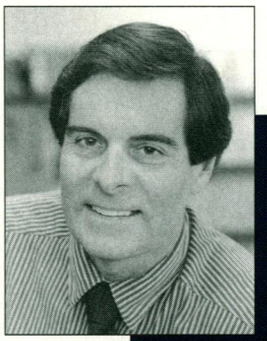
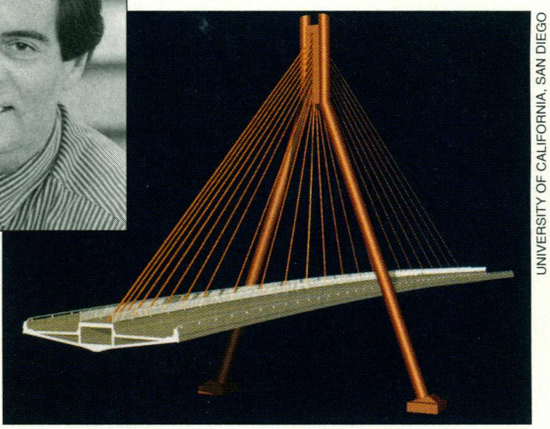
Defense Conversion Comes to Campus

A surge in federal funding for industry-led research collaborations presents a growing opportunity for academic scientists. But the programs aren't for everyone

For more than two decades, Gilbert Hegemier has been touting an idea he believes could prevent the kind of damage that was inflicted on Los Angeles freeways by the recent Northridge earthquake. Build bridges with advanced composite materials developed by the aerospace industry, Hegemier argues, and you will reduce their weight by a factor of 10—light enough for them to escape damage in even a major quake. But until now, Hegemier, a professor of structural engineering at the University of California (UC), San Diego, has never had enough money to test his ideas fully. His fortunes changed, however, when the Cold War ended and the Clinton Administration began to invest heavily in efforts to put defense technology to civilian use.

Last fall, UC San Diego received a $10.5 million, 18-month award from a new Defense Department initiative called the Technology Reinvestment Program (TRP). The university is the lead institution in a consortium that includes two universities (the University of Delaware is the other) and three companies that are trying to develop knowledge, tools, and techniques for building bridges and elevated highways from advanced composite materials.

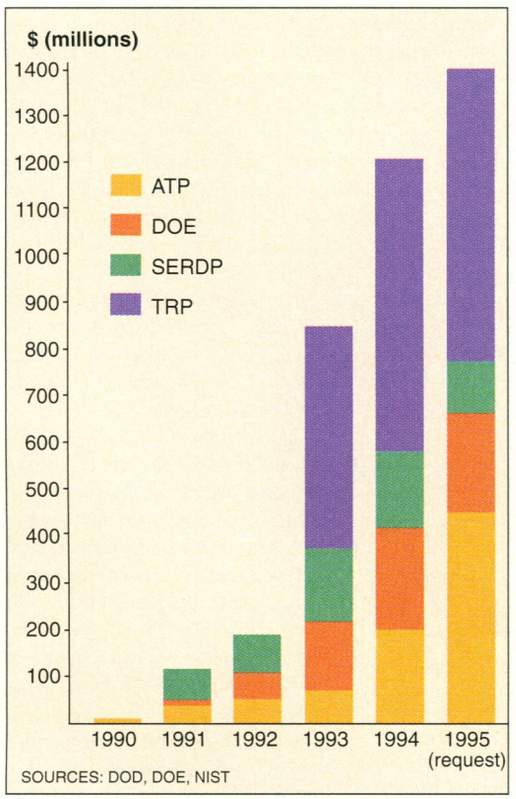




UNIVERSITY OF CALIFORNIA, SAN DIEGO

Bridge builder. Gilbert Hegemier has a TRP grant to develop an earthquake-proof composite bridge.

The TRP award is a downpayment on what is expected to be a 5-year, $63 million project. When it's finished, Hegemier hopes to be ready to build a 600-foot bridge spanning Interstate 5 to unite two parts of the San Diego campus. "The defense industry has known about the technology for years, but when times were good [the Reagan-era defense buildup] you couldn't get their attention," says Hegemier. "Now that times are tough, a lot of companies are suddenly very interested in building composite bridges for the civilian sector."



Scaling up. Initiatives like the Technology Reinvestment Program (TRP), the Advanced Technology Program (ATP), the Strategic Environmental Research Defense Program (SERDP) and the Energy Department's technology transfer fund are providing university researchers a new source of funding.

