R&D Policy That Emphasizes the 'D'

The Clinton Administration was fast out of the blocks with a plan to spend billions of dollars helping industry develop technology, but prospects for basic research are not yet clear

This article is the first in an occasional series on the Clinton Administration's new push to involve the government in civilian industrial R&D. Next week: DARPA and the computer industry.

Just a month after the new Administration was inaugurated, Jack Gibbons, President Clinton's science adviser, summoned the press to the White House to unveil a new strategy for federal R&D. Clinton had sketched out the outlines a few days previously in his State of the Union address, but Gibbons filled in the details with a 36-page manifesto that promises billions of dollars for high-tech programs, while continuing "traditional" investments in basic science. The new strategy reflects the thinking of Vice President Al Gore and the brain trust Gibbons has recruited to his new office from his own former staff on Capitol Hill.

The big change, says Gibbons, is that the government will no longer rely on "serendipity" to produce commercial technology. Federal agencies have long invested in high-tech development, but for narrow purposes—for example, to make weapons for the armed forces and satellites for astronomers. In the past, these programs yielded commercial spinoffs, but in a random way, and this "trickle-down" approach doesn't make sense any longer, says Gibbons. Instead, the new administration wants to refocus the defense industry on nonmilitary needs, aim federal civilian research at specific commercial goals, lure industry into high-risk experiments—and do it all in a hurry. And in the past few weeks the Clinton team—including Clinton himself, Gore, Gibbons, and Secretary of Commerce Ron Brown—has gone into high gear, courting Congress, meeting with reporters, organizing policy councils, and staging photo opportunities to promote it.

In announcing the new thrust, Gibbons is taking care not to spook the traditional R&D constituency at universities. He studiously mentions the value of untargeted research, for example. And his booklet says the nation's long-term economic health depends on "adequate and sustained funding for university research grant programs at the National Science Foundation (NSF), [the National Institutes of Health (NIH)], and other research agencies." The strength of this commitment will become clear when the president's 1994 budget is sent to Capitol Hill (due on 5 April). Even so, the Administration's early actions seem focused more on the "D" than the "R" of R&D.

As a result, the path they've laid out for agencies that support targeted or industrial research is clearer than for the ivory-towered likes of NSF and NIH. The signs point specifically to big roles for the Pentagon's Defense Advanced Research Projects Agency—DARPA, recently renamed ARPA to emphasize its civil role—and the Advanced Technology Program (ATP), a fledgling effort in the Commerce Department that subsidizes high-tech startups. Probably no other program will grow as fast as ATP, slated for an amazing 1000% increase in 4 years (see story on p. 1818). This may sound fantastic, but Secretary Brown has taken the numbers to Congress himself, advocating a budget rise from $68 million to $750 million by 1997. And the proposal got a warm welcome from both Democrats and Republicans on the House Science Committee on 2 March. It will probably do well in the Senate, too.

It should come as no surprise that Congress likes these ideas: They were born on Capitol Hill. Key senators including Ernest Hollings (D–SC), Jeff Bingaman (D–NM), John Glenn (D–OH), and Gore himself, together with House members such as George Brown (D–CA) and Tim Valentine (D–NC) of the science committee, tried to push both the Reagan and Bush Administrations into spending more on civilian industrial research. When Clinton moved into the White House, the congressional outsiders became insiders, and their policy-in-exile is now established doctrine. Gibbons and Secretary Brown, for example, concede that much of their plan is copied from an omnibus technology bill assembled last fall by Representatives Brown and Valentine. Testifying before the House Science Committee on 2 March, Secretary Brown noted that Clinton's economic plan "includes—indeed, it is the same as—the vision of HR 820," their own bill. He added, "Without your work, we would not have a technology policy." A few days later, Gibbons testified that "we relied a lot on prior knowledge," including "the work of this committee."

With so much agreement, the questions facing the government should be straightforward: How much should be spent, and where? The answers to those questions, however, are "still emerging from the fog," says Robert White, president of the National Academy of Engineering (NAE) and a strong supporter of having government lead the way in technology development. White says he likes what he's seen of the new plan so far but wants to see more. Gibbons agrees that many details need to be filled

THE BIG WINNERS

PROJECT/AGENCY	quick stimulus 1993	early growth 1994	long-term growth 1994-1997
Information highways: Commerce	64	NA	275
High-performance networks & computing: multi-agency*	161	NA	2054
Industrial technology: NIST	117	NA	1306
National Science Foundation	207	NA	2297
Dual-use technology: Defense		133	1331
New environmental technology: EPA		14	271
Civil and short-haul aviation: NASA		39	600
Smart cars/highways: Transportation		70	345
High-speed rail/Maglev: Transportation		27	646
FCCSET initiatives*		100	1206

Source: Office of Science and Technology Policy
Numbers represent millions of dollars growth in budget authority.
NA=Not available at this time.

