

DOE would not save as much money as she has proposed through management changes, staff cuts and asset sales. "I think [abolishing DOE] may be more about trophies and philosophies," declared O'Leary. A day before, after debating the department's future with Congressman Tiahrt on the CNN Morning News, she told a DOE advisory board that the House Republican rookies were a "group of characters" who "have not got a clue" about the department's mission and operations.

Speaking with news reporters after the House hearing with the three former Energy Secretaries, DOE Under Secretary Charles B. Curtis rejected the accusation by Watkins that

the department has neglected its defense mission. If Watkins really believes the department has jeopardized weapons safety and cleanup responsibilities, said Curtis, he is "absolutely flat-out wrong." Curtis, a former securities lawyer who served in the Treasury Department and the Securities and Exchange Commission, argued that no previous Administration has done a better job of managing the environmental restoration of the nuclear weapons complex than the present one. Moreover, Watkins's charge that the DOE under O'Leary has neglected its weapons stewardship responsibilities is incorrect, said Curtis. In the department's defense, he noted

that the Clinton Administration has requested a 9% increase in fiscal 1996 for DOE's defense program in a time of stringent fiscal restraint. "That's no mean accomplishment."

Curtis said he regretted that able scientists are leaving DOE. The departures are inevitable, he observed, given the changing defense mission in the post-cold-war era. "The department has to find ways to maintain and refresh our scientific staff," he said, "and that's a reason for keeping the multipurpose laboratories. But at no time since World War II has the threat to the nation's R&D base been so apparent or serious."

IRWIN GOODWIN

Sure of Basic Science's Payoff in Technology, White House Economists Speak Up for Research

The Clinton Administration's case for investing in basic research was set out last August in a brief, 31-page document, "Science in the National Interest" (PHYSICS TODAY, September 1994, page 79). In it, the Administration proclaimed science "an endless and sustainable resource with extraordinary dividends." While the policy paper offered no evidence for the statement, the Administration pledged to raise its budget allocations for both science and technology. But in November, when Republicans won control of the House and Senate, brandishing their "Contract with America" to reduce the Federal deficit by sharp spending cuts, to decimate a few departments, including two that support science and technology, and to balance the budget by the year 2002, economists in the White House started scrambling for studies and statistics to back up the representations about basic research in last year's report.

In February, accordingly, just after President Clinton sent Congress his fiscal 1996 budget request, containing some carefully chosen increases for R&D, his Council of Economic Advisers issued its annual *Economic Report to the President*. This year's report affirmed the message in the policy paper about basic research, "which increases the store of fundamental knowledge that underlies most technological innovation," and described science and technology as "important determinants of long-run productivity growth."

The White House economists allowed that "as the history of this and other nations demonstrates, public investment has long played a vital role in promoting scientific discovery and

technological change." The report cited several examples of this theme in the American experience: "At the heart of the dramatic improvements in agricultural productivity over the last century have been the research efforts conducted at Federally supported land-grant colleges and the rapid dissemination of their results to millions of American farmers by the [Department of Agriculture's] extension services. . . . Similarly, Federal investments to promote research in public health, primarily through the National Institutes of Health, have produced many commercially successful new drugs, new treatments and new medical equipment, which are the foundations of America's premier position in the global biotechnology and medical equipment industries." In its own way, the Defense Department supported research during World War II and since then has fostered the development of many new technologies for military purposes—such as jet engines, computers and advanced materials. This has enabled the US to attain worldwide leadership in commercial markets.

The economic return on investment in basic research also was the topic of a session of the National Science Board on 23 March. Not surprisingly, the speaker was Joseph E. Stiglitz, on leave from Stanford University and one of the three members of the Council of Economic Advisers. Stiglitz began his talk by noting, ironically, that he had been introduced to the science board by Robert Solow, a Nobel Prize-winning economist at MIT, who devised a methodology in 1957 for estimating the fraction of economic growth that could be attributed

to advances in science. The process examined by Solow, said Stiglitz, is still at work: "The fastest-growing economies and the fastest-growing companies around the world are those that remain at the forefront of scientific discovery and technological innovation."

Another early attempt to measure the rate of return in science and technology was by Zvi Griliches in 1958, while he was at the University of Chicago. Griliches found that the research costs for developing hybrid corn generated a total 40% return to the universities and companies involved. Since that study, Griliches, now at Harvard, Edwin Mansfield of the University of Pennsylvania, Richard Nelson of Columbia University and other economists have figured the "private" rate of return for companies engaged in R&D on various products to average between 20% and 30%. Stiglitz considers such returns to corporations investing in R&D to be "impressive, to say the least," especially when compared against the average rate of return in investments by businesses generally, which is around 10%.

"Economists have found, however, that estimated rates of return from R&D to society as a whole are even greater, thanks to the spillover effects," Stiglitz told the science board. Spillovers from basic research and from applications-related developments are often available to anyone who reads scientific and engineering journals, attends professional meetings or learns about discoveries and innovations from messages and accounts transmitted instantaneously by telecommunications around the world. "The existence of spillovers

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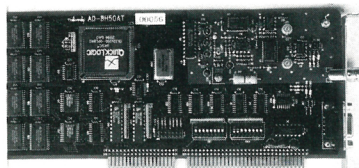
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implies that the rate of return to society rather than to the researcher or the firm average perhaps 50%, about twice the private rate," said Stiglitz.

In the report published by the White House economic council, an estimate of the rate of return of optical fiber R&D—an "admittedly atypical case," the text says—was estimated at 423%. "In a wide range of areas, however, case studies evidence points to rates of return between 30% and 80%." Why are the returns so high? In the case of private returns, said Stiglitz, one probable explanation is that investing in R&D is risky. For every idea that yields a high payoff there may be dozens of dead ends and losers. The researcher or firm is left out on a limb with the risks.

Physics provides two famous examples of high payoffs from basic research, both of which required long periods of development. The transistor was discovered in 1947 at Bell Labs in the quest to fabricate active, solid-state circuit elements. But it wasn't until the 1960s that the transistor was introduced into radios. Likewise, nuclear magnetic resonance was discovered in the 1940s, but its commercialization as an imaging device in medicine was not ready until the 1970s. Stiglitz expressed worry about the recent trend among some of the biggest US corporations to cut back in basic research to pursue, instead, short-term financial goals and to commercialize products more quickly. When this happens, Stiglitz observed, "significant economic gains from scientific discovery and technological innovation may remain unexploited because markets alone cannot guarantee that the innovator will capture all or even most of the economic returns to investment. This is particularly true of basic research in corporate labs."

The National Science Foundation calculates that spending on basic research by US companies declined from nearly \$10 billion in 1990 to \$9.7 billion in 1993 and didn't rise at all last year. In a recent survey by *R&D* magazine, half of all companies with research and development budgets of \$50 million or more reported that they plan to reduce spending this year, for a 3.5% decline overall.

Stiglitz concluded his talk with a thinly veiled reference to the threat in the Republican-dominated Congress to the Administration's proposed R&D budget for 1996. For the sake of US technological leadership, he said, "it's essential that government-backed research not be shortchanged."

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