Hegemier's project is the beneficiary of a growing stream of research funds flowing to university campuses from new federal programs designed to fund industry-led projects. "This is the future for more and more universities—multiagency federal collaborations with industry participation," says mechanical engineering professor Bruce Kramer of George Washington University, who recently ran a small industrial research program at the National Science Foundation (NSF).

Most of the new programs, which require participants to match or exceed the government's contribution, are aimed at transferring defense technology to the civilian sector or developing new technologies to increase U.S. industrial competitiveness. University researchers are finding that the programs also offer the kinds of large-scale funding and resources that once were beyond their reach. "It never could have been done piecemeal," says Hegemier about the inability of other agencies that have funded his work to support his bridge project. "You need enough money and people to cover all the bases at once—materials, designs, databases, standards, and so on."

The participation of academic researchers in these collaborations comes at a price, however. Because companies are helping foot the bill, the projects are largely designed by industry with industrial, not academic, objectives in mind. As a result, they're much more applied than many previous collaborations in which industry was more interested in tapping into academic brain power than in finding a marketable product.

Lee Buchanan, a plasma physicist at the Defense Department's Advanced Research Projects Agency (ARPA) who manages TRP, and his counterparts at other agencies emphasize that this new breed of program gives industry the lead in choosing topics and setting targets. This makes jobs and potential products more important considerations than publications and Ph.D. theses. "These projects are industry-led and industry-financed," says George Uriano, who manages the National Institute of Standards and Technology's (NIST) Advanced Technology Program (ATP). "The purpose of the program is to stimulate economic growth within industry. It's not to support basic research."

A wealth of opportunities

For universities willing to fit themselves into this kind of structure, the new programs are the fastest-growing source of federal research funds. The combined funding of four of these programs has grown from just $10

DOE Extends a Virtual Hand to Computer Industry

The Clinton Administration's latest foray into industrial research—a cooperative agreement with the U.S. semiconductor industry to build a new research center—might be called a groundbreaking venture that won't require much literal ground to be broken. Instead of existing in three dimensions, the new structure will occupy prime space in virtual reality.

Earlier this month, Energy Secretary Hazel O'Leary unveiled a plan to create a center to design, model, and simulate the integrated circuits, materials, and devices U.S. semiconductor makers will need to remain competitive over the next decade. But while O'Leary mentioned a $100 million center located "somewhere out West," the center will exist mostly on paper, and its research will be carried out by scientists already employed at the Department of Energy (DOE)'s three nuclear weapons laboratories and at universities around the country. "We're really talking about a virtual center, with a computer network that ties everybody together," says Sig Hecker, director of Los Alamos National Laboratory, which has led DOE's effort in this area. "It may look like one location to industry, but it won't be something that's going to take a lot of construction."

In addition to heavy reliance on data superhighways—a favorite topic of Vice President Al Gore, who spoke at a press briefing on the project—the collaboration incorporates two other key elements of the Clinton Administration's approach to technology-based research initiatives: Reallocate existing funds and move technologies from defense to civilian use. Hecker says those designing weapons at Los Alamos, Lawrence Livermore, and Sandia national labs "can easily shift" into simulating and modeling the latest designs for faster, smaller, and cheaper chips for civilian products. "The uses may be different," he says, "but there's a big overlap in the skills people possess."

The center is part of a plan to ensure the long-term health of the U.S. semiconductor industry. In 1987 the government joined with industry to form Sematech, a research center aimed at improving manufacturing quality. That collaboration is credited with helping U.S. industry regain global leadership over Japan in sales of computer chips—a market dominated by U.S. companies until the mid-1980s. The new center, according to industry and government officials, is intended to provide the research underpinnings for a range of new technologies for the products of the 21st century.

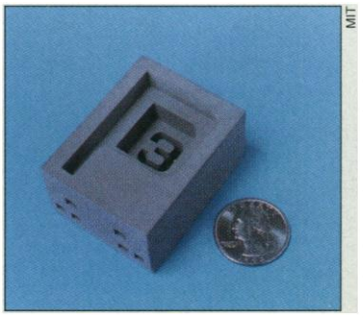
The government's contribution to the center will come from a $215 million account set aside for cooperative agreements (known as CRADAs) between industry and the national labs. The semiconductor industry will funnel its share through the 12-year-old Semiconductor Research Corp., which spends about $35 million a year on university research, including half a dozen centers of excellence. DOE officials expect to spend about $5 million on the center in the fiscal year that begins on 1 October, but they say many details remain to be worked out. They also emphasize that the activity requires reshuffling existing funds. "If you're talking about new money, there isn't any in the DOE budget," says O'Leary. "We're just trying to make the best possible use of what we have."

