Science Weathers Economic Storm

Basic research is protected as industry trims R&D spending, while government and universities pursue new ways to improve quality and promote collaboration

TOKYO—For Japanese science, the 1980s and early 1990s heralded a long-awaited spring. With the economy booming, companies and government agencies began to feel that large-scale, ambitious basic research was a luxury they could finally afford. Prodded by Western nations as well as by Japanese scientists, the government increased its support for long-neglected national universities, launched a variety of big science projects at home, and began to spend money on international programs such as the Human Frontiers Science grants. Major companies sank hundreds of billions of yen into palatial basic research labs.

But with the puncturing of the "bubble economy" in 1990 and the economic stagnation that ensued, profligacy has given way to parsimony. Corporate employees accustomed to first-class seats on trans-Pacific flights are now packed into economy class. Growth in the national budget is at a virtual standstill. Rising numbers of college graduates are jobless as companies clamp down on hirings. Newspaper articles warn that "never have Japan's economic prospects been gloomier."

In these belt-tightening times, how fares Japan's science? At first glance, the spring growth seems to have been nipped by a sudden freeze. After soaring by more than 50% in 5 years, to $78 billion in 1991, total R&D spending by Japanese companies plunged by 7.5% in the next 2 years—the first such drop since the 1973 oil shock. But so far at least, the cuts have taken a larger bite out of applied research and development than from basic research. And for the universities and national research institutes, the chilly economic winds have actually brought new government investment: Hundreds of billions of yen in economic-stimulus money have gone into new buildings, equipment, and computer networks in an effort to upgrade the nation's science infrastructure.

So, while the economy remains sluggish, work is progressing on big science projects such as the "b-factory" particle accelerator, an 8-meter optical-infrared telescope on Hawaii's Mauna Kea, the Super Kamiokande neutrino observatory in an old mine near the Sea of Japan, the deep-sea drilling ship *Godzilla*, the SPring-8 synchrotron in Harima, and the Large Helical Device fusion reactor outside Nagoya. Human genome research received nearly $40 million in 1993 from various agencies, and the Science and Technology Agency's Exploratory Research for Advanced Technology (ERATO) program added four new projects in 1994, giving each of them from $13 million to $16 million over the next 5 years.

Yet it may be only a matter of time before Japanese scientists feel the bite of the economy. A sluggish recovery or a further drop in sales could undermine basic research in industry. And government resolve to increase spending on science may flag in the face of a gaping $1.8-trillion national debt.

EIJI MIYAZAWA/BLACK STAR

Overdue facelift. The University of Tokyo gets a new science building.

How industry adjusts

Although researchers at corporate labs have been made increasingly aware of tightening budgets, the actual impact on their work can be subtle. At Hitachi's development laboratory on the western fringe of Tokyo, requests for silicon wafers are met with much ado about "watching the budget," says Alison Shull, a Harvard University graduate student who spent this past summer there as a U.S. National Science Foundation (NSF) fellow. "Then, miraculously, more appear the next week." Nonessential items, however, are a thing of the past. When Shull needed to take the $2000 chips for testing at the company's Central Research Laboratory, "they gave me a company bicycle and a used Isetan department store bag to carry them in."

Slumping sales have, in fact, forced Hitachi—Japan's largest R&D spender—to make more serious economies in labs: Since 1991, the company has slashed its R&D budget by more than $300 million, to $4.8 billion. At the Central Research Laboratory, projects are being redirected toward near-term product development. But the elite Hitachi Advanced Research Laboratory, 2 hours north of Tokyo and dedicated to basic research in areas ranging from superconductors to molecular biology, has not been hit any worse than the other company labs. It still receives its 1% share of the company's R&D kitty.

It's a similar story in other corporate research labs across Japan. "We had a slight decline in R&D, but essentially, it's almost flat," says Roy Lang, general manager of NEC Fundamental Research Laboratory in Tsukuba. "But fundamental research has suffered less," he adds. Kazuo Imahori, president of Mitsubishi Kasei Institute for Life Sciences, says Mitsubishi Kasei trimmed the institute's budget by 5%, although overall R&D spending suffered a 15% cut. And the institute has covered its loss with some hefty grants, including one of the new ERATO awards to Daisuke Yamamoto for his work on genes for fruit fly courting behavior.