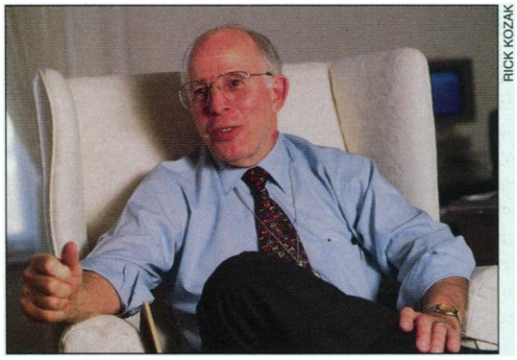
*FCCSET multiagency categories may overlap others; they include climate change, computing, math and science education, materials processing, and advanced manufacturing.

in. He said recently that the technology policy is "like new wine: It has some aging to go and changes need to be made."

The basic structure is clear, though. At the top of the pyramid are two organizations in the Executive Office: The Office of Science and Technology Policy, which Gibbons heads, and the newly formed National Economic Council, which differs from earlier domestic strategy councils in that it includes Gibbons as the president's top technical adviser. At a recent meeting at the NAE, two old hands in advising the government on technology—John Foster, chairman of the Defense Science Board, and Harvey Brooks of Harvard University—gave the Administration high marks for including engineering-literate people in the inner sanctum. They specifically praised the nomination of Laura Tyson—an expert in trade and technology from the University of California, Berkeley—to head the Council of Economic Advisers.

Below the White House, the Department of Commerce and the Pentagon will play lead roles in the technology push. Some other old hands—including former defense secretary Harold Brown—had hoped to see a new, independent, quasi-governmental agency set up to run the technology program. That will not happen, it's now clear. Nor will there be a "civilian DARPA," as many recommended. The Clinton team has decided instead to build upon existing institutions.

There is a big advantage in doing this, says White: You can move quickly. But there's a disadvantage as well. Federal agencies are more susceptible than quasi-private ones to political influence. And one of the toughest challenges, says White, will be to keep the program free of wasteful, pork-barrel awards. This hasn't been a problem so far in the ATP at Commerce, but as its budget grows, it could become vulnerable. The Administration will have to develop a systematic way of fending off requests for special favors from Congress and special pleading by industrial advisers, White predicts.



RICK KOZAK

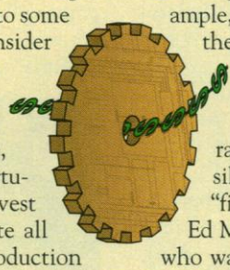
On the team. Science adviser Jack Gibbons played major role in formulating the plan.

For now, the Administration has handed the civilian side of the technology program to Commerce. In addition to guiding the boom at ATP, Secretary Brown says, the department will establish "over 100" educational centers modeled on the agricultural extension service. Their mission will be to keep small companies attuned to the latest manufacturing techniques and train employees in their use—essentially serving as low-cost management consultants.

Commerce will also host the National Telecommunications and Information Administration, budgeted for $64 million in 1993. This outfit, Brown says, will run the next phase of a program to build "information superhighways"—a pet project of Gore's. The program has already established the Internet, a computer network that links basic researchers around the globe; now it aims to broaden the network from its current base in the research community to in-

Technology Boosting: A Checkered History

The Clinton Administration isn't the first to throw its weight behind new technology schemes—and skeptics point to some of these earlier projects as a reason for being wary. Consider what happened in the Nixon Administration. Back in the early 1970s, says former White House budget official Hugh Loweth, two of his colleagues (William Magruder and John Ehrlichman) launched a massive, $5 billion proposal called the New Technology Opportunities Program. Among other things, they wanted to invest in balloon-based logging, elevated tracks to eliminate all railroad crossings, short take-off aircraft, and mass production methods for the building industry. None of these yielded significant results.



In the end, that program was much smaller than what the Clinton Administration has in mind. "Nixon was concerned about unemployment on the West Coast," recalls Loweth, "and I kidded them about building nuclear-powered whaling ships." Loweth whittled the Magruder-Ehrlichman plan down to a few tens of millions of dollars. Nixon's science adviser, Edward David Jr., recalls that the building project got funded and "we learned something" from it, David says. But he judges the program "a monumental failure," because mass production building techniques never caught on.