–J.M.

million in 1990 to an estimated $1.4 billion in the president's 1995 budget (see chart). Take TRP, Hegemier's fairy godmother. The biggest and newest example of this class of programs, TRP is funded by ARPA and managed by ARPA and five other agencies. Last fall, Congress gave the program $475 million; Pentagon officials recently transferred another $150 million to it for the current fiscal year. The Clinton Administration hopes to follow that up with another $625 million for fiscal year 1995, which begins on 1 October. University researchers are participating in about 20% of the more than 200 projects funded to date.

And TRP is not the only game in town. NIST will award $200 million this year under its ATP. This effort, which began with $10 million in 1990, is a favorite of the Clinton Administration, which has requested $450 million for it in 1995 and has promised to expand it to $750 million by 1997. University researchers are also eligible to share in a pot of money from the Department of Energy (DOE), amounting to $218 million this year, for researchers at its national laboratories to spend on cooperative research that is relevant to industry (see box). And ARPA will award $160 million in 1994 through the Strategic Environmental Research Defense Program (SERDP), which Congress created in 1991 to use military assets as part of academic and commercial research projects aimed at preserving and cleaning up the environment (*Science*, 3 September 1993, p. 1250). SERDP doesn't even require collaboration with industry, says its director, Robert Oswald of the Army Corps of Engineers, although projects must fit the mission of the three participating agencies—defense, energy, and environmental protection—and complement work going on at one of their laboratories.

These programs represent a new funding opportunity for academic researchers at a time when competition for federal dollars is fiercer than ever and there is dwindling support for big increases for basic research. "Those who are waiting for the past to return are missing the boat," says Kramer.



Printed parts. MIT leads a TRP-funded team developing printed stainless steel molds.

Not for everyone

Of course, not every academic researcher should want this kind of support. "Universities have a tendency to go after whatever sources of money exist, and some are willing to twist themselves into knots to fit the requirements," says TRP's Buchanan. "What they should do instead is ask themselves, 'Do I want to be closely allied with industry?' If so, then TRP is for them. But if the answer is no, they need to make a no-bid decision and stick to it."

In mulling over the decision, Kramer argues, universities should be aware of the potential threats to their own traditions and culture. "Universities don't want merely to provide low-cost manpower for industry," he says about possible collaborations that enlist university facilities and faculty solely to help a company do work that it could not perform in its corporate labs. "At the same time," he adds, "university scientists need to go beyond publishing papers." That latter point isn't always understood, says James MacBain, a technology transfer officer at the University of Michigan who has helped engineering faculty win three multimillion-dollar ATP projects. "I have to convince professors that the world doesn't love them because they do good research," he says.

For those already in tune with the needs of industry, however, like the Massachusetts Institute of Technology's Emanuel Sachs, a TRP or an ATP grant is simply the next logical step. In 1989 Sachs, an associate pro-

fessor of mechanical engineering, received a 3-year, $800,000 NSF grant that offered him the carrot of more money than the usual NSF grant and the stick of having to produce, within 3 years, something of potential value to industry. Kramer, who ran the NSF program (called STRATMAN, for the Strategic Manufacturing Initiative) before returning to George Washington University last winter, was intrigued by Sachs' vision of making ceramic parts layer by layer in hours via computer, rather than months by hand. The idea, based on the technology used by ink-jet printers, has immediate applications for injection molding dies, as well as the potential to fundamentally alter machine-tool manufacturing. The STRATMAN grant, renewed in 1992, convinced 11 companies to sign on, and Sachs drew from that group to seek funding from TRP. Last fall, the program came through with a $3.1 million grant to a consortium consisting of Sachs' team and seven companies to scale up the process.

That preparation was an essential ingredient in his success, he believes. "Starting from scratch would have been impossible," he says, "because the 2 to 3 years it would take to come up with a physical product just wouldn't cut it for TRP. Now we're able to put parts into people's hands almost immediately, and we can offer a combination of tantalizing near-term results and the long-term prospect of changing the way people do business."