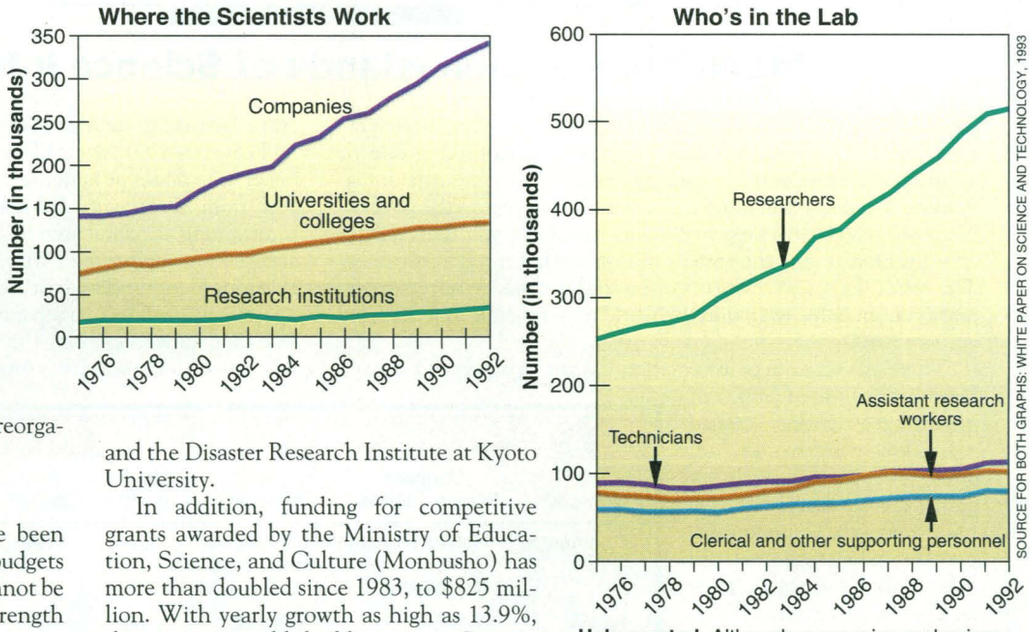
Many companies have responded to budget cuts by restructuring their central research labs. In 1992, for example, Toshiba fused the nine laboratories in its R&D center in Kawasaki into three multifield labs and brought its Ultra Large-Scale Integration Research Center and System and Software Engineering Laboratory to the reorganized lab. The move was aimed at enhancing overall efficiency, says Akinobu Kasami, Toshiba's chief research director. At NEC, says Michiyuki Uenohara, a senior adviser on corporate R&D, "we're moving some applied researchers from Tokyo to the Tsukuba lab in order to increase the interaction with basic research. We planned it that way initially, but we're accelerating it."

One factor that has buffered the shock of the recession for many major firms is the relative youth of their lavish basic research centers. "We were lucky to have moved to this new lab before the slowdown," Lang remarks, motioning toward his plush, 5-year-old surroundings. Although Lang says he is "a little sad" about being unable to buy some new equipment, including a costly crystal-growth machine, "we're trying to manage without new machines."

Things may get bumpier in the next few years, however. A survey commissioned by the Ministry of International Trade and Industry's Agency of Industrial Science and Technology (AIST) found that in contrast

to past years, companies are more likely in 1994 to have reduced their basic research budgets than their spending on research applications and development.

Still, Japanese industry can be expected to maintain a solid foothold in basic research, believes Fumio Kodama, a technology management expert at the University of Tokyo. "What is important to Japanese companies is to attract the best college graduates," he observes. "Having a central research lab and a big star is a good way to attract them. If you're aware of that, you can reorganize your lab based on that fact."



Help wanted. Although companies and universities have hired more scientists, the numbers of technicians and other support staff have not kept pace with that growth.

University upgrades

Although many Japanese firms have been able to absorb cuts in their R&D budgets without drastic restructuring, they cannot be complacent, Lang warns. "The great strength of the United States is the infrastructure supporting science and technology," he says. "You have fellowships and scholarships, electronic mail, and academic societies that actively support the interests of scientists."

Japan has similar mechanisms, but they are on a far more modest—indeed, many say inadequate—scale. The Japan Society for the Promotion of Science, for example, offered 2100 postdoctoral fellowships and doctoral scholarships this year. While that's a 110% increase since 1992, it's dwarfed by the 25,000 offered by NSF. And Japan's computer networks are "10 years behind the United States," estimates Hiroshi Inose, director general of the National Center for Science Information Systems (see box on p. 1172).

The recession has prodded the government to pump money into Japan's science infrastructure in an effort to shore up the foundations for long-term economic growth. The major science-related agencies received around $460 million to upgrade computer networks. The national universities are undergoing a facelift financed by $3.5 billion in economic-stimulus funds in 1992 and 1993. "The government usually channels this extra money to things like bridges and roads," explains Genya Chiba, vice president of the Research Development Corporation of Japan, "but we had so much scandal in the construction business, the government thought it might be good to pump money into science."

At the University of Tsukuba, "we've expanded our library, bought a supercomputer, upgraded our local-area networks, and put up new buildings," chortles university president Leo Esaki. "It was wonderful! We have no complaints." Tohoku University scientists have three new supercomputers to play with, and there are new buildings for biology and the Disaster Research Institute at Kyoto University.

