servation groups that took part in the negotiations declined to sign the settlement, complaining that the rules didn't go far enough. And most representatives of the fishing industry backed out too, arguing that the rules are far too restrictive.

NEFSC's estimates of the harvest rates needed to sustain a productive fishery lie at the heart of these disagreements. The center's experts marshaled a vast array of data to argue that the target biomass should be increased for more than half of the stocks. Those data include detailed catch statistics stretching back to the 1930s and 40 years of scientific surveys. For many species, the catch data includes the ages of the fish caught—critical information for estimating how many young fish reach maturity each year.

These so-called recruitment data are key to calculating the revised biomass targets. Older models don't use this information, and incorporating it raised the targets considerably—in some cases doubling the previous target biomass as the researchers reassessed the importance of strong recruitment. The result of this thorough comparison of many models and data, says Ransom Myers, a fisheries scientist at Dalhousie University in Halifax, Canada, better addresses the inherent uncertainty of projecting fish populations. Unlike previous targets, he says, the scientists have taken into account the shifting baseline problem—the idea that as time passes, fishers and researchers become used to populations that are slowly spiraling downward.

Jeff Hutchings, also at Dalhousie, calls the higher biomass targets "very brave, and very necessary." Striving for bigger biomass would prevent fish populations from sinking below a threshold that could trigger not only economic hardship but also fundamental changes in food webs that prevent the species from ever rebounding, he says. That's what happened with the Newfoundland cod population, still in dire straits despite a 10-year fishing moratorium.

But fishers are skeptical of the higher biologic targets and the corresponding bleak picture the report paints of stock status in the Northeast. "We're continually amazed by these reanalyses that push the numbers [for target population levels] up," says Jim Kendall, director of the New Bedford Seafood Coalition and a member of NEFMC, which drafts fishing management plans. He and others also wonder if the seas can support such large increases in every type of fish. Murawski says that's a fair question but that the researchers feel justified in pushing all populations back to at least 1960 levels.

Aside from their fundamental disagreement over population targets, both sides are at odds over the means to prevent overfishing. The new rules only limit fishing effort—how much time and energy is spent pulling fish out of the water—rather than regulating what is actually caught. Fisheries scientist Ellen Pikitch of the Wildlife Conservation Society says this means "you have to sit back and pray" that the fishers don't kill too many fish from species in trouble, preventing populations from rebuilding to the new biomass targets. Her group, one of the three that refused to join the settlement, criticized the rules for failing to impose a quota on each fish stock that would force fishing to stop once the catch limit is reached.

But the fishing industries object strongly to quotas. They argue that quotas fundamentally change the market structure for fish, fall more heavily on small-volume fishers, and can reduce safety by encouraging fishers to fish in bad weather in order to beat other boats to the fish, says Anthony Chatwin, a fisheries scientist at the Conservation Law Foundation in Boston—the only conservation group that signed the settlement. They're also hard to enforce in real time, he says. "They've just finished tallying the fishing mortalities for 2001," he notes.

A quota system appears to be the most straightforward way to implement the science, admits Chatwin, "but we need something that works on the water as well as on paper." Those who agreed to the settlement must now work on a longer term plan that will fully incorporate the new science, he says, and lay the groundwork for the greater harvests to come. **–KATIE GREENE**

CORPORATE RESEARCH

# Japan Asks Why More Yen Don't Yield More Products

**Officials look beyond a sluggish economy to understand why R&D spending hasn't translated into greater success in the marketplace**

**TOKYO**—The importance of research is an article of faith within Japanese industry and government. "It is simply held to be true that investment in research and development is the biggest factor in keeping a company growing," says Tatsuro Ichihara, vice president for research at Omron Corp. "New technologies are very important for the nation's economic growth," adds Tagui Ichikawa, a science and technology policy official at the Ministry of Economy, Trade, and Industry (METI, formerly the Ministry of International Trade and Industry).

**Customers first.** Hitachi's Michiharu Nakamura says a healthy corporate research budget hinges on rising sales.

CREDIT: D. NORMILE

But recent news is straining that belief in the power of R&D. Government officials are puzzling over an equation that shows a simultaneous rise in research spending and a decline in global competitiveness. The total has been buoyed by steady increases in governmental research budgets that offset a tightening of corporate spending on research. In March, the government released figures showing that Japan's R&D investment in 2000 was a world-leading 3.18% of gross domestic product, far ahead of the 2.66% ratio in the United States. Unfortunately, the news barely preceded an announcement that the nation has slipped into its second recession in 5 years, and that many of the biggest corporate R&D spenders—including NEC Corp., Hitachi Ltd., and Toshiba Corp.—were among a near-record number of Japanese companies announcing losses for the fiscal year ending 31 March.

Research managers say fixing the mismatch between spending and results will require help from both the public and private sectors. "The problem is that the fruits of the R&D are not going into commercialization," says Ichikawa. Takemitsu Kunio, general manager of research planning for NEC Corp., admits that their research efforts haven't helped the company as much as they should. "Our research has often been out of touch with corporate goals," he says.

Concerns about Japan's ability to commercialize high technology mark a dramatic turnaround from a decade ago, when Japan's high-tech companies seemed in-

vincible. Private sector research was growing at 5% or more per year as corporations forged ahead on basic research and hired top American and European scientists to staff overseas R&D labs. But Japan's economic malaise has taken its toll, and private R&D spending has been nearly flat since 1997.