Next up to bat was the Carter Administration, which went along with one of the least successful energy ventures of all time—the Synfuels Corp. The quasi-public outfit gave away hundreds of millions of dollars in the hope of developing new domestic fuel sources. But it lost political support in the 1980s and went out of business with little to show for its work.

The government may have had a couple of inverse successes during the 1970s, according to critics, by failing to invest in "hot" technologies that later proved to be not so hot. France, for example, invested heavily in the supersonic transport plane and the liquid metal fast breeder reactor. The United States nearly did the same, but backed away. Two decades later, neither project has had any commercial success.

In the 1980s, computers and electronics were all the rage, and the U.S. government made big investments in silicon chip manufacturing. One of these projects was a "fiasco" and the other worked reasonably well, according to Ed McGaffigan, an aide to Senator Jeff Bingaman (D–NM), who was involved in both cases. The fiasco was a Pentagon-based initiative called the Very High Speed Integrated Circuit (VHSIC) project. Costing around $1 billion, it was designed to give U.S. defense electronics firms a technological boost through special procurements. It never lived up to its promise, while nondefense firms outside VHSIC moved ahead rapidly on their own. In contrast, McGaffigan says, the government's recent $100 million a year investment in Sematech, a 50-50 federal-industry venture to develop chip production technology, has been a success. McGaffigan believes that the key difference is that Sematech was an industry-led initiative to begin with, and that it remained under private control. The government handed over 50% of the startup funds, then stepped away to let Sematech's board make decisions.

And what does history reveal about the fate of the Clinton plan? No certainties. But one obvious point, according to Barry Guile, a staffer at the National Academy of Engineering, is that there will be some failures. The Clinton team, he says, will have to explain that experimental technology programs are risky, and setbacks are to be expected. The Administration's first real test of commitment to the effort will come with the first big failure.

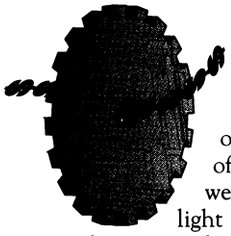
–E.M.

clude public schools, libraries, health care facilities, and "other providers of community services," according to Gibbons' booklet. John Rollwagen, the former Cray Research chief, will help steer this effort as deputy secretary of commerce.

In parallel to this civilian technology push, the Administration plans a military-based initiative at DARPA. Responsibility for this effort falls to William Perry, a former electronics executive and one-time Pentagon official in the Carter Administration, who has been nominated to be deputy secretary of defense. For many years Perry has advocated using the military budget to promote "dual-use" technologies of value both in weapons and commercial products. Perry endorsed a Carnegie Commission report last year recommending that DARPA drop the "D" and become a "dual-use" agency.

Even before Perry's arrival, ARPA had taken the lead in coordinating a five-agency plan to spend $500 billion in 1993 on converting defense industries to civilian goals (*Science*, 19 March, p. 1690). Under Perry, ARPA will continue to lead a government-wide initiative in supercomputers and will also take on a role in expanding the data superhighways. Last year, in a big step in the direction the Clinton Administration is now heading, Congress boosted ARPA's 1993 budget from the Bush Administration's request of $1.3 billion to $2.2 billion, two-thirds of it for "dual-use" technology development. Congressional staffers predict the funding will remain steady at that level.

Elsewhere in the government, agencies are being tapped to take part in a smorgasbord of not-so-clearly defined technology promotion jobs. The NSF will be asked to increase its support of high-performance computing, too, and to contribute to the push for better technical education. The Department of Labor, the National Aeronautics and Space Administration, and the Pentagon will be involved in joint projects aimed at retraining defense industry employees and devising new educational programs for displaced workers who don't have access to college classes. The Gibbons technology plan also promises support for "smart highways," magnetic levitation trains, civil aircraft research, and energy improvements in federal buildings and public housing. The Department of Energy's national laboratories will be asked to set aside "at least 10%-20% of their budgets to R&D partnerships with industry." A new "clean car" task force led by Gibbons will "encourage the development of prototype vehicles" that meet extra-tough antipollution stan-



NIST: Measuring Up to a New Task

For much of its 92-year history, the National Institute of Standards and Technology (NIST) has been best known as a keeper of standards—measuring everything from the weight of pingpong balls to the brightness of light bulbs. But it has recently been assigned a more daunting task: help jump-start the economy and win back U.S. business markets by working with industry to develop innovative technologies. Over the next few years, NIST—a bureau within the Commerce Department—will lavish hundreds of millions of dollars on this task, making it one of the federal government's largest sources of funds for civilian research and development.

