The bucks stop elsewhere: The Midwest's share of federal R&D

Eleanor Erdevig

Research and development (R&D) activities are generally regarded as the basis for technological innovation and are important to improving the competitive position of many U.S. industries through increased productivity and the development of new products and services. R&D spending is also important to the competitive position of industries in the different regions of the country.

The federal government is a major source of financing for R&D. According to the *Special Analyses Report* on R&D in the proposed United States budget for 1985, the federal government supports R&D to meet the direct needs of the government where the principal users of the results are the supporting agencies, and to assist in meeting broad national needs, particularly where the private sector lacks incentives for adequate investments, to assure long-term growth and continued improvement in the quality of life. R&D for national defense purposes is an example of the first category, and basic research across all fields of science is epitomized in the second. Federal dollars represent about one-half of all such funds spent in the country. In fiscal year 1985, the proposed total federal funding for R&D, including R&D facilities by all departments and agencies, represents approximately 6 percent of total federal obligations.

Federal R&D expenditures provide direct benefits to an area through increased employment and the development of scientific personnel. The research results and the trained labor force can provide the basis for the growth of existing and new industries in the area. In the long run, however, the benefits may be more widespread as the results of the R&D become available to other regions of the country. This article discusses the extent to which disparities exist among the regions in federal government obligations for R&D and the R&D outlook for Seventh District states, where economic problems have raised serious concerns about the future of many industries.

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R&D and productivity

During the past 20 years an increasing amount of economic research has been devoted to the relationship of R&D to increases in productivity, technological change, and economic growth. This research has generally found a pervasive relationship between R&D and productivity gains although the amounts and timing may be uncertain.

The strongest relationship between R&D and productivity has been found in privately funded R&D, with government-funded R&D in some studies showing little or insignificant effects on productivity.[1] Much of this research, however, has focused on the relatively short-run effects of federally-funded R&D, and some economists have suggested that the benefits of government-sponsored R&D may be more long-term and diffuse. Privately funded R&D may tend to be more directly related to the problems of the individual firm and thus have more explicitly recognized benefits.

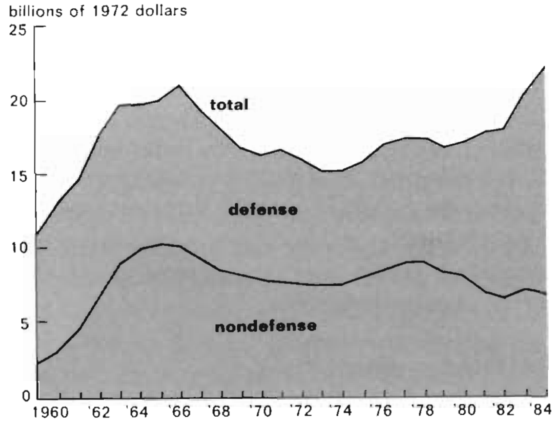
Trends in federal funds for R&D

Total federal obligations for R&D in constant dollars rose sharply during the early 1960s, almost doubling from 1960 to 1967 (see Figure 1). Four-fifths of this increase was for non-

[1]Rolf, Piekarz, "R&D and Productivity Growth: Policy Studies and Issues," *American Economic Association Papers and Proceedings*, Vol. 73 (May 1983), pp. 210-214.

Nestor E. Terleckyj, "What Do R&D Numbers Tell Us About Technological Change?" *American Economic Association Papers and Proceedings*, Vol. 70 (May 1980), pp. 55-61.

Figure 1. **Federal R&D spending by purpose**



defense purposes, the result of the buildup in space R&D. After reaching an all-time high in 1967, real R&D spending declined 28 percent by 1974-1975, as a result of the cutbacks in both defense and space R&D. Subsequently, total real R&D obligations increased only gradually until 1980.

R&D, whether private or governmental, is generally broken down into three major categories: basic research, applied research, and development. (Definitions of the categories are summarized in the accompanying box.) These three categories are frequently considered to represent a continuous process: Knowledge gained from basic research leads to the application of results by means of applied research and finally to commercialization through development.

Real expenditures for basic research rose sharply during the sixties until 1967, but declined only about 9 percent by 1970. Real basic research expenditures remained about constant until 1977 before again rising (see Figure 2). Federal expenditures for applied research in constant dollars have followed a somewhat different pattern, doubling from 1960 to 1966, but then declining one-fifth by 1969. They recovered about half of this loss by 1978, but have since returned to the levels of the early 1970s. Real development expenditures rose about two-thirds to a high in 1967, declined about a third by the early 1970s, and have risen sharply only in the last two years.

