

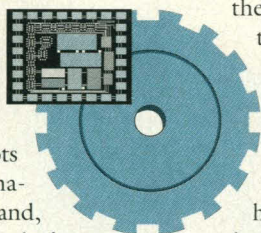
U.S. Technology Strategy Emerges

After a decade of debate, the federal government has begun to invest in new civilian technologies; skeptics say the gesture is just a "spit in the ocean"

ON 17 MAY GEORGE SUTHERLAND plans to throw open the doors of the Great Lakes Manufacturing Technology Center in Cleveland to show off the \$5 million worth of robots and exotic metal-working machines he has acquired. Sutherland, a Ph.D. mechanical engineer, isn't the proud manager of a high-tech auto plant or a steel factory that will save Ohio. What he does operate is a nonprofit industrial research center. It produces nothing tangible but, rather, aims to educate small manufacturers—basically "people who make things out of metal," says Sutherland—in the use of advanced, computerized machine tools and efficient management techniques. The Great Lakes Center, located at an interstate crossroads, has a national as well as a local mission. It uses workshops, symposia, even site visits—and, of course, fancy machines—to help local companies turn themselves into 21st-century operations. Its objective is to make U.S. industry more competitive, in other words.

What makes Sutherland's place particularly unusual is that, in addition to receiving support from the state and more than 100 local companies, it gets help from the feds. During most of the 1980s, the Reagan Administration blocked attempts to use federal money to give U.S. industry a boost. The guiding philosophy was to fund basic research and shun applied research—or to put it another way, to leave product development entirely to the private sector. Indeed, the idea of pumping money into promising new technologies was tagged "industrial policy" and the idea was treated as anathema in the Executive Branch—something to be expected in Romania or Bulgaria but not in the American heartland. And this is why the decision by the U.S. Department of Commerce to support George Sutherland's shop—and four other regional centers—is radically new.

Until very recently, the Bush Administration toed the Reagan-hatched ideological line on supporting industrial technology. But of late there have been three signs that it is softening its stance. Those who read the tea leaves on federal research policy point to



these recent developments as indicators that a new attitude is emerging from the Administration. The first is a statement on technology policy quietly put out by the White House last fall. On its face, it seemed almost too subtle; but it had a section that many feel was cleverly negotiated into the document by presidential science adviser D. Allan Bromley: In black and white, it says that the federal government should help develop generic industrial technologies.

The second signal of a sea change is that, after more than 2 years of congressional pressure, the Administration is finally willing to put some money—albeit piddling amounts so far—into technology development programs in the Commerce Department—not only the five regional centers, but also directly into products being developed for the commercial market.

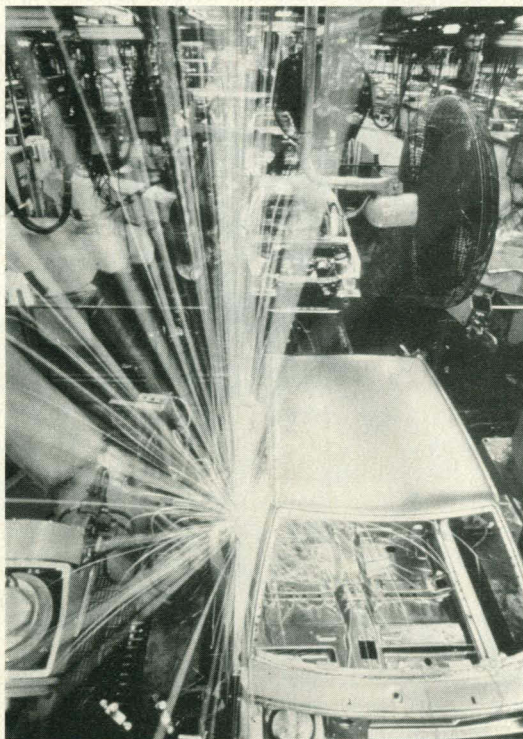
And third, there's a still nascent but promising new policy thrust: The development of a list of critical technologies for the

economy being developed by the White House Office of Science and Technology Policy (OSTP) at the urging of Congress. The list is expected to help guide future government investments.

