# Tackling R&D Stagnation

*The United States trails major trade competitors in the share of its economy devoted to civilian industrial research*

By JANET RALOFF

Although the United States spends considerably more than any other nation on science and engineering, its preeminence in civilian industrial science and technology "can no longer be taken for granted," a major new study warns. Indeed, its authors report, the more they analyzed recent investment trends and productivity indicators, the more "strongly and repeatedly" one major conclusion emerged: America's "once strong across-the-board [industrial R&D] position of a decade ago has deteriorated substantially."

What makes that finding so troubling, notes this Aug. 12 report by the National Science Board, the presidentially appointed policymaking body for the National Science Foundation (NSF), is that the decline is rooted in the sector that drives most American research — the one whose efforts are most closely tied to the economy.

Industry conducts about 71 percent of all U.S. R&D — programs collectively valued last year at about $107 billion. About $30.6 billion of that is supplied by the federal government.

NSF surveys have documented a recent slowdown in total spending on industrial R&D — from an average annual growth rate of 7.5 percent (in constant 1987 dollars) during the first half of the 1980s, to just 0.4 percent annually between 1985 and 1991. Because all major R&D-performing U.S. industries contributed to this slowdown, the Science Board decided to investigate the trend and its implications for U.S. technological competitiveness.

The "grim picture" it now paints shows that at the same time American industry has come to depend increasingly on technology, this segment of the economy has been investing less in science and technology. U.S. companies have also become less willing than most abroad to wait for the long-term payoffs of R&D, notes Roland W. Schmitt, president of Rensselaer Polytechnic Institute in Troy, N.Y., and a co-chair of the Science Board committee that produced the new report.

Indeed, he says, in the early to mid 1970s, Japan, West Germany, France, the United Kingdom, Italy, and Sweden collectively spent about as much on civilian R&D as the United States did. "Today," he notes, "they're spending about 34 percent more." And when the Science Board compared those investments as a percentage of each country's economy, it found that Japan and Germany today spend about 50 percent more of their gross domestic product (3 percent) on civilian R&D than the United States does (1.9 percent).

Overall, the Science Board concludes, "the United States is spending too little [on industrial R&D], not allocating it well, and not utilizing it effectively."

In fact, Schmitt says, the new study's major contribution may be its demonstration that because "there is no single big thing that's gone wrong — but a lot of things — there is no one magic bullet that will fix things."

Not only has U.S. industry recently lost its lead in several fields critical to its competitive position in world trade — including semiconductor production, consumer electronics, and construction — but it "is weak or losing competitive strength in others," the report notes.

To reverse that trend, the Science Board believes, U.S. industries must focus on improving industrial processes. For every yen Japanese companies spend on product innovation, they invest two yen on speeding and lowering the costs of production technologies, the new report notes. Among the U.S. manufacturing firms and their subsidiaries surveyed by the NSF each year, four times as much money goes for product R&D as for process R&D, according to research conducted last year by Marie-Louise Caravatti, a consulting economist in Washington, D.C.

Japan's heavy emphasis on process improvements "is thought to be one of the reasons why it is more competitive," Caravatti told SCIENCE NEWS: It allows the Japanese "to get their products to market faster and at the lowest price."

Consider video cassette recorders (VCRs). While the United States pioneered this technology, "it couldn't figure out how to turn it into a product," she notes. Through *process* innovations the Japanese developed such a product, quickly cornering the world market.

U.S. companies frequently "fall short of their foreign competitors by being slow to digest and respond to market information and by missing crucial opportunities to be first on the market with low-cost, high-quality products," the Science Board report says. It cites one study, for instance, indicating that compared to U.S. automakers, Japanese companies require on average just half the engineering hours and two-thirds the time overall to transform a new concept into vehicles on the showroom floor.

A number of new initiatives aim to reinvigorate process R&D within U.S. industries. As with SEMATECH, a consortium of U.S. semiconductor manufacturers created in 1987 (SN: 2/21/87, p.117), a driving motivation for the new U.S. Consortium on Advanced Biosensors, organized last month, was the participants' interest in improving manufacturing processes. A federal interagency program to begin later this year also will emphasize production innovation — not only in its title, Advanced Materials and Processing, but also in its activities.

But if U.S. companies hope to make effective use of process R&D, they will have to adopt many other changes as well, Caravatti asserts in a commentary published in the September/October issue of RESEARCH-TECHNOLOGY MANAGEMENT. Among those changes: "more interdisciplinary teamwork, more feedback between the research department and customers, and — equally important — [more communication] between managers and those on the shop floor." Such close ties — "common in Japan, but not in the U.S." — enhance productivity and efficiency, she says.

The Science Board also asked some of the nation's largest industrial companies to rate a variety of business factors on their relative contribution

to the eroding U.S. lead in technology. That survey, conducted jointly by the Board and the Washington, D.C.-based Industrial Research Institute (IRI), polled 139 IRI members – all R&D directors.

The respondents laid primary blame for the changing R&D picture on their general management practices – such as "short time horizons" in planning, "management by the numbers," an inability to integrate technology into business strategies, and their corporate executives' lack of technical insight and experience. The surveyed officials also ranked "external financial pressures" high. In particular, many noted a concern about having to maximize the apparent value of their companies – often at the expense of long-term investments in R&D – to satisfy institutional investors, such as mutual funds and pension funds.