Since 1980, real total federal obligations for R&D have risen sharply. Proposed fiscal year 1985 R&D expenditures are 31 percent above the 1980 level. Although real nondefense obligations are expected to be down 18 percent between 1980 and 1985, defense R&D is estimated to be up 70 percent. Real expenditures on basic research, which represent 15 percent of the total, are expected to be up about 27 percent during this period.

Categories of R&D

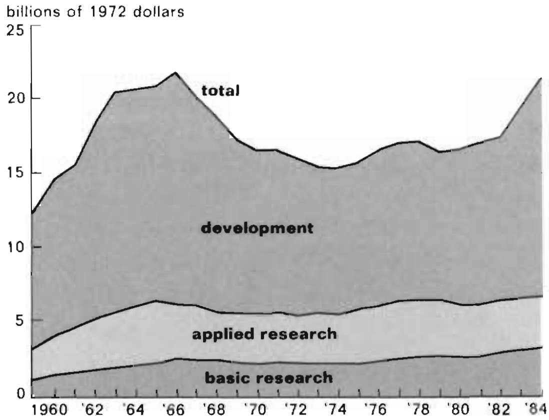
Basic research. For the federal government, universities and colleges, and other nonprofit institutions, basic research is directed toward increases of knowledge in science with ". . . a fuller knowledge or understanding of the subject under study, rather than practical application thereof." To take account of an individual industrial company's commercial goals, the definition for industry funding is modified to indicate that basic research projects represent ". . . original investigations for the advancement of scientific knowledge . . . which do not have specific commercial objectives, although they may be in fields of present or potential interest to the reporting company."

Applied research. The NSF states: "Applied research is directed toward practical application of knowledge." Here again, the definition for the industry survey through which NSF collects private-sector data takes account of the characteristics of industrial organizations. It covers " . . . research projects which represent investigations directed to discovery of new scientific knowledge and which have specific commercial objectives with respect to either products or processes."

Development. The NSF's survey's concept of development may be summarized as " . . . the systematic use of the knowledge or understanding gained from research directed toward the production of useful materials, devices, systems or methods, including design and development of prototypes and processes."

SOURCE: National Science Board, *Science Indicators 1980* Government Printing Office), p. 254.

Figure 2. **Federal R&D spending by type**



Priorities in the eighties

Federal R&D spending during the eighties reflects two major policy decisions. The first and most important is the commitment to increased defense spending, including defense-related R&D. The second is the increased reliance on the private sector to fund many R&D activities that were formerly considered the government's responsibility and the limiting of government support of nondefense R&D primarily to basic research.

As a result of current policies, significant changes have taken place in federal government R&D spending patterns since 1980. Federal government R&D spending in real terms declined 3 percent from 1980 to 1982, the first full-year budget of the current administration. During this period real defense R&D spending grew by 26 percent, with most of the gain in development expenditures. Real nondefense R&D expenditures, on the other hand, were down 28 percent, and almost all of that loss was in funds for applied and development research.

From 1982 to 1984, real overall R&D spending rose 13 percent, but the patterns established in the 1982 budget continued. All of the increase was in defense-related R&D, and most of this was for development. Although there was little change in total real nondefense R&D expenditures, nondefense development funds declined 30 percent and basic research funds were up 23 percent.

Recent trends in government R&D spending continue in the 1985 budget request. Total overall spending on R&D is proposed at $52.8 billion, an increase of 13 percent in constant dollars. Only defense-related development and nondefense basic research funds show gains in real terms, with defense development funds up 23 percent and nondefense basic research up 3 percent. In nominal terms, the gains are $7.4 billion and $0.6 billion, respectively. In 1985, defense-related government R&D spending will represent almost 70 percent of all government spending on R&D, the highest proportion since 1962.

The emphasis on defense-related R&D and basic research in nondefense R&D has shifted the proportions of government R&D spending in the three traditional categories of basic research, applied research, and development. Despite the decrease in nondefense development expenditures, development funding has grown from 63 percent of the 1980 federal R&D request to 69 percent of the 1985 budget request because it dominates defense-related R&D. Basic research accounts for about 15 percent of total R&D spending, almost the same as in 1980, and applied research has fallen from 22 percent in 1980 to 16 percent in 1985.

Increased government support for basic research in the proposed 1985 budget is directed toward the physical and engineering sciences. The agencies that support primarily physical sciences and engineering, e.g., the Department of Defense (DOD), the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), and the Department of Energy (DOE), will increase their basic research funds 8.7 percent in real terms. As shown in Table 1, these departments and agencies will account for more than 56 percent of all federal spending for basic research in 1985, up 2.7 percentage points from 1981. The more rapid growth in spending on basic research in the physical sciences and engineering is largely the result of the substantial increase by the Department of Energy.