Yet these modest steps have been controversial within the Administration, and key White House officials, including Chief of Staff John Sununu and budget director Richard Darman, are said to be reluctant to see industrial research programs expand too rapidly. Moreover, some critics think that while the Administration is beginning to become more generous in supporting industrial technologies in civilian agencies, it is cutting back on the same kind of projects funded by the Pentagon (see box, p. 22). Throughout the Reagan era, the Pentagon was the only federal agency that invested directly in industry in this way. And even for those who believe they see a thaw in the rigid laissez-faire stance, the melting seems too slow. For example, Guyford Stever, former director of the National Science Foundation (NSF), would like to see the

government directly finance civil R&D projects, but says that "we are far from having a coherent technology policy in this country."

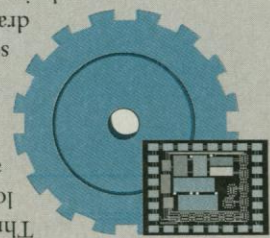
Nevertheless, the Administration's recent statements are prompting cautious optimism among some of the harshest critics of the previous doing-nothing approach. Robert White, president of the National Academy of Engineering (NAE), who in a widely quoted 1988 speech blasted ideological "hangups" that have prevented the establishment of a "workable technology structure in the federal government," now sees "good forward motion" in the Administration. "You've got to start someplace," he says, and recent policy statements represent "a beginning." Still, he adds, "I would not say we had reached a consensus" yet on the need for bold federal action. Another advocate of federal intervention, Representative George Brown, Jr. (D-CA), gave an optimistic reading in a speech to the Semiconductor Research Corporation on 26



Robots to the rescue. Does U.S. industry need Uncle Sam's help to compete in high technology?

NIST: High Command for Industrial Research?

Three years ago, when Congress was looking for a way to do something big and dramatic to remedy a perceived failure of leadership in U.S. manufacturing, it decided to create a new R&D command post for the civilian sector. At first glance, the agency drafted for the role seems an unlikely choice. Created 90 years ago during the presidency of Teddy Roosevelt as a technical arbiter for the electrical industry and known for 88 years as the National Bureau of Standards, the National Institute of Standards and Technology (NIST) got a new name and a new mission in 1988. The mission: to coordinate policy on industrial technology and stimulate innovation in the private sector.



NIST got its facelift partly by default. A few members of Congress led by Senator John Glenn (D-OH) wanted to create an agency that would do for civilian manufacturing what the Defense Advanced Research Projects Agency (DARPA) had been doing for the military (see page 22). While DARPA spends about \$1 billion a year backing new technologies—such as high-speed computer chips, lasers, and manufacturing processes—military applications are favored. So Glenn campaigned for a “civilian DARPA” with a budget of several hundred million dollars. Then the chairman of the Commerce Committee, Senator Ernest Hollings (D-SC), had a different idea. Favoring a more cautious approach, he argued that it would be better to entrust the new mission to the well-established bureaucracy at the National Bureau of Standards, which was already on good terms with industry. Hollings prevailed.

The result is NIST, which in its honeymoon period today enjoys both the trust of industry and the enthusiastic support of Congress. When NIST’s director, John Lyons, and his boss, Robert White, undersecretary of commerce for technology, made the usual rounds to the funding hearings on Capitol Hill this year, they were showered with praise. The House has even created a new tailor-made panel called the subcommittee on technology and competitiveness, chaired by Representative Tim Valentine (D-NC), to oversee the agency. Even the Administration has shown interest. In the last budget cycle, it proposed to increase NIST’s budget 15% in 1992, from \$215 million to \$248 million, putting it on a 5-year doubling track.

Lyons says this will bring welcome relief to NIST staff scientists after 15 years of drought during which funding was “essentially flat.” The increase will make it possible to expand intramural R&D—making self-correcting industrial robots, for example, and standardizing manufacturing software so that electronic blueprints may be transferred from one shop to another. But NIST’s extra-mural awards are even more interesting to Congress (and to many scientists knowledgeable about inside-the-beltway funding shifts). Take the new Advanced Technology Program (ATP).

ATP was created in 1988 to help finance private R&D projects working on “generic technologies” that NIST believes will have a dramatic and lasting impact on the U.S. economy. The program marks a significant new step for the federal government, the million in total, were announced on 5 March. Though small, the broad value for the nation. The first ATP awards, providing \$9 million in total, were announced on 5 March. Though small, the program marks a significant new step for the federal government, which for a decade has resisted Japanese-style investments in technology development.

Lyons says the initial ATP budget of \$10 million was provided by Congress in 1990 “before the Administration asked for it.” Then in 1991, Congress increased the figure to \$36 million, and now the Administration has followed suit by seeking the same amount in 1992. Congress, which is dragging a reluctant Administration down this path, will probably raise the ante again this year.

