DILEMMAS DOWN THE ROAD

by John D. Holmfeld

Since World War II science has become a major claimant on the federal budget; it now involves every federal department, some 45 congressional committees, a score of specialized agencies, about 500 universities, and nearly 2 million scientists, engineers, and technicians—one third of them concentrated in research and development.

If this effort seems diffuse, there are nevertheless some overarching principles. Among them: that the federal government should, in fact, be in the business of supporting science, and that a substantial share of that support should go to the universities. This essentially political consensus underlies the growth of modern American science.

Often forgotten is the fact that the policy of federal support for science in general—and for the universities in particular—is less than four decades old. Like Keynesian economics, which served as a basis for U.S. government economic policy for 40 years until the "stagflation" of the 1970s, some of the general assumptions of federal science policy are now being challenged.

The public and private universities face severe enrollment declines in the 1980s; their scientific endeavors have already been weakened by inflation, and obsolete instruments and facilities have not been replaced. "There is no doubt," reports Charles Kidd of the Association of American Universities, "that academic science has decayed in recent years." Not yet by much, to be sure, but the trends are clear.

Meanwhile, congressmen and agency officials worry about the magnitude and direction of the larger research effort. Should the current diverse pattern of federal subsidies be somehow reshaped to funnel scientists into specific tasks? Recently there have been sizable increases in government outlays for energy and environmental research. At the same time, funds for basic research, which rose by 11 percent annually during the 1960s, are now increasing at a yearly rate of only 5 percent, thereby encouraging "basic" scientists to go into "applied" fields. Should these trends be further encouraged by Washington? "If we push too far one way," warned Senator Edward Kennedy (D.-Mass.), chairman of the Senate Subcommittee on Health, "it could mean loss of cherished scientific freedom; but if we push too far the other way, it could mean investing billions of public dollars on research that remains irrelevant to fundamental human needs."

One of the government's justifications for its support of scientific research is that an advanced society has an obligation, for inspirational or cultural reasons, to maintain the arts and sciences. There is continuing popular interest in such fields as astronomy, oceanography, and physics. Although no one can define what the "right" level of support for science as a cultural activity should be, it is surely exceeded by the present level. In fact, the current level can only be justified in terms of an eventual technological benefit to society.

The Reservoir of Research

The use of tax revenues to pay for scientific research stems from a dramatic change that took place during and immediately after World War II. Prior to that time, the government had fostered little research except in applied fields such as agriculture or in the "mission-related" activities of the U.S. Coast and Geodetic Survey and other agencies. During the 1920s and '30s, basic research was generally viewed by Washington and the public as the province of the lone, even eccentric scientist—of people like Albert Einstein, whose work in relativity and atomic physics was expected to have little practical benefit. Then came World War II, radar, the proximity fuse, mass-produced penicillin, and the atomic bomb, all growing out of the earlier "impractical" work of generally unknown American scientists.

As a result, the pendulum in the postwar years swung to the opposite extreme, with basic science seen as the key to national security, technological progress, and public health. The cost of this shift was cheerfully borne by Washington. As Vannevar Bush put it in his influential *Science: The Endless Frontier* (1945), "We can no longer count on ravaged Europe as a source of fundamental knowledge." Bush, the Yankee engineer and M.I.T. dean who became President Roosevelt's science adviser, stressed the urgency of replenishing the reservoir of research findings so that society could tap the results for their technological applications. Not all of it would be tapped immediately, he conceded, but most of it would be tapped eventually, even if it was impossible to say exactly when and where.

With this rationale—prodded further by Sputnik and competition with the Kremlin—Washington embarked on a spectacular expansion of scientific support. From the modest sum of $74 million in 1940, federal science outlays have grown steadily. Last year $14.2 billion was spent in the United States on scientific research, of which $8.1 billion came from federal sources. Some $14.4 billion of the $40.8 billion invested in technological development also came from the government.