Table 1

Federal obligations for conduct of basic research by major departments and agencies: 1981 and 1985

	1981 actual		1985 estimate		1981-1985	
	Amount	Percent of total	Amount	Percent of total	Amount	Change Percent
	($mil)		*($mil)*		*($mil)*	
Agencies supporting primarily physical sciences and engineering[1]						
National Science Foundation	898	17.6	1330	16.8	432	48.1
Energy	591	11.6	1230	15.5	639	108.1
Defense-Military functions	603	11.8	939	11.8	336	55.7
National Aeronautics and Space Administration	532	10.4	828	10.4	296	55.6
Other agencies[2]	106	2.1	122	1.5	16	15.1
Subtotal	2730	53.4	4449	56.1	1719	63.0
Agencies supporting primarily life and other sciences[3]						
Health and Human Services	1955	38.3	2914	36.8	959	49.1
(National Institutes of Health)	(1767)	(34.6)	(2738)	(34.5)	(971)	(55.0)
Agriculture	314	6.1	420	5.3	106	33.8
Other agencies[4]	109	2.2	142	1.8	33	30.3
Subtotal	2378	46.6	3476	43.9	1098	46.2
Total	5108	100.0	7925	100.0	2817	55.1

[1] Include mathematics and computer sciences.

[2] Includes the Corps of Engineers, the Federal Emergency Management Agency, the Tennessee Valley Authority, and the Departments of Transportation, Commerce, and the Interior.

[3] Includes psychology and social sciences.

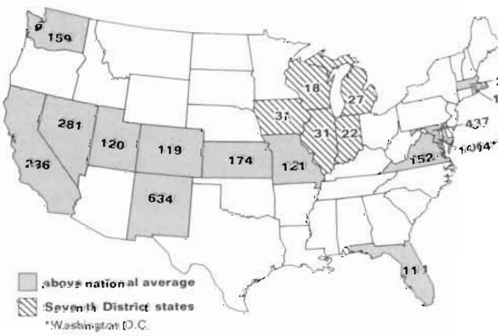
[4] Includes the Departments of Education, Labor, Justice, and Treasury, the Smithsonian Institution, the Environmental Protection Agency, the Veterans Administration, and the Agency for International Development.

SOURCE: *Special Analyses, Budget of the United States Government, 1985*, "Research and Development," Superintendent of Documents, U.S. Government Printing Office, Washington, D.C.; *Special Analysis, The Budget of the United States Government, 1983*, "Research and Development," Superintendent of Documents, U.S. Government Printing Office, Washington, D.C.

Regional impact of departmental R&D funding

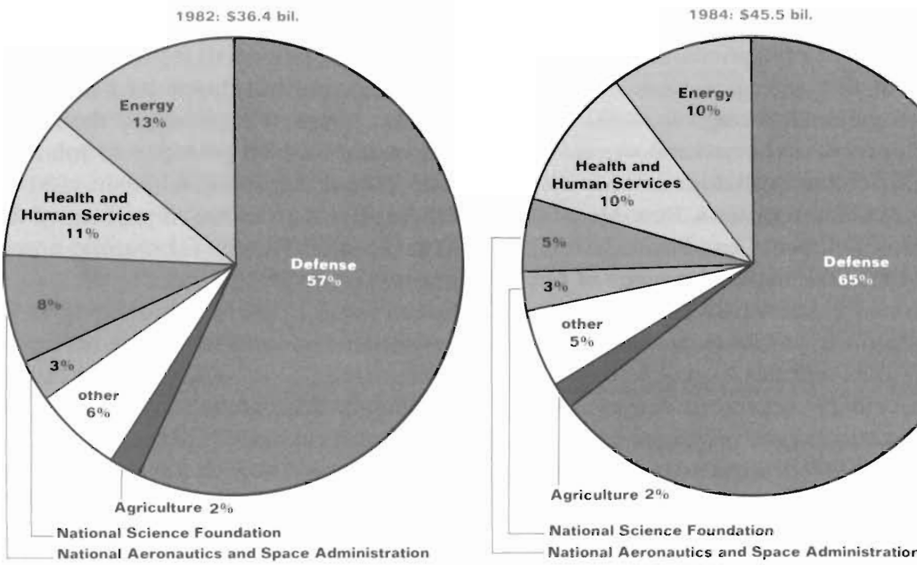
The Seventh District is not a major recipient of federal R&D funding. On a per capita basis the five states of the Seventh District received from 18 to 31 percent of the national average of total federal obligations for R&D in 1982. The states benefiting most from federal R&D spending are located primarily in the West, Southwest, New England, and near Washington D.C., as shown in Figure 3.