The ATP awards also seem popular in the private sector. Lyons says NIST was swamped with 250 applicants last fall, leading to a 22-to-1 rejection rate. “We got to choose the cream of the cream,” he says. When asked how NIST intends to avoid political or pork-barrel pressures in selecting winners, Lyons points to an elaborate three-stage review process that is meant to fence politics out. First, grant applicants must survive a rigorous federal procurement review; then they submit to a technical inspection by NIST’s staff, and finally they must get the approval of a blue-ribbon panel of business advisers—like no other advisory board in government, says Lyons—which decides whether the projects look like good bets. Lyons approves the final selections.

Among the 11 ATP winners this year were many who hope to produce goods for the computer and communications industries. For example, the Microelectronics and Computer Technology Corp. of Austin, Texas, won \$823,000 to coordinate a group of companies interested in manufacturing a revolutionary data storage system. Unlike the magnetic tapes and disks now in use, this gadget would require no motor. It would use an electronically steered light beam to store entire data “pages” of digital imagery on photorefractive crystals. With NIST’s grant, the inventors hope to build a prototype crystal array capable of storing 2 gigabits of data and operating 100 to 1,000 times faster than present machines.

Implicit in the new assignment Congress has given NIST is the expectation that great results will follow. And that raises a concern. There’s always a risk that with all the emphasis on ATP awards and technology centers, “we could end up with the tail wagging the dog” at NIST, says one White House staffer who works on technology issues. He echoed a common concern that NIST could become so swept up in its popular role that it neglects its old, less glamorous, but essential work on standards. But Lyons says this is not about to happen. If anything, the traditional research projects will do better than before, he argues, because they will benefit from the additional prestige. ■ E.M.



John Lyons

February. Brown said that for almost 50 years “we have been imprinted with a national security mentality in interpreting the federal role for technology,” but now that attitude is changing. After a decade of indecision, he said, leaders have finally decided that “commercial technology development can no longer be a stepchild of the defense structure.” Former NSF director Brich Bloch endorsed a more aggressive policy when he appeared before Congress on 20 March to deliver a report prepared by the Council on Competitiveness, a nonprofit group for which he consults. The Administration has made an “admirable start” on promoting better manufacturing methods, Bloch said, but “a more decisive” shift away from military R&D and toward civilian

In reality, Bloch's audience had already taken this advice to heart, for it was Congress that led the way in founding what is now being called the Administration's "technology policy." Congress's initial step, taken in 1988, was to pass the Omnibus Trade and Competitiveness Act, giving the

Commerce Department authority over civilian technology and renaming its former Bureau of Standards the National Institute of Standards and Technology (NIST). The same law gave NIST a new portfolio: It was to oversee joint government-industry ventures in technology development and diffusion, including the establishment of educa-

The first hint that the Administration might be willing to sign on to this congressional initiative came on 7 March 1990, when President Bush, in a speech to the American Electronics Association, said that his Administration would cooperate with industry in converting new discoveries into

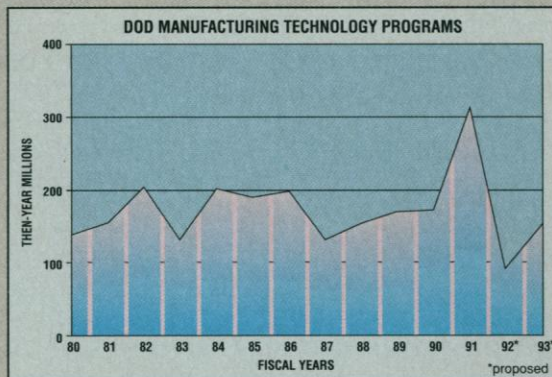
A large blue gear is the central graphic. In the top-left corner of the gear, there is a small inset showing a film strip. The film strip contains a black and white photograph of a film set with various pieces of equipment and a person.