In addition, funding for competitive grants awarded by the Ministry of Education, Science, and Culture (Monbusho) has more than doubled since 1983, to $825 million. With yearly growth as high as 13.9%, the program could double again in 7 years. But that would still be less than what NSF alone spent this year on grants to university scientists.

Grants and contracts from industry to academic labs also grew rapidly during the bubble years—more than tripling, to $500 million, in the last decade. Tokyo's Kodama hopes economic pressures will force companies to continue that trend. "If companies realize they can't cover every field that they might be involved in 10 years from now, they might be interested in 'outsourcing' their research, hopefully to universities," he says.

So far, however, the recession appears to have done the opposite. Monbusho declined to release figures for industry contributions in 1994, saying it did not want them to be "misunderstood by the media." However, the AIST survey found signs of declining support in 1994, a finding backed by comments from R&D managers. "We've been talking about getting some private university professors here [as visiting scientists], but it's on hold because of the recession," says NEC's Lang. The director of a commercial agricultural biotechnology lab says "the number of collaborations with universities has decreased during the recession."

Another disincentive to smoother relationships between the two sectors is the fact that many corporate officials still look down upon the quality of research at most Japanese universities. Industry labs are usually far better equipped, although Monbusho's funding increases should help to narrow that gap. And the way academic research is managed is openly ridiculed. "The universities are feudalistic—most ancient," declares Eiichi Ohno, managing director of corporate R&D at Mitsubishi Electric Corp.

Nonetheless, NEC's Uenohara, for one, believes Japanese universities are essential for the long-term health of industry. He notes, for example, that multimedia technology depends on advanced software for such things as intelligent interfaces between humans and machines. That requires experts in social sciences such as linguistics and psychology, who are largely academics. "In Japan, such people won't join a company," he explains. "So we have to collaborate with them in universities."

Cutting-edge collaboration

Economic pressures may be helping to nudge government-sponsored projects increasingly towards basic research, as the sponsoring agencies seek to open new frontiers in technology rather than simply replicate what companies are already doing. The ERATO program, for example, "is moving toward a stricter definition of basic research," says Alan Engel, ERATO's overseas representative, "one that excludes materials research, for example."

Another example is MITI's Joint Research Center for Atom Technology (JRCAT), a 10-year, $250-million project to manipulate matter at atomic scales for such future technologies as quantum devices and micromachines. JRCAT shows that MITI projects "are increasingly for 'precompetitive' technologies," says Tsuneo Nakahara, deputy CEO of Sumitomo Electric Industries. "It's very high risk for one company. For example, with nanotechnology, we don't know how far we can control atomic-scale structures. We're choosing to participate in only those kinds of research projects."

In order for JRCAT to achieve its aims, its

planners decided that they needed to assemble a topnotch team of scientists from universities, several national labs, and 30 participating companies, and get them to work shoulder to shoulder in labs located at MITI's National Institute for Advanced Interdisciplinary Research in Tsukuba. According to NEC's Lang, it took some behind-the-scenes lobbying to persuade Monbusho bureaucrats to allow professors to work in a MITI lab. "We asked our colleagues at headquarters in Tokyo to visit Monbusho to convince them of the importance of collaboration," he recalls.

As a result, JRCAT now boasts an impressive lineup of scientists from the University of Tokyo, as well as from NEC and Hitachi. "The level is very high, so we are very willing to send our young researchers to this project," says Mitsubishi's Ohno. The sluggish economy didn't hurt either, JRCAT director Eiichi Maruyama says. "The recession has made it easier for us to get good basic researchers from industry," he chuckles. "This is a good way for companies to keep their scientists in basic research."

But JRCAT's role as a model for future projects will hinge not on its scientific output so much as on whether research results "can create a new technology in the future," says Shoji Tanaka, director of another MITI-backed lab, the International Superconductivity Technology Center. Tanaka presided over early discussions on JRCAT, but he has misgivings about the direction it has since taken. "They started with very basic research. As long as they keep this direction, it is not favorable for industry or MITI," he believes. Such views cause Lang to worry that in the future the pendulum may swing away from basic research, and "MITI may emphasize more product-oriented research."

JRCAT's role as a model of cooperation between ministries is also up for grabs. Scientists say there's not much sign that the traditional wasteful rivalry among government agencies is diminishing. Many researchers point to Japan's human genome research as a prime example. Although richly funded by Monbusho, the Science and Technology Agency (STA), and the ministries of agriculture and health, "genome research in Japan is in very bad shape," charges Imahori of the Institute for Life Sciences. "Every agency wants its own genome project, and they're doing it independently. So how can we expect big results from that?"

Such turf battles are also said to have contributed to delays in building Japan's information superhighway. And some scientists question the value of maintaining two space programs and two powerful synchrotrons (Monbusho and STA support one of each). "Japanese like to set boundaries and try not to interfere with others," observes Kazuo Abe, a particle physicist at the National Laboratory for High-Energy Physics (KEK). "They compromise and don't optimize for the overall design."