Figure 3. **Total Federal R&D spending: 1982**
(per capita, percent of national average)



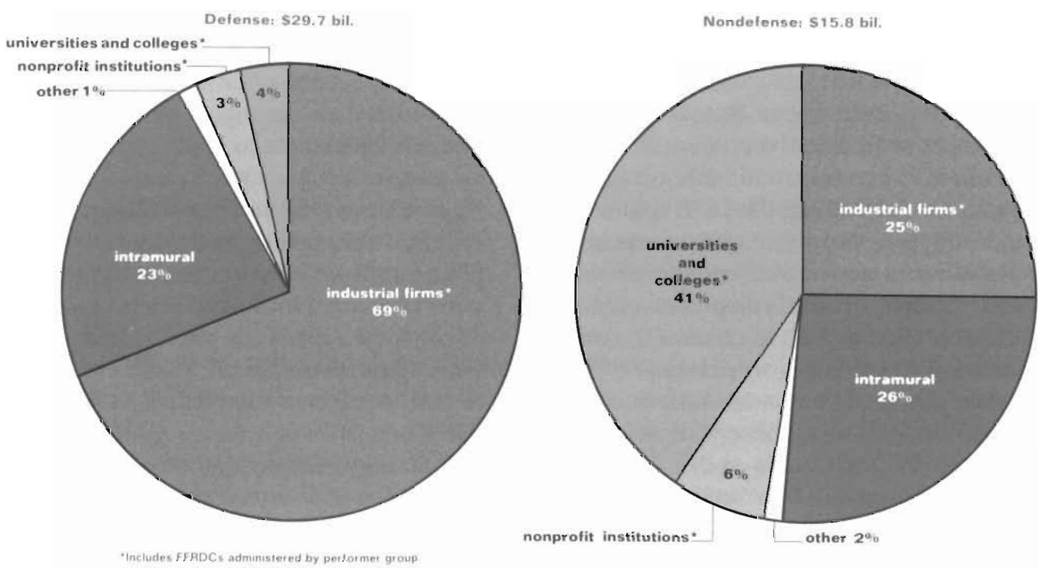
Defense. The Department of Defense (DOD) is the major source of federal R&D funds. In 1984, DOD provided about $29.7 billion, about two-thirds of all federal R&D obligations (see Figure 4). The dominant share (88 percent) of defense R&D is for development as opposed to 3 percent for basic research. Industrial firms are the primary performers of defense-related R&D, receiving 69 percent of such funds (see Figure 5). Most of the balance is used

Figure 4. **Department or agency sources of Federal R&D funds**



SOURCE: **Federal Funds for Research and Development: Fiscal Years 1982, 1983, and 1984**, Volume XXXII, NSF 83-319, National Science Foundation, Washington, D.C.

Figure 5. **Performers of Federal R&D: 1984**



*Includes FFRDCs administered by performer group.

SOURCE: **Federal Funds for Research and Development: Fiscal Years 1982, 1983, and 1984**, Volume XXXII, NSF 83-319, National Science Foundation, Washington, D.C.

directly by DOD or another federal department or agency, i.e., intramurally, and only a small portion is received by universities and colleges and nonprofit institutions.

The poor showing of Seventh District states in the per capita receipt of federal R&D funds relative to the national average is largely the result of the limited amount of defense R&D funds obtained by firms and institutions in the area. Per capita DOD obligations for R&D for District states in the aggregate were only 15 percent of the national average in 1982 and ranged from 2 percent of the national average in Wisconsin to 26 percent in Michigan. In contrast to this, six states (Massachusetts, New Mexico, Maryland, Kansas, California, and Rhode Island) received over twice the national average of per capita obligations for defense R&D.

DOD obligations for R&D performed by industry where the emphasis is on development are part of and closely related to defense procurement contracts and tend to be concentrated in a few states. In 1982, three states (California, Massachusetts, and Missouri) accounted for just over half of all defense R&D obligations to industry, and over three-fourths of such defense R&D is performed in only ten states. On a per capita basis, the primary beneficiaries of defense-related R&D are Maryland and Virginia in the Washington, D.C. area and a few states with major defense plants. None are Seventh District states. Based on past experience, therefore, and without a major diversion of defense R&D awards to firms in the Seventh District, industry in this area is not expected to benefit directly as a result of increased federal expenditures for defense R&D.

Obligations for R&D by the DOD to universities and colleges, nonprofit institutions, and university-administered and independent federally-funded research and development centers (FFRDCs) represent a small fraction of the total DOD budget. During 1984, only about 7.4 percent of the total DOD funds for R&D went to these institutions. About three-fifths of these funds will go to universities and colleges or university-sponsored FFRDCs, and the balance to independent nonprofit institutions.