To disburse these vast sums there emerged an array of federal agencies: the Atomic Energy Commission (1946), the National Science Foundation (1950), the National Aeronautics and Space Administration (1958), and several others. The investment yielded great advances in medicine, physics, space, oceanography, and indeed in every scientific field.

Questioning Dr. Bush's Rationale

In recent years, however, the pendulum has begun to swing back once again—the result of no single issue but of a pervasive sense on Capitol Hill and among the public that our money could be better spent.* In the popular press this is reflected in "horror stories" suggesting frivolous government expenditures on such subjects as "Polynesian Linguistics" or "Basic Labor Productivity Measures for Popular Breakfast Menu Items." But more serious expressions of concern have also been heard.

Some observers doubt that much current research will ever prove useful. Others wonder if basic scientific research will really provide the "best" solution to certain problems. These are not always simply "antiscience" questions; they are not aimed at getting government out of the laboratory. But they do suggest that there may be better ways to allocate science money.

The idea that most scientific research eventually finds a use

*One early manifestation was the Mansfield Amendment to the 1970 Military Appropriations Act. The amendment prohibited the use of defense funds for research that lacked "a direct and apparent relationship to a specific military function." Though no longer in effect, it has had a lasting—and inhibiting—effect on the Defense Department's basic research effort.

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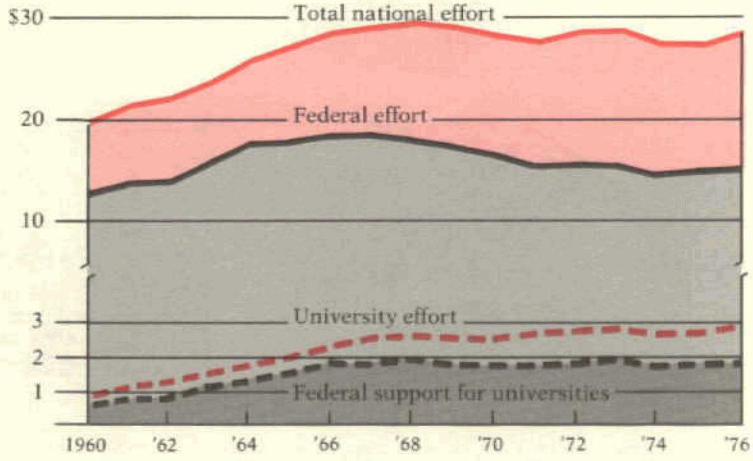
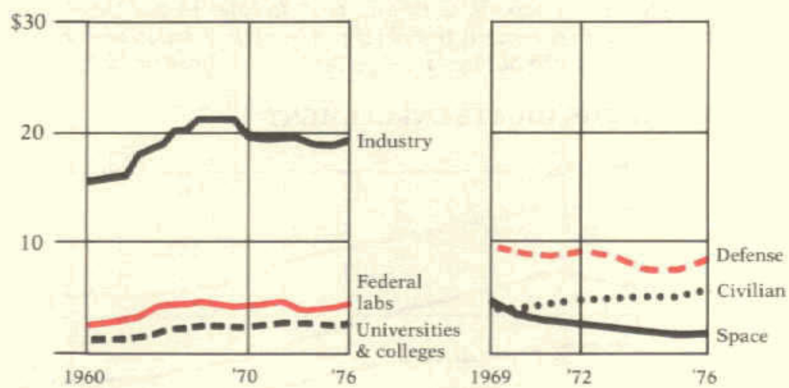
FINANCIAL SUPPORT FOR RESEARCH AND DEVELOPMENT

(in billions of constant 1972 dollars)



R&D 'Performers' *

Federal R&D Obligations

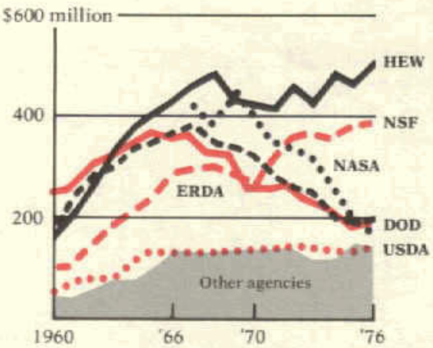


Since 1967, total R&D support has slipped 3 percent, with the federal share down by 18 percent (top). The mix of major R&D performers is unchanged (above, left) but the emphases in federally funded research have changed substantially (above, right). Defense and space R&D are down 18 and 50 percent, respectively; civilian R&D, swollen by energy and environmental research, is up 48 percent.

