicist Haimin Wang, who spent 12 years at Caltech, says that Caltech—whose founder, George Ellery Hale, was a solar astronomer—is downsizing its solar physics program "to concentrate on Keck." (Located on the island of Hawaii, the two Keck telescopes are the world's largest and most powerful for optical and infrared astronomy.) Zirin agrees, and laments "the low standing of research on the Sun in the US."

The state of ground-based solar research also concerns investigators involved in space-based solar research. "The success of ongoing and anticipated space missions depends on the unique partnership with ground-based research," says William Wagner, who is in charge of solar physics at NASA. Wagner emphasizes that now is a particularly exciting time for solar research: "We are beginning to probe the very core of a star and learn how its engine works—how it uses magnetic fields to throttle the neutrino and