FFRDCs are exclusively or substantially financed (70 percent or more) by the federal government, usually from one agency, either to meet a particular R&D objective or, in some instances, to provide major facilities at universities for research and associated training purposes. Most or all of the facilities are owned by, or are funded under contract with, the federal government.

Almost half of the funding by the DOD for the conduct of R&D at universities and colleges in 1981 (the latest year for which these data are available), was at schools located in the South Atlantic region. This is largely the result of the substantial support provided to Johns Hopkins University at Baltimore, which in 1981 received $280 million, or about 40 percent of the total. (The Applied Physics Laboratory, a university-administered FFRDC funded by the Navy became part of Johns Hopkins University in 1978.) The only other region in which the universities and colleges received above average per capita DOD funding for R&D is the New England area. Massachusetts received 7.5 percent of all DOD funding at universities with the Massachusetts Institute of Technology receiving just over half of this amount. About half of all DOD support of R&D at universities and colleges is concentrated at four schools—Johns Hopkins, MIT, Georgia Institute of Technology, and Stanford University. Ten schools received almost two-thirds of the DOD support for R&D; none are located in the Seventh District.

Schools in the Seventh District received only 4.3 percent of DOD funding for R&D at universities and colleges in 1981. A review of budget requests since 1981 indicates that DOD funding for R&D at District universities and colleges has not changed significantly.

In 1982, the DOD supported R&D at six FFRDCs, of which two were administered by universities and four by other nonprofit institutions. Total support by the DOD was $510 million and the three largest FFRDCs accounted for over 90 percent of this form of DOD support for R&D.

Energy. The second largest source of federal R&D funds is the Department of Energy (DOE), which in 1984 provided roughly $4.5 billion or 10 percent of total federal funding for the conduct of R&D. About three-fifths of DOE's

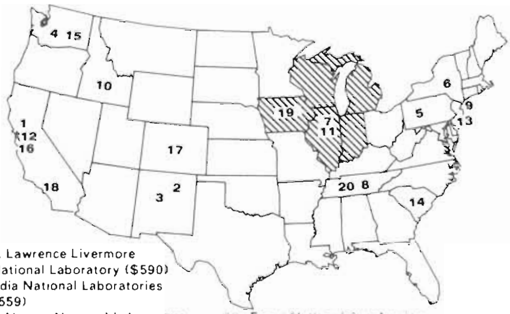
R&D is for development, and the balance is about evenly divided between basic and applied research. In addition, the DOE is the largest supplier of funds for R&D facilities and fixed equipment, such as reactors, wind tunnels, and radio telescopes for use for R&D activities at federal or non-federal installations. In 1984, it supplied about $900 million, or 56 percent of all federal funding for R&D facilities. Almost all of the R&D funded by the DOE is performed outside the federal government, with only about 3 percent of the funds used intramurally.

About two-thirds of the DOE's R&D in 1984 was performed by 20 FFRDCs. Of the 20, eight are administered by industrial firms, ten by universities and colleges, and two by nonprofit institutions. The type of R&D performed by the individual FFRDCs, whether basic or applied research or development, depends to a large extent upon who administers the facility. Those FFRDCs administered by industrial firms devote, in the aggregate, about four-fifths of their federal R&D funds to development and only 6 percent to basic research. FFRDCs administered by universities, on the other hand, spend only about two-fifths of their R&D funds on development and the balance is about equally divided between basic and applied research.

The 20 FFRDCs currently sponsored by DOE are located in twelve states (see Figure 6). Two FFRDCs in New Mexico receive about 27 percent of the federal obligations for the conduct of R&D and facilities at DOE FFRDCs, and four in California receive 21 percent. Other individual states with DOE-sponsored FFRDCs receive 10 percent or less of the funds.

Among the Seventh District states, only Illinois had per capita DOE obligations for R&D above the national average in 1982. This was the result of two large FFRDCs located there—Fermi National Accelerator Laboratory, Batavia, Illinois, administered by Universities Research Association, Inc., and Argonne National Laboratory, Argonne, Illinois, administered by the University of Chicago and Argonne Universities Association. Together these two FFRDCs received $363.7 million from the DOE for R&D and R&D plant support in 1982. The only other FFRDC located in the Seventh District is Ames Laboratory, Ames, Iowa, administered by Iowa State University of Science and Technology, which received $15.6 million in 1982.