"Capital Choices," a more detailed analysis of U.S. business released in June, traces some of those practices to the changing source of investment capital.

*New laser-sintering process reduced from three months to just 40 hours the time to make this wax pattern (green) and mold (metal) for a prototype engine rotor. The innovation, developed by DTM Inc. of Austin, Texas, epitomizes the process R&D that many analysts believe U.S. firms should invest in more.*

DTM

This two-year study was conducted jointly by the Harvard Business School and the Council on Competitiveness, an independent, Washington, D.C.-based coalition of chief executives from business, higher education, and organized labor.

It pointed out that in Japan and Germany – the United States' primary technological competitors – a company's dominant investors "are virtually permanent owners who seek long-term appreciation" of the firm's value. U.S. companies possessing a similar ownership structure also tend to "achieve superior results," the study found.

But among stock-issuing U.S. companies, institutional investors "have increased their holdings from 8 percent of total equity in 1950 to almost 60 percent in 1990." Not only do these shareholders fail to pay detailed attention to the hundreds of companies in which each invests, the report says, but "they seek near-term appreciation of their shares, holding stock for an average of only 1.9 years."

To make themselves more attractive to such powerful institutional sources of capital over the past 20 years, publicly traded companies have focused their investments on increasing tangible assets – such as new factories – at the expense of R&D, employee training, and other harder-to-value "soft" investments, the Harvard/Council on Competitiveness study found. However, it notes, "these 'softer' investments are of growing importance" and must be supported if U.S. companies hope to remain competitive in world markets.

Such findings "lead to significant apprehension about the present trajectory of U.S. industrial R&D," Schmitt says, "and to the conclusion that stronger federal leadership is needed in setting the course for U.S. technological competitiveness." Toward this end, his committee offers a number of concrete recommendations.

For instance, NSF may want to broaden its traditional focus – basic research and science education – to include programs aimed at the training of corporate leaders, the Science Board said. Acknowledging that federal research agencies traditionally have exerted little, if any, influence on the management of U.S. companies, the new report suggests "it may be time to reexamine this traditional isolation from business."

Along these lines, Schmitt's committee suggested that NSF consider helping develop new curricula for business and engineering schools – instructional materials aimed at providing students "with a better understanding of the R&D process and the importance of skillful technology planning and management to commercial success." The new report also recommends increasing support for research and education programs that emphasize production-systems engineering and the integration of product design and manufacturing.

While the Science Board notes that such initiatives might be coordinated through NSF's new Management of Technology Program, that program currently exists in name only.

The new report also recommends:

- establishing a permanent R&D tax credit for U.S. companies,
- eliminating a Treasury Department regulation (1.861-8) that can provide tax benefits to some U.S. corporations when they move some of their R&D outside the United States,
- expanding NSF's Engineering Research Centers Program, the Commerce Department's Advanced Technology Program, and its Manufacturing Technology Centers Program,
- disseminating new research findings among researchers and industry on such issues as the development of new engineering and science indicators, the management of technological change, and the links between technology transfer and industrial competitiveness,
- expanding support for fundamental engineering research, and
- identifying new near- and long-term R&D objectives through the Critical Technologies Institute, a federally funded think tank created on Aug. 13. Operated by the RAND Corporation's Washington, D.C. office, the institute is expected to receive $9.4 million over the next three years to assess issues related to the competitive status of specific industries – starting with machine tools.

Many of these recommendations would boost federal spending. Where will this money come from in an era of budget deficits, growing trade imbalances, and escalating joblessness? Perhaps from the Defense Department budget, suggests Rep. George E. Brown Jr. (D-Calif.).

Under the Budget Agreement of 1990, Congress divided its fiscal responsibilities into three accounts: defense, foreign aid, and domestic discretionary spending. "There can be no transfer of funds between these budget categories until that budget agreement expires – which is next year," Brown says. So any "peace dividend" – savings in defense spending attributable to the breakup of the former Soviet Union – can't be used for civilian programs until Oct. 1, 1993.

Currently, about 60 percent of all federal R&D spending goes for defense programs, notes Brown, who chairs the House Committee on Science, Space, and Technology. "But you get a bigger payoff, in terms of economic growth, from civilian R&D [than from defense]," he says. As Congress begins paring down Defense spending next year, he says, "I've laid the case for moving money from military R&D accounts into civilian R&D. So the total amount of R&D would remain about the same, but the proportion going to the military would change."

What kind of change does he envision? "It ought to get back to 50:50," he told SCIENCE NEWS – "what I call historical levels" for the post World War II era. Based on this year's budget proposal (SN: 2/8/92, p.86), that might free up more than $7 billion, much of which could be directed toward industry programs. "And then if we find we really are in a world that is less threatening from a military standpoint," he said, "we might even consider going back to spending 40 percent on military, 60 percent on civilian R&D."

However, he also proposes plowing much of that peace dividend into "leveraged" programs – more 50:50 partnerships with the private sector. Says Brown, "We'll essentially tell various industries: You need to do more R&D – we'll pay half if you'll increase your spending." □