Hints of progress

Although skeptics say initiatives such as JRCAT are the exceptions that prove the rule, even outspoken critics of Japan's scientific establishment are convinced that the culture of Japan's research enterprise is slowly and subtly starting to change. Take the stranglehold that Japan's elite universities have long had on top corporate jobs. With fundamental research becoming a higher priority for companies, an applicant's ability has become as important as his or her alma mater. "My impression is that the quality of students varies widely today, even within one university," says NEC's Lang.

Masaki Furuya, a retired University of Tokyo plant biologist who now works at the Hitachi Advanced Research Laboratory, sees that trend, too. "At Hitachi maybe 95% of our top management are from the University of Tokyo," he says. "Now there is more diversity in where we hire from, and in 30 years you'll find our top people coming from many universities." He adds, "We even have a biologist from Tsukuba, a mother with two kids."

On the crest of that new wave are maverick outfits such as the Osaka Bioscience Institute (OBI) and Kanagawa Academy of Science and Technology. Both were founded in the late 1980s with funds from local governments and industries. They have recruited first-rate scientists to work on limited contracts, with generous funding and the freedom to hire adequate numbers of support staff. "In our institute we have only annual appointments," says the OBI's headstrong director, Osamu Hayaishi. "Even me. If I don't work hard, I'll be fired!"

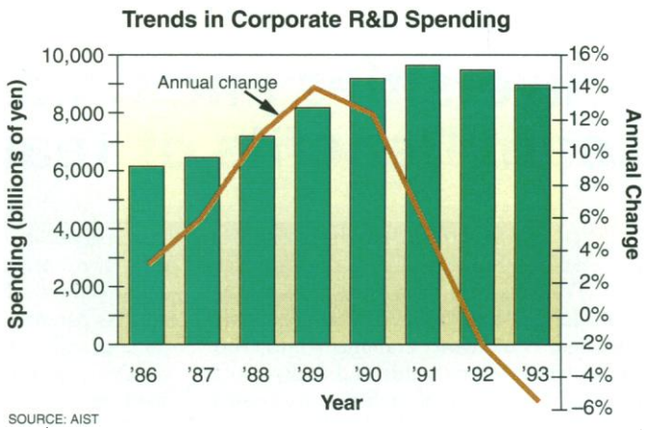
The OBI's high standards have paid off. Some 70% of the institute's grant applications to Monbusho are successful—the highest rate for any institution in the country and almost three times the national average. "I think we set a new precedent for the Japanese academy," declares Hayaishi proudly.

Success has brought numerous would-be imitators to OBI's door. "But there's one difference," says Hayaishi about newer institutions such as the Kazusa DNA Institute and a dozen small institutes in northern Japan that belong to a project called Tohoku Intelligent Cosmos Plan: "They mostly are meant to have a direct impact on local industries." But some people "realize the importance of basic research," he adds. The Gifu-prefecture town of Yaotsu, home of the late Chiune Sugihara, the Japanese consul who saved 2000 Lithuanian Jews from the Nazi death camps, wants to establish a basic bioscience institute in Sugihara's memory. But with the economy shaky, "nothing is concrete" yet, according to one of the planners, Kunio Yagi of the Institute of Applied Biochemistry in Mitake.

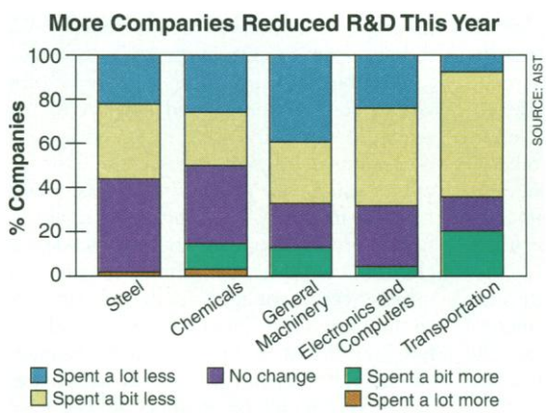
The idea of a private research institute created for its humanitarian and scientific value is a welcome gust of fresh air in a climate heavy with economic concerns. "To really increase basic research in Japan, we need to think about it in a different context," says Kodama. "It's important for us to make our basic research more visible to the outside world. Our technology is so powerful, but we have so few Nobel laureates."

Ultimately, Kodama says, Japan cannot afford to be perceived as a scientific consumer rather than a producer. "I argue to our policy makers that if Japan looks odd to outsiders, it's bad for our national security."

–June Kinoshita



Hard times. Slower rates of growth have turned into actual declines in corporate R&D spending.



Squeeze play. Most sectors of the high-tech economy are tightening their research belts.