Figure 6. **Department of Energy obligations for R&D to FFRDCs*: 1982**
($ millions)



1. E.O. Lawrence Livermore National Laboratory ($590)
2. Sandia National Laboratories ($559)
3. Los Alamos National Laboratory ($490)
4. Hanford Engineering Development Laboratory ($288)
5. Bettis Atomic Power Laboratory ($283)
6. Knolls Atomic Power Laboratory ($232)
7. Argonne National Laboratory ($224)
8. Oak Ridge National Laboratory ($201)
9. Brookhaven National Laboratory ($164)
10. Idaho National Engineering Laboratory ($144)
11. Fermi National Accelerator Laboratory ($140)
12. E.O. Lawrence Berkeley Laboratory ($131)
13. Princeton Plasma Physics Laboratory ($125)
14. Savannah River Laboratory ($95)
15. Pacific Northwest Laboratory ($91)
16. Stanford Linear Accelerator Center ($71)
17. Solar Energy Research Institute ($53)
18. Energy Technology Engineering Center ($36)
19. Ames Laboratory ($16)
20. Oak Ridge Associated Universities ($9)

*FFRDCs are federally funded research and development centers

Industrial firms perform most of the balance of the R&D (23 percent) funded by DOE. About 84 percent of this is for development and the balance is almost all for applied research. Only about 6 percent of DOE R&D is performed at universities.

Health and Human Services. The Department of Health and Human Services (HHS) is the largest supporter of R&D at universities and colleges and independent nonprofit institutions, largely through the National Institutes of Health (NIH). In 1984, HHS provided about $4 billion, or 10 percent of total federal funding for the conduct of R&D. Of this amount 56 percent went to universities and colleges and 13 percent to nonprofit institutions, primarily hospitals. This represents almost half of all federal support for R&D at universities and colleges and at nonprofit institutions. Most of the balance was used intramurally by HHS.

HHS funds primarily basic and applied research in the life sciences, notably the biological and medical sciences and the social sciences. In 1985, about seven-eighths of the Department's funds for the conduct of R&D is proposed to be used by the National Institutes of Health for biomedical research in the prevention, diagnosis, and treatment of disease.

As a result of the administration's increased emphasis on federal funding for basic research, all of the increase in the HHS budget for the conduct of R&D since 1981 has been for basic research. HHS obligations for the conduct of basic research are up 49 percent in nominal terms (23 percent real) between 1981 and 1985, but obligations for applied research and development are nominally unchanged and down 17 percent in real terms. Consequently, basic research will represent 59 percent of the Department's R&D budget in 1985 compared with 49 percent in 1981.

Although the geographic distribution of HHS support for R&D at universities and colleges might be expected to be roughly proportional to the distribution of population, such does not appear to be the case. As shown in Figure 7, HHS obligations for academic R&D on a per capita basis ranges from highs of 406 and 275 percent of the national average in the District of Columbia and Massachusetts, respectively, to less than 10 percent in Idaho, Alaska, Maine, and Nevada, which do not have major medical research centers.

On a per capita basis, none of the Seventh District states were among the top ten in obligations to schools for R&D by HHS in 1982. Only Wisconsin and Iowa were above the national average and ranked 13th and 15th, respectively. The other three states, Illinois, Michigan, and Indiana were all below the national average.

Among the individual universities, the nine schools receiving the largest amounts in 1981 were either on the East or West Coast (see Table 2). Seventh District schools receiving the largest amounts were the University of Michigan, University of Wisconsin-Madison, and the University of Chicago, which ranked 12th, 13th, and 16th, respectively.

The state distribution of HHS funding for R&D at nonprofit institutions, primarily hospitals, is even more unevenly distributed, as shown in Figure 8. Four-fifths of such HHS support goes to nonprofit institutions located in just ten states, and three states, Massachusetts, California, and New York, receive over half. Illinois is the only Seventh District state represented among the top ten. On a per capita basis, Massachusetts received 935 percent of the national average in 1982 followed by the District of Columbia at 820 percent (see Figure 8). None of the Seventh District states received above the national average, and Indiana received only 6 percent and Iowa 1 percent.

Air and space. The National Aeronautics and Space Administration (NASA) is currently the fourth largest supporter of federal R&D. R&D accounts for about two-fifths of the total NASA budget. In 1984, NASA provided roughly $2.5 billion, 5 percent, of total federal funds for

Figure 7. **Department of Health & Human Services obligations for R&D to universities and colleges: 1982**

(per capita, percent of national average)

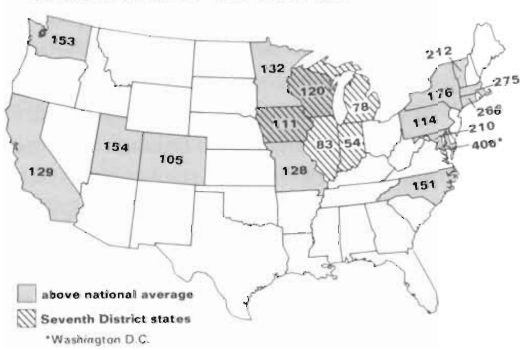


Figure 8. **Department of Health & Human Services obligations for R&D to nonprofit institutions: 1982**