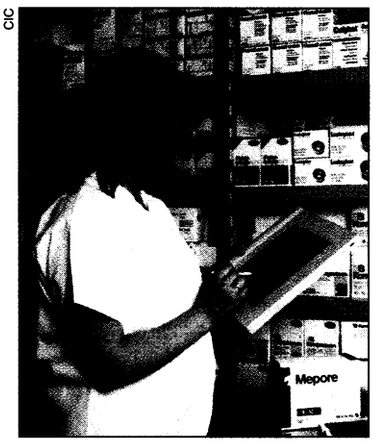
NIST's own in-house R&D efforts are slated to double over the next 4 years, but the biggest growth will come in direct support for research performed by industry. At the center of this new thrust is the Advanced Technology Program (ATP). Created by Congress in 1988, ATP currently has a budget of approximately $68 million. But under the Clinton Administration's proposals to shift funds from military to civilian R&D (see p. 1816), the program will be shelling out $750 million each year by fiscal year 1997. Advocates of a more aggressive government role in industrial technology are cheering the prospect, but that kind of growth rate has some critics wondering whether the money can be spent wisely.

ATP hopes to meet its lofty goals by awarding matching grants to companies or joint ventures that agree to share the costs associated with research and development of precompetitive, generic technologies. "Precompetitive means the effort is at an early enough state that it's a high technical risk, but not a high business risk," explains ATP director George Uriano. "Generic means that if you solve technical problems the results will be widely used a number of ways by many companies."

Single-company awards are limited to $2 million to be spent over no more than 3 years. Joint ventures, on the other hand, can win $5 million or more but must put up more than 50% of the matching funds. Uriano says the ATP money is essential to firms trying to develop risky, "breakthrough" technologies. "In this economic climate, few venture capitalists are willing to take such high-stakes gambles. We are willing to fund it up front."

Consider the case of Communication Intelligence Corp. (CIC), a small firm in Redwood Shores, California, specializing in computers that can read handwriting. According to John Ostrem, vice president of research at CIC, Japanese firms are aggressively entering the same market. His $1.2 million ATP grant is to help CIC develop the early phases of a sensor and control system. While the technology could be used in a wide range of laptop and hand-held computers, a breakthrough would "give the U.S. industry a running start in handwriting recognition technology," he says. "The improvements we are making with the grant will give us a 12- to 18-month lead over our nearest competitors," he predicts. "And in the field of computers, that's a lifetime." Ostrem's prediction may seem optimistic, but it's in line with the experience of ATP award-winners so far. A recent study conducted by Solomon Associates concluded that the grants gave companies a 1- to 5-year time savings on accomplishing their research.

CIC



Taking stock. Communications Intelligence Corp.'s writing recognition technology, used in this hand-held computer, received NIST grant.

Like politics, joint ventures seeking ATP funding can produce strange bedfellows. James Hurd is CEO of Planar Systems of Beaverton, Oregon, and a member of an eight-company consortium to develop improved flat-panel displays for computers. Hurd says the $7 million project has "eight competing companies who would rip each other's throats out for market share" cooperating in this research. The firms (which will be joined by other companies in the next few months) already have worked out ways to share technical information and potential royalties. "Our goal is to find ways to inspect and repair the equipment we all make. It will reduce all our products' time to market and

dards. And some broad economic and legal changes have also been proposed to foster civilian technology, such as converting the research and experimentation tax credit to a permanent subsidy, relaxing antitrust laws, and changing the federal advisory committee rules to make it easier for businessmen to advise the government.

While the initial technology package covers a lot of ground, it leaves some key issues unresolved. One is the fate of the big Department of Energy (DOE) laboratories. The Gibbons blueprint says the labs will "continue their key role in basic research," and that "we will develop new missions...to make full use of the talented and experienced men and women" in the labs. Gibbons also said in testimony recently that a special working group is conducting a "survey" of research going on at those labs. His office is also looking into the possibility of setting up peer-review methods to help DOE set funding priorities in places like Livermore and Los Alamos, which now peer review only a small fraction of their work. The goal would be to focus resources more efficiently and see that new projects are aligned with national economic priorities.

DOE's fans on Capitol Hill, meanwhile, have jumped in with their own plan to ensure that the $19 billion agency and its $7 billion labs will be included in the action. Senator Bennett Johnston (D–LA), chairman of the energy appropriations subcommittee, along with two others—Senators Bingaman and Domenici—introduced a bill (S 473) on 2 March designed to make it easier for DOE and laboratory officials to form joint partnerships with industry. It also ensures that these senators and other members of Congress who are patrons of DOE and its projects (including projects in their own states) will be a part of any future negotiations on technology policy. Johnston has already scheduled hearings and hopes to have his bill cleared though his committee and ready for a final vote this spring.