These trends have some old hands, such as former Pentagon R&D chief Robert Costello, concerned that research funds are being dissipated on projects that may not provide the most benefit for the military or the economy. Costello, now a fellow at the Hudson Institute in Indianapolis, says he believes the military is "re-

Controversy over the Pentagon's role as a technology support agency is relatively new, although the military has been supporting "generic" technology for several decades. For example, DARPA, which sprang to life in 1958 as manager of space projects, evolved into a backer of all kinds of novel gadgetry, especially electronics, in the 1970s. DARPA's rationale was that by betting its mad money shrewdly, it could speed the growth of critical new innovations, giving an edge to U.S. consumer and military goods and keeping costs down. In recent years, for example, DARPA has been bankrolling joint efforts in partnership with industry in areas such as high-definition displays—a critical element in the development of high-definition television systems—and by supporting the development of high-speed chips, specialized lasers, computer networks, and infrared sensors.

gies likely to have both military and civilian applications. According to a report from the White House Office of Management and Budget in February, the federal government now spends \$1.3 billion on "advanced manufacturing and materials R&D," more than 40% of it in the defense budget. The most prominent of these defense programs is Sematech, a joint industry-government research center created in 1987 to focus on manufacturing processes for computer chips, costing the government \$100 million a year (see page 23). In addition, a department-wide program known as the Manufacturing Technology, or "Mantech," program has a budget of \$311.5 million this year to help improve technologies ranging from machine tools to automatic machinery for making military uniforms. Mantech's budget oscillated in the 1980s between \$130 million and around \$200 million (see chart).

Congress is behind much of this growth, in part because it has insisted on bankrolling specific projects. For example, members of Congress huddled with the Reagan Administration in the late 1980s and put a machine tool program called the National Center for Manufacturing Sciences into the Air Force Mantech budget. Soon other members began inserting targeted funding into the DARPA and Mantech budgets for such things as x-ray li-



This year, the Bush Administration has decided to attempt to reverse the trend. The president's 1992 budget proposal, says a congressional aide, has "gutted" DARPA and Mantech. The x-ray lithography projects, the machine tool funding, and many other high-technology initiatives have been stripped away. The total Mantech funding, for example, is supposed to drop from the present level of \$311.5 million to \$96.9 million next year.

While the White House hasn't specifically articulated its rationale for the moves, Pentagon officials have privately expressed resentment at the "earmarking" of funds by Congress and regard the growing support for industrial projects as a form of pork-barrel politics that must be stopped, particularly at a time when the overall military budget is shrinking. However, these budget cuts, and the decision to remove Fields from office a year ago, has DARPA's civilian fans—like Senator Jeff Bingaman (D-NM)—wondering how deep the Administration's commitment is to using the resources of the federal government to stimulate new technology. ■ E.M.

"generic technologies that support both our economic competitiveness and our national security." Until this point, it was acceptable to spend federal funds to develop military hardware, but not on technologies that lacked a national security link of some kind. But now the rigid prohibition of the 1980s is giving way to a more tolerant approach in the 1990s, as revealed in a blue booklet (labeled "U.S. Technology Policy") issued last fall by the White House (*Science*, 9 November 1990, p. 747). In it, Bromley wrote that one of the federal government's responsibilities is "to participate with the private sector in precompetitive research on generic, enabling technologies that have the potential to contribute to a broad range of government and commercial applications."

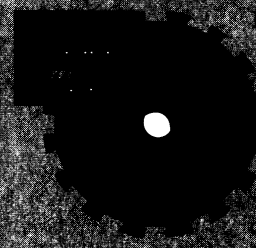
To many, the book still seemed thin on substance, but, to some, it had set a precedent. This, at any rate, is what Lewis Branscomb argues. Branscomb, now at the John F. Kennedy School of Government at Harvard University, has served on many White House advisory panels dealing with technology and was vice president and chief scientist at IBM from 1972 to 1986. He observed Bromley's negotiations with other, more skeptical White House officials and insists that getting the blue book published was a case of "masterful diplomacy." Because it has been endorsed by the White House, says Branscomb, "every agency that wants to fund industrial technology can quote this document as the justification for doing so."

To the doubters, cash carried more weight than a thin publication. The Great Lakes Center and four sister agencies in New York, South Carolina, Kansas, and Michigan have been allocated \$11 million this year—though on a base of local business support and state funding that was required to get the federal funds. The cash isn't an endless stream, though: After 6 years the agencies must become self-supporting.

The White House science office deserves credit for pushing a few other technology-boosting efforts through the mill this year. These include Bromley's inauguration of a multiagency drive to improve the speed and quality of U.S. computer technology, an effort that has been accorded a 30% budget increase (*Science*, 15 February, p. 737). In the future, Bromley intends to promote materials research and biotechnology.