(per capita, percent of national average)

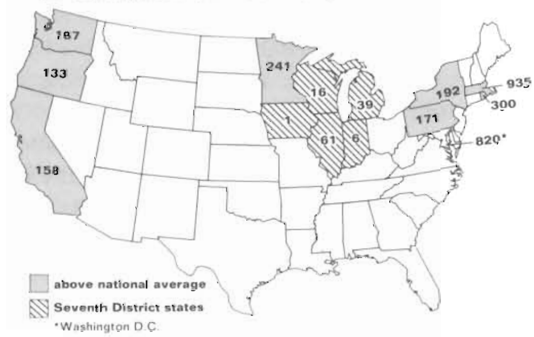


Table 2

Federal obligations to universities and colleges for R&D by Department of Health and Human Services: 1981

Rank	University or college	Amount	Percent of total
		($mil.)	
1	John Hopkins University (Maryland)	66.5	3.1
2	Harvard University (Massachusetts)	63.4	3.0
3	University of California Los Angeles	63.0	3.0
4	University of California-San Francisco	59.7	2.8
5	Yale University (Connecticut)	56.1	2.7
6	Columbia University Main Division (New York)	53.8	2.5
7	University of Pennsylvania	53.4	2.5
8	University of Washington	52.9	2.5
9	Stanford University (California)	52.5	2.5
10	University of Minnesota	47.1	2.2
11	Washington University (Missouri)	46.6	2.2
12	University of Michigan	44.7	2.1
13	University of Wisconsin-Madison	43.8	2.1
14	Yeshiva University (New York)	41.3	2.0
15	Duke University (North Carolina)	36.9	1.7
16	University of Chicago (Illinois)	35.1	1.7
	Subtotal	816.8	35.5

SOURCE: *Federal Support to Universities, Colleges, and Selected Nonprofit Institutions: Fiscal Year 1981*, NSF 83-315, National Science Foundation, Washington, D.C., Table B-16, pages 68-69.

the conduct of R&D. About one-third of the funds were used for development, about two-fifths for applied research, and the balance for basic research.

Almost one-half of NASA R&D was performed intramurally in 1984 with three-fourths of these expenditures for personnel costs. About 80 percent of the work is in basic and applied research.

Industrial firms perform about one-third of the R&D funded by NASA with almost one-half of the funds devoted to development. Universities receive only about 8 percent of NASA R&D funds with emphasis on basic research. NASA also sponsors an FFRDC, Jet Propulsion Laboratory at Pasadena, California, which is administered by California Institute of Technology and is primarily devoted to development.

California is the primary location for industry performing R&D for NASA. In 1982, firms located in California received 46 percent of the NASA R&D funds allocated to industry. Other important states with industrial firms performing NASA R&D are Florida, Texas, Maryland, and Louisiana. Very little NASA R&D is done by industry in Seventh District states.

National Science Foundation. The other agency that is a major source of federal R&D funds is the National Science Foundation (NSF) which supports primarily basic research through grants to scientists and engineers in academic institutions. Emphasis is currently being placed on strengthening support for the physical sciences such as mathematics, physics, and chemistry, for engineering, and for molecular and cell biology. In 1984, NSF funds for R&D were about $1 billion, or 3 percent of total federal obligations for R&D. Nearly all of this amount was for basic research and the balance for applied research.

Universities and colleges received $914 million, or 74 percent of NSF R&D funds in 1984, and six FFRDCs administered by universities received an additional $103 million or 8 percent. Other nonprofit organizations, along with industrial firms, received 7 percent. Only about 11 percent of NSF R&D funds are used intramurally.

Four of the Seventh District states, Illinois, Indiana, Michigan, and Wisconsin, are among the top ten in the receipt of funds from NSF for R&D by universities. On a per capita basis, however, only Indiana, Illinois, and Wisconsin received such funds above the national average (see Figure 9). Nationally, universities in three states, Rhode Island, Alaska, and Massachusetts, receive NSF funds for R&D over four times the national per capita average.

In summary, the DOD is the largest and fastest growing source of federal R&D funding. Almost all the funds are for development rather than basic or applied research, and industry is the primary performer of defense-related R&D. Generally, development funds are a prelude to procurement. Consequently, a large part of federal R&D expenditures follow the same regional patterns as defense procurement. California dominates defense procurement, and it also is the largest recipient of federal R&D funding. Seventh District states receive below average defense R&D expenditures.