As these programs grow in popularity, some academic scientists have questioned whether the work meets the high standards set by agencies that traditionally fund the bulk of university research. Not to worry, says C. Grant Willson, a professor of chemistry and chemical engineering at the University of Texas, Austin, and principal investigator of two ATP grants while an IBM fellow at the Almaden Research Center and manager of its division of polymer science research. "The review that I went through was more rigorous than any I've seen," says Willson, who has received funding and reviewed grant proposals from NSF, ARPA, and other federal agencies.

It is too soon to know whether programs like TRP and ATP can live up to that kind of enthusiasm and give U.S. industry the high-tech shot in the arm the Clinton Administration expects from them. (Ironically, Willson left IBM last fall after 17 years, disheartened by what he characterizes as the company's increasing emphasis on short-term software products over long-term research.) But it is not too early to recognize that they represent a golden opportunity to help academic scientists with ideas that might make a difference in the marketplace.

–Jeffrey Mervis

NATIONAL INSTITUTES OF HEALTH

Report Calls for Smaller Clinical Center

The Clinical Center at the National Institutes of Health (NIH)—the world's largest research hospital—is twice as big as it needs to be, a panel of scientists examining NIH's $1 billion intramural research program has concluded. NIH officials have long been arguing for funds to replace the 42-year-old hospital, which now has a capacity of 500 beds. A new Clinical Center is expected to cost about $1.5 billion.

The recommendation to reduce the size of the Clinical Center, *Science* has learned, is a key feature of a draft report by an external advisory group scheduled to be made public next month. The report is part of a far-ranging review of NIH's intramural program that Congress requested last summer. Specifically, the House subcommittee that funds NIH questioned whether the division of labor between the intramural program—which receives 11% of NIH's budget and funds research at 24 institutes, centers, and divisions—and the extramural program that supports investigators across the country was "well thought out." The legislators instructed the NIH director to review the role, size, and cost of the intramural program as "a central part" of the 1995 budget process. A report from an internal NIH fact-finding committee preceded the work of the external advisers.

RICK KOZAK

Vital signs. Varmus must heal an ailing hospital.

Testifying on 17 March before the Senate appropriations subcommittee that funds NIH, NIH Director Harold Varmus said he was still reviewing the outside panel's report, which he described as "address[ing] a number of concerns about maintaining the vitality of the intramural program through recruitment, training, and evaluation processes." He said the Clinical Center "is in a state of increasing decay and should be rejuvenated."

In addition to being the hub of the intramural program, the Clinical Center became a focus of the report because it's "a big-ticket item," says Michael Gottesman, acting deputy NIH director for intramural research and cochair of the intramural fact-finding committee. And the panel's conclusion that NIH no longer required a hospital with a capacity of 500 beds, says Gottesman, acknowledges significant changes over the years in clinical medicine. "We don't need a fixed number of beds nearly as high as in the past," he says. The center's occupancy rate for fiscal year 1993 was 53%.

Gottesman says the occupancy rate is low in part because the center, like other hospitals, has been putting more emphasis on outpatient care as a way to reduce costs. Over the years, lab work also has replaced many studies that once required human subjects, suggests William Kelley, dean of the medical school at the University of Pennsylvania and an NIH alumnus. But Kelley cautions that the tide is turning toward clinical research again, as results from the human genome project and advances in molecular biology are leading to a "tremendous explosion" of new experimental drugs and biologicals.

NIH officials have been trying for years to convince Congress of the need for a new facility to replace the aging Clinical Center complex, which houses the hospital and about 40% of the research labs at NIH's Bethesda campus. "The Clinical Center Complex is in serious need of major corrective action to resolve its facilities' deficiencies," the U.S. Army Corps of Engineers concluded in a 1991 report spelling out how the utility systems have "deteriorated beyond reasonable repair" and "violate codes and regulations."

Although the intramural fact-finding committee noted that the price tag for a new facility is steep—between $1.4 billion and $1.6 billion—it argued in a report to the external advisers that there is no good alternative. "If you were to renovate the building, you'd end up with a state-of-the-art 1952 building," says Gottesman. "I'm not sure our modern hospital should be based on a 1952 building." Although a smaller hospital, perhaps with only 250 beds, would certainly be less expensive to operate, Gottesman says it would not be that much cheaper to build than one with twice the capacity.

The report of the panel—cochaired by Paul Marx of Memorial Sloan-Kettering Cancer Center and Gail Cassell of the University of Alabama at Birmingham, is expected to be released in early April. Varmus has promised to discuss its details during a round of hearings later in the month before the House appropriations committee that requested the review.

–Jon Cohen

With reporting by Robert Service.