The inability of the private sector to keep boosting R&D investment led to a dramatic expansion of government research. It was hoped that public sector basic research would provide discoveries that corporations could commercialize and that would eventually restart the nation's sputtering economy. But the economic payoff has been very difficult to see. The lackluster economic performance represents what Ichikawa calls "a valley of death" between basic research and applications, a gap that claims fundamental discoveries before they can become money-making products.

The government has tried to do its part to bridge that valley with laws encouraging university and national lab researchers to file for patents and work with technology licensing offices to help them market their discoveries. It has loosened regulations preventing university professors from advising private companies and adopted measures to foster start-up businesses. METI also reorganized its own group of applied research labs to make their efforts more focused and subject to stricter evaluations. "We had lots of overlapping efforts, lots of projects, but no one could understand how they were doing," says Ichikawa.

But ultimately, responsibility for commercializing research rests with the private sector. And here, Ichikawa says, "the management [of corporate R&D efforts] has not been very effective." NEC's Kunio admits that his company tended to "place small bets on every possible number at a roulette table." In 1999 NEC tried a new tack, giving managers more responsibility for how their divisions performed. That led to greater involvement in setting research objectives. Although Kunio declines to identify which research efforts were dropped and which survived, he notes that the company's software division has cut the number of projects by half and doubled the number of researchers in each group in an effort to increase the payoff.

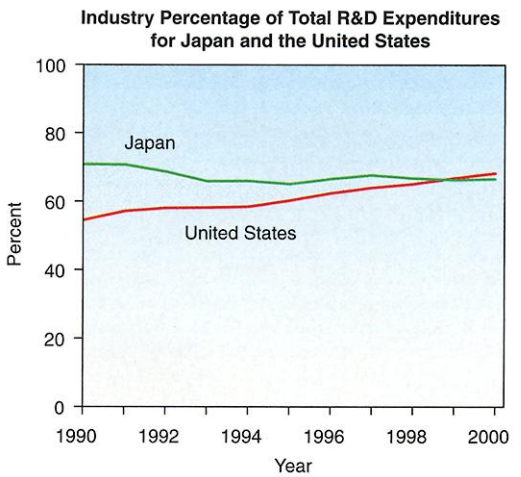
A similar reorientation has been carried out at Hitachi, which has abandoned a linear model in which researchers handed off discoveries to production departments. Now researchers work directly with engineers and customers, says Michiharu Nakamura, who heads Hitachi's Research & Development Group, and all have a stake in finding a market niche.

Even the optimists acknowledge that the reforms will take time, however. "Over the next 10 years you will start to see the fruits" of corporate research restructurings, predicts Omron's Ichihara. But government officials want to see corporate spending recover more quickly. METI's Ichikawa says they are particularly concerned because U.S. corporate R&D spending grew briskly through the latter half of the 1990s—by an average of 7% per year, according to the U.S. National Science Foundation—just as Japan's corporate spending has flattened out (see graph).

One step that the government is considering would bolster tax breaks for new R&D investment. Companies can currently deduct up to 15% of any new spending, but the reduction cannot exceed 12% of the tax the corporation would otherwise pay and spending must have risen for two consecutive years. METI would like to eliminate those conditions and possibly increase the percentage that can be deducted. It is also weighing new tax incentives to encourage university-corporate R&D cooperation. More generous tax breaks help U.S. companies save 10 times the amount of their Japanese counterparts, Ichikawa notes. Details of the tax package will be worked out this summer after negotiations with the Ministry of Finance.

Hitachi's Nakamura welcomes the tax incentives, even though their effect is likely to be more psychological than fiscal. More important, he says, "for R&D budgets to really rise, sales will have to rise." Such a rise would go a long way toward restoring the country's faith in the value of research.

–DENNIS NORMILE




**Trading places.** U.S. industry now funds a larger share of overall domestic research than does industry in Japan, where the government is becoming a bigger player.

SOURCES: NSF AND THE JAPANESE MINISTRY OF PUBLIC MANAGEMENT, HOME AFFAIRS, POSTS, AND TELECOMMUNICATIONS

## Japan's Drugmakers Need a Boost to Compete

TOKYO—Japan's major manufacturers have long been able to match, if not top, the research investments made by their overseas competitors. But the same is not true of Japan's pharmaceutical firms, which are dwarfed by the behemoths that now dominate the global market. Japan's Ministry of Health, Labor, and Welfare estimates that on average domestic pharmaceutical firms spend only one-fifth as much on research, in absolute terms, as do their U.S. counterparts. And the gap seems to be growing. "If we don't rally [R&D activities], in 10 years Japan's pharmaceutical sector will be significantly weaker," warns a new report from the health ministry, "Vision for the Pharmaceutical Industry."

The report, released last month, is short on specifics. But it calls for increased support for biomedical research at national laboratories and for money specifically for joint public-private research projects. One such project would be a major effort to identify and analyze disease-related proteins. The ministry would also like to create a national basic biomedical research institute, streamline the regulatory process for new drugs, and better coordinate public, academic, and industry research efforts.

The plan gets a warm reception from Japan's pharmaceutical industry, but academic researchers are more cautious. Ken-ichi Arai, director of the University of Tokyo's Institute of Medical Science, says the ministry's plans are well intentioned and that the drug-approval process in Japan certainly needs to be reformed. But he worries that the differences between investigator-initiated basic research and the work done to develop a drug are being blurred and that the plan doesn't address the conflict of interest inherent in having the ministry both promote drug development and judge the efficacy and safety of the drugs that ultimately result from those funds. "The player and the judge should be separated," he says.

A ministry spokesperson says that talks with industry and researchers are continuing, with the target being a concrete proposal by this summer for next year's budget.

–D.N.