Basic research represents less than one-sixth of federal R&D funding. From the major federal departments and agencies that support basic research, other than the Department of Defense, Seventh District states receive above average funding for R&D in certain instances. The two FFRDCs in Illinois make the state a major recipient of energy-related funds. Only Wisconsin and Iowa are above the national average in per capita R&D funds to universities and colleges by the Department of Health and Human

Where to base the biggest machine?

Some economic benefits of R&D funding for basic science are more immediate than the nature of the research itself might suggest. Besides the initial construction costs, for an observatory, say, or a national laboratory, the ongoing ripple of research funds can be a boon to local economies. So state and local competition for such installations can be intense. A case in point is the superconducting super collider (SSC) proposed by U.S. high-energy physicists.

The SSC, with which scientists would investigate the nature of matter and energy by slamming beams of protons at energy levels of 20 trillion electron volts against each other, would be the largest machine ever built. Present designs call for a tunnel, 200 - 300 feet underground, describing a circle 60 to 80 miles in diameter. The tunnel would contain 10,000 to 20,000 supercooled magnets, which would provide the magnetic field needed to contain the proton beams. Ancillary equipment and facilities include cooling equipment, storage facilities for liquid helium and nitrogen, detectors, and computers. Teams of high-energy physicists working on alternate design proposals for the SSC have come up with remarkably similar price tags, around $3 billion.

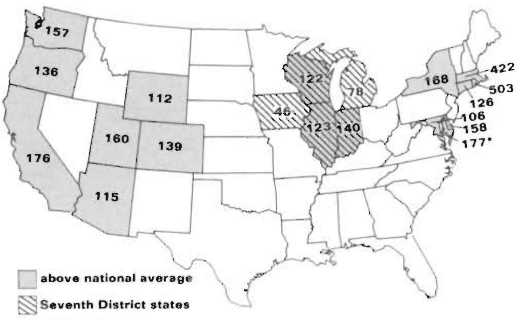
Whether the SSC will actually be built is by no means clear. The American physics community, fearful of losing out to the Europeans in high-energy particle physics, is clearly in favor. But a long and chancy schedule must be met. The Department of Energy (DOE), which is funding the preliminary design work, must get a commitment from the Congress for the funds to build the machine. This will not be easy in a time of high deficits and spending cutbacks. Assuming Congressional approval, plans call for a final site selection by April 1986, a construction start later that year, and a fully operational SSC by 1994.

Despite the uncertainties, many states are beginning to plan and lobby for selection as the home of the SSC. Among them are New York state, Utah, Arizona, New Mexico, Washington, and Texas. In the Seventh Federal Reserve District, Illinois, already home of Fermilab, one of the two largest high-energy physics centers in the world, is gearing up for a run at the SSC.

Illinois' plan would base the SSC at Fermilab in Batavia. The existing infrastructure, officials say, would reduce the preliminary price tag of the SSC by $500 million, and provide a seasoned technical staff as well. In addition, because of Chicago's ongoing Deep Tunnel project, Illinois has an edge over other areas in tunneling technology.

The Illinois state government has already allocated funds for geological, natural history and environmental impact surveys of the area. The Congressional delegation is preparing for its role in landing the project. State officials are also lining up private business support. But the final decision will be made in Washington and it will be based on national goals and the state of the economy, available scientific resources and local economic inducements, and, not least, political clout.

Figure 9. **National Science Foundation obligations for R&D to universities and colleges: 1982**
(per capita, percent of national average)



*Washington D.C.
NOTE: Alaska (445%) and Hawaii (134%) not drawn on map.

Services. Indiana, Illinois, and Wisconsin are above the national average in the receipt of R&D funds from the National Science Foundation on a per capita basis. None of the District states are major recipients of R&D funds from NASA.

Outlook for the Seventh District

Current trends in federal spending for R&D by the major agencies indicate that states in the Seventh District will not benefit from the increase in federal obligations for R&D. Consequently, federal R&D support cannot be relied upon to improve the competitive position of industry in the area or serve as a stimulus to the development of new goods and services.

The increased emphasis on defense-related R&D, in particular, will not benefit the District. Instead, it may be expected to improve the competitive position of a limited number of states where it is already important. Only if District industry begins to aggressively seek out defense R&D contracts, will states in the District obtain these funds, and the subsequent defense procurement contracts.

Increased federal funding for basic research, especially at universities, may be expected to aid the District states. Basic research, however, represents only 15 percent of the total federal R&D budget and the impact, therefore, may be limited. In addition, funding by the agencies where basic research will increase in real terms, namely, DOD, NASA, NSF, and DOE, is generally below the per capita national average in District states. It will require a concerted effort by both the private and public sectors to obtain funds from these departments and agencies for R&D in those fields where the District has, or expects to have, the resources and skills to conduct successful research.

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