This is the opening bid in what could be an intense season of policy making. The next round will come after the Administration releases its budget next month, when the fine print of its spending plans should become clearer. Each committee on Capitol Hill will be looking to see how its particular stable of programs fares. But for the research community, the big question is how this new-found enthusiasm for technology development will affect the government's traditional support for basic science.

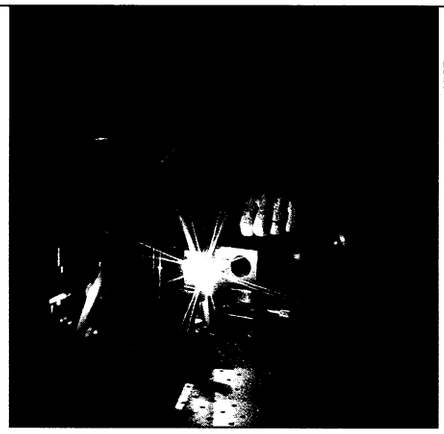
–Eliot Marshall

lower our costs. The consortium works because it meets all our needs," he says.

Before a company or consortium can share Uncle Sam's largess, it first must submit a proposal—they currently cost $20,000 to $30,000 to develop—and endure a grueling three-step evaluation process. First, a group of experts screens the projects for scientific and technical merit. One major question: Is the proposal technically feasible? Second, a group of venture capitalists and business experts ask whether the plan can make it out of the lab and into production. Are there broad benefits for companies in the United States? Is the company strong enough to carry the process from proposal to product application? Finally, those proposals with the highest marks get tagged as "semifinalists." In what one participant characterized as "the most intense grilling since my Ph.D. thesis," company representatives are questioned by a committee about any problems with the proposal. All the semifinalists are ranked in order and grants are made down the list until cash runs out. About one of every three semi-finalists is actually funded. ATP spokesmen stress that special care is taken to spread the grants through a wide range of technologies and applicants.

After several rounds of competition, ATP spokesmen say it's easy to envision spending $750 million per year productively. But does it work? So far ATP has handed out 60 grants totaling more than $400 million in federal and company money. Development is nearly completed on technology ranging from high-intensity data recording heads capable of writing and reading 10 gigabits per square inch to techniques for making materials needed in ceramics, robots, and pharmaceuticals. Uriano says the flat-panel display consortium already has found a way to put circuits directly on glass computer panels. "This advance may hit the market as early as 1994," he adds. Several other companies are using the early benefits of the research to restructure their manufacturing processes.

That's exactly the kind of achievement ATP's supporters in Congress, such as science committee chairman George Brown (D–CA), expected. But critics warn that this large-scale venture into industrial research and development by government could ultimately turn out to be a waste of money. Claude Barfield, resident scholar at the American Enterprise Institute, supports NIST's traditional role as an agency devoted to measurements and technology. But, he says, "Congress likes things it can touch and see. This will put pressure on ATP to fund product development—something that companies and stockholders rather than taxpayers should subsidize." Conservative economist Murray Weidenbaum warns that ATP will be hard to isolate from political pressure for pork projects. "You've got to watch out that all the grants don't go to West Virginia," he cautions, referring to a state that has recently been blessed with an abundance of federal moneys as the result of lobbying from the state's powerful Senator Robert Byrd. And Jerry Jasinowski, president of the National Association of Manufacturers, warns that "people in government are generally naive about how quickly they can gear up and spend money wisely."



NIST

Focal point. NIST's in-house R&D, like this research on optoelectronics, will be doubled in 4 years under the Clinton plan.

Certainly, any agency that suddenly finds itself with $750 million a year to hand out will face a wide range of outstretched palms. And Uriano says that if the big funding increase does come his way, the agency will have to modify its approach. Aside from increasing the number of competitions from one to three or four per year, staff and consultants will look for "trends," Uriano says. Based on previous competitions, the ATP staff will try to spot sectors where ATP grants are most in demand and hold special competitions stressing one type of technology. These will be in addition to the open competitions. The program may also try to cuu down on paperwork by having companies submit just a brief initial proposal. And Uriano says ATP might consider one or two "supergrants" to be divvied out to consortiums seeking perhaps $100 million each year. "If Congress wants to raise a massive effort in just one field, we would have the funding to accomplish that end," he says.

–Jerome Cramer

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