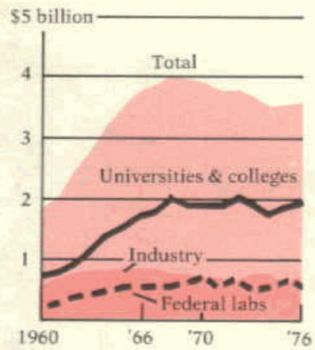
*Excluding federally funded R&D centers and miscellaneous nonprofit research institutes.

BASIC RESEARCH (in constant 1972 dollars)

Federal Obligations by Agency*



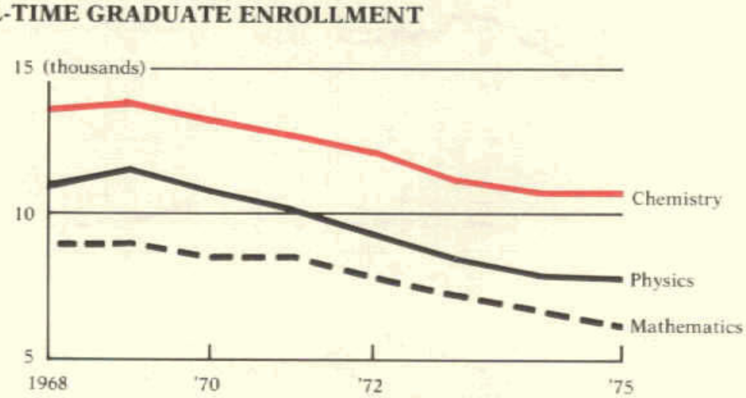
Expenditures by Performer†



*U.S. Department of Health, Education, and Welfare; National Science Foundation; National Aeronautics and Space Administration; Energy Research and Development Agency (Atomic Energy Commission, prior to 1974); Department of Defense; Department of Agriculture.
†Excluding federally funded R&D centers and misce!' ineous nonprofit research institutes.

Dramatic shifts have occurred in federal agencies' basic research funding, with HEW and NSF reaching new highs but all others dropping below earlier peak levels (above, left). Sharpest decline: in the Defense Department. Universities remain the chief performers of basic research (above, right) but their 1976 outlays are 4 percent below those of 1972.

FULL-TIME GRADUATE ENROLLMENT



In 1968–75, total graduate student enrollment in physics, chemistry, and mathematics declined by 30, 21, and 31 percent respectively. First-year enrollments have since picked up slightly in physics and chemistry.

Charts adapted from The State of Academic Science *(New Rochelle, N.Y.: Change Magazine Press, 1977) and* Science Indicators 1976.

was explored by a House subcommittee in 1976. It concluded that although we have an accurate picture of the resources going into the $22 billion federally supported R&D system, "in terms of what, so to speak, comes out the other end of the pipeline, little of a quantitative nature is available." Individual success stories—penicillin, transistors, the ball-point pen—have long served to justify the government's investment. These anecdotes, as one congressman noted, "are of undoubted veracity but of unknown representativeness." In terms of the Bush rationale, the question is whether a large percentage of scientific research placed in the common reservoir of knowledge ever emerges again. Even granting that many findings will contribute to technology indirectly through further advances in basic science, government officials wonder how many studies and papers sink to the bottom of the reservoir without a trace.

A second concern is that basic research may not provide the most effective solution to some major problems. This is especially apparent in the largest government-supported field, biomedical research, long a congressional favorite. Funded chiefly through the U.S. National Institutes of Health, a great deal of biomedical research is based on the notion that once a disease is understood, a cure is near at hand. Proponents of basic research point out that this approach has often been successful, and they note, anecdotally, that if efforts to deal with polio had been concentrated on the development of better iron lungs, progress would have been modest indeed.