In April, at the urging of Congress, OSTP is expected to unveil a list of 26 critical technologies for civilian and military purposes that it judges to be the most important to target for special attention. Then, in June, OSTP will announce the membership of a new Critical Technologies Institute, a quasi-governmental agency advocated by Senator Jeff Bingaman (D-NM) and created

Sematech: Techno-Policy in Action



In the mid-1980s, leaders of the U.S. semiconductor industry were getting nervous. The computer industry was stalled in recession and U.S. companies had virtually abandoned the market for the selling memory chips called DRAMs. Semiconductor industry leaders were quick to blame their problems on "predatory" trade practices by Japanese companies, and they loudly warned that the Japanese next planned to "target" dominant U.S. companies making more specialized chips. Their best hope for salvation, they said, was a helping hand from Uncle Sam.

Congress was listening. By mid-1987, legislators were drawing up plans for what has since become one of the more ambitious examples of direct federal support for civilian technology. Sematech, an affiliation of 14 major U.S. semiconductor manufacturers, was \$100 million a year from the Defense Advanced Research Projects Agency (DARPA) (member companies more than match the federal contribution, giving the entire program an annual budget of about \$125 million). Sematech is charged with leading a veritable revolution in chip manufacturing technology and industry relations.

Sematech is focused on the process of manufacturing, not its end result. Consequently, it has devoted much of its effort to beefing up the 130 or so American companies that supply most of the tools for processes such as photolithography, chemical etching, and molecular epitaxy. Sematech not only helps these generally small companies fund the development and testing of new equipment, it's also engaged in a wholesale attempt to alter cutthroat business practices by preaching the virtues of "partnerships" between suppliers and their customers.

Sematech has also been busy developing new manufacturing techniques itself. At a state-of-the-art fabrication line, which utilizes only equipment from U.S.-based suppliers, Sematech engineers and technicians from member companies work side-by-side to iron the kinks out of processing steps. Last fall, it turned out its first batch of chips with a resolution of 0.5 microns—an achievement Sematech officials say trumps them even with their Japanese competitors.

The gains from such activities are difficult to quantify. No Sematech members contacted by *Science* were willing to claim they'd increased their market share as a result of Sematech advances. But spokespersons for IBM, Digital Equipment, and Motorola practically radiate with enthusiasm over Sematech's progress. "There is a tremendous sense that Sematech is doing the right things," says Paul Bergevin, an IBM spokesman.

With federal funding scheduled to end in 1993, Sematech officials are busily drawing up plans to keep the DARPA money flowing. Federal participation has been essential to keeping the consortium together, they say. "I doubt very seriously...if the industry would ever have formed Sematech on its own," says Turner Hasty, Sematech's chief operating officer.

But there is a dark cloud on Sematech's horizon: the vulnerability of small suppliers to foreign takeovers. Despite anguished cries from Sematech officials, a federal judge last week refused to block the sale of Semi-Gas, a \$2.4 million Sematech-affiliated gas equipment manufacturer, to Nippon Seisak of Tokyo. Sematech CEO Bill Spencer says the case shows that "foreign firms are able to purchase U.S. technology at a bargain price." Unless the federal government acts to block such sales, however, more are probably inevitable—a prospect likely to make Sematech's most ardent admirers pale. ■ DAVID P. HAMILTON



Cutting edge: Sematech's \$100-million-a-year federal subsidy is paying off.

by an amendment to the defense authorization bill last fall. It will be run by a board chaired by Bromley and composed of other Cabinet representatives and leaders from industry and academia. According to William Phillips, associate director of OSTP, this institute will have \$5 million to spend over the next 2 years as it prepares "road maps"—or investment strategies—for each technology identified in the April document.

These steps, bolder than any taken by the Reagan Administration, are still viewed by the technology activists on Capitol Hill as extremely modest. And now that Bromley's office and even the Office of Management and Budget have opened the gate just a crack, those who advocate stronger action are likely to pour in and clamor for more funds. They clearly are not satisfied with what has been appropriated to date.

Supporting a handful of regional technology centers and spending \$36 million to help industry develop pathbreaking ideas, says Julie Fox Gorte, chief author of a 1990 study by the congressional Office of Technology Assessment, is just a "spit in the ocean." Even if the Administration were to let these parts of the NIST budget grow to \$100 million, she says, this would merely amount to "a pittance" in the context of what other nations are doing. Japanese efforts to promote industry are much better funded, she says, and the Europeans are now gearing up to support "hundreds" of technology development efforts under two schemes known as ESPRIT and EUREKA.

Fox Gorte's views have plenty of supporters on Capitol Hill: Each year since the creation of NIST, Congress has tried to increase the budget rapidly and the Administration has put on the brakes. The pattern is likely to continue as the Administration is expected to keep NIST's policy experiments on a short leash until they have proved their value. Nevertheless, Congress will keep pushing. Last year, for example, the House Science Committee tried to increase funding for NIST's technology awards program, authorizing \$250 million for 1992. The bill didn't pass, but Representative Brown, the committee's chairman, recently promised to try again this year.

The negotiations have just begun on where and in what quantity to invest federal dollars, and they could well become a regular feature of the budget dance, like the biomedical funding waltz, in which the White House and Congress each year start at a distance and make their way to middle ground. But the important change in technology policy is that the Administration is no longer starting at zero. And that, according to the optimists, makes all the difference. ■ **ELIOT MARSHALL**

Calmer Waters at Primate Institute?

Last fall New Mexico State University's (NMSU) unique primate research institute—one that could be crucial to the U.S. AIDS research effort—looked battered. It had lost its director and a new, prestigious AIDS research team in a falling out with the university administration. Suddenly endangered was an AIDS research resource of 100 chimpanzees, as many as one quarter of all the chimps available for AIDS research in the United States.

Six months later, prospects for the institute are either a whole lot brighter or still fraught with danger—depending on whom you listen to. To a group of researchers from the National Cancer Institute (NCI), the Food and Drug Administration, and the Centers for Disease Control, the worst may be over. A team from those three organizations visited the institute late last year, prompted in part by an article in *Science*. After inspecting the facilities and being briefed by high-level NMSU officials, the group's head, John Donovan of the NCI, concluded in a special statement provided to *Science* that: "Considering the nature and extent of problems," a "formidable effort" was under way by the university administration and the institute's management to make the institute a "national research resource." But the team also agreed, said Donovan, that "the next 6 to 12 months would be a critical time period" for assessing the institute's "ability to progress to a stable and smoothly functioning organization."

Meanwhile, the stream of resignations at the institute has continued. In January, Dave Rehnquist, a former NCI veterinarian who was universally respected at the institute, left his position as head of veterinary services. In February, Ron Couch, a toxicologist with some \$1 million worth of research grants, resigned to work for White Sands Research Center, a private primate-research operation in Alamogordo. And in April, Brenda Billhymer and the rest of her eight-person clinical chemistry group, which provided support for the institute's contract research, will also move to White Sands.

The resignations aren't likely to help the institute's new director, Preston Marx. Marx came to the institute last summer from the University of California at Davis to replace former director Bill Hobson, who had hoped to make the primate facility into an AIDS basic research lab of national stature. It was Hobson who lured virologist Mika Popovic from Robert Gallo's lab at the National Cancer Institute, along with a bevy of top talent. When Hobson was abruptly dismissed in December 1989, Popovic, his research group, and most of the rest of the institute's total of 15 Ph.D.s left one by one.

In interviews with the local press, Marx has reiterated optimism concerning the institute, which he maintains has the potential to be a great research facility of the kind Hobson envisioned. Marx has been struggling to fill the institute's many vacancies and has been working with the university to clean up accounting procedures, which had been a bone of contention with Hobson. Sources say he was particularly cheered by the recent hiring of Andrew Lachner, a pathologist and former colleague from the California Primate Research Center at UC Davis.

Marx also changed the institute's name from the Primate Research Institute to the New Mexico Regional Primate Research Laboratory (NMRPRL), a move he told the Alamogordo *Daily News* reflected the lab's position as a statewide resource—and had nothing to do with the bad press the lab got under its previous title. Marx himself is in Sierra Leone and could not be reached for comment. But many independent observers credit him with prodigious labors. Will they be sufficient?

The NCI team isn't the only one interested in the answer. Last week an advisory council appointed by the university administration met to review the institute's research activities. The council, chaired by Leonard Napolitano, dean of medicine at the University of New Mexico, includes Dani Bolognesi of Duke University Medical Center, Ronald Desrosiers of the New England Regional Primate Research Center, and Bill Goodwin, deputy director of the Southwest Foundation for Biomedical Research.

Napolitano told *Science* the advisory body thought "significant progress had been made in stabilizing the program." The institute seems to be "on its way to establishing programs in immunology and virology." But on the key question of whether PRL will ever house the kind of basic AIDS research group Bill Hobson intended, Napolitano responds: "I really can't answer that now."

In any event, Marx's efforts won't lack for scrutiny. The advisory council has become a permanent fixture, and, according to Donovan's statement, the NCI team will visit PRL within the next 6 to 12 months "to evaluate their progress." ■ **KAREN WRIGHT**