Troubled Universities

In cancer research, it is becoming clear that this strategy is, at least for the short term, less effective. Here, prevention—the elimination of carcinogens from our food and environment—would probably save *more* people *sooner* than an eventual cure based on research into the nature of cancer. "We have wiped out smallpox, we have wiped out cholera and typhoid and typhus," one scientist reminded a congressional panel. "We don't know very much about how these diseases are caused, but what we do know is how to prevent them, and that can be something very different."

An alternative strategy would reduce reliance on basic research as the means of solving such problems. At issue is not the value of scientific research per se, but the magnitude of the effort and the need to be selective in the use of the government's money. It is too early to say how—or if—this dilemma will be resolved. But any modifications will certainly affect the current precarious position of the great research universities, nearly half of whose 150,000 scientists and engineers are working on federally funded research projects with a combined budget of $2.5 billion.

The universities are plagued by problems they can do little about. Enrollments will decline by about 15 percent in the 1980s because the 1950s baby boom is over; the dollar will decline because inflation persists. Universities have already been forced into cutbacks to avoid or eliminate deficits. Graduate enrollments have dropped sharply in physics, mathematics, engineering, and to a lesser extent, chemistry.

These factors have reduced the ability of universities to hire young scientists fresh from their Ph.D. studies. This is the age group that most frequently makes the path-breaking discoveries (physicist Carl Anderson, for example, discovered the positron two years after earning his Ph.D.; he was 27). Now, science departments are overtenured (as high as 70 percent in some fields), and positions may have to be eliminated when the demand for graduate training drops.

Where To Invest?

There is no lack of proposed remedies. Students as well as the federal and state governments are being asked to contribute more to defray the cost of research and education—the latter already subsidized by "overhead" payments on research grants awarded to the universities. There is also pressure within the federal government for subsidies of general university operating costs—a course Congress has hitherto avoided. And Dr. Frank Press, now President Carter's science adviser, urged in 1975 that the traditional close association of teaching and research in the universities be weakened. Young scientists could then be hired not to teach but to do research exclusively in federally sponsored research centers within the universities. Whatever the proposals, the message is clear: both Washington and the research universities are worried about the future.

Basic to the debate is the question of whether the government should continue to invest so heavily in the universities in order to maintain this unique source of research; or whether it should instead place a greater share of its research funds in the hands of, say, industry, or perhaps entirely new types of institutions. In his 1945 report Vannevar Bush had touted the universities as "uniquely qualified" to carry on basic research. Since that time the government-university relationship has come to seem indispensable—and undissoluble. Frank Press observed several years ago that the strength of U.S. science was "directly related to the health of the universities." But Press and others have noted that in its reliance on these institutions, the United States is unique. Other countries employ a more diverse group of institutions. Germany's Max Planck Institutes, which perform specialized research in medicine, chemistry, and physics with government funds, are often cited as an example.

Several recent proposals would shift some research responsibility away from the universities. The most notable was that of the Senate Committee on Labor and Public Welfare, which has jurisdiction over the National Science Foundation. Pointing out that an increasing number of bright, young scientists were finding employment not in the university but in industry, the committee last year urged an end to NSF's preferential treatment of academic scientists. This proposal was not enacted into law.

However the matter is resolved, the government, looking to the future, must consider how society's needs will be served. University officials often describe the current labyrinthine funding arrangement—with its many sources of money in many different agencies—as a healthy kind of "pluralism." Looking in the direction of research "performers," the government may find pluralism healthy, too.

Less than 40 years ago the science-government relationship underwent a radical change. It may be on the verge of changing once again, as the principle of government support of science—mainly in the universities—comes under increased scrutiny. Even if it does change, we should not forget the resilience of American science, which moved from obscurity to the front rank in scarcely two generations.

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