

# ***The Future of Science and Technology in the Midwest: Trends and Indicators***

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## **Foreword**

After nearly 50 years of steadily increasing budgets, the U.S. research community is facing the prospect of significantly reduced federal funding. Efforts to balance the budget and reduce the size of the federal government have created great uncertainty about the future of federal funding for science and technology. Although science and technology funding fared relatively well in FY 1996, outyear projections by both the President and Congress indicate it will decrease significantly as discretionary spending falls over the next several years. At the same time, the congressional agenda is increasingly dominated by issues involving science and technology, and polls continue to show strong support for R&D among the American people.

In January 1996, the American Association for the Advancement of Science's Center for Science, Technology, and Congress undertook to produce a series of reports to provide information on the state and regional impacts of federal R&D spending and to organize a series of meetings associated with these reports. This report on science and technology in the Midwest was prepared for presentation at an August 21 meeting in Indianapolis, Indiana, sponsored by the Big Ten universities and the Center.

The goal of this project is to help the research community, both industrial and academic, state and federal lawmakers, and local opinion leaders better understand the effects of current trends in public and private sector R&D spending in key regions of the U.S. We also want to provide oft-requested information to Congress and the public about the role of science and technology, including federal, state, and industrial R&D, in the economies of various states.

In gathering information for *The Future of Science and Technology in the Midwest: Trends and*

*Indicators*, we used the most recent data available from the National Science Foundation. Because of the complexity of collecting information on a state-by-state basis, especially with regard to industry spending, the most recent NSF data details obligations from fiscal year 1994 and expenditures during the 1993 calendar year. The numbers may change as data for more recent years become available. We have augmented the NSF data with additional research and with projections of future government spending based on outyear funding data from the President's budget request and the congressional budget resolution. The report provides a statistical portrait of the Midwest's R&D activity as a region and an overview of R&D in each midwestern state; examines the distribution of federal R&D funding in the states; discusses university-based research, federal laboratories and FFRDCs; and assesses the potential future impacts of trends in R&D spending.

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### Highlights

- The seven states of the Midwest play a key role in the U.S. R&D enterprise. Nearly a quarter of the nation's R&D is performed in this region, primarily by industrial firms. The region received \$5.4 billion in federal R&D funds in fiscal year 1994, 8 percent of the national total.
- The region's technological strength comes from the diversity of the R&D performed in each of the states. **Illinois** has Argonne National Laboratory and four major research universities; **Indiana** performs automobile-related R&D and defense development; **Iowa** has a diverse and well-balanced set of R&D performers, including a national lab, research universities, federal labs, and industrial firms; **Michigan** has the fifth-ranked research university in the nation and a large private-sector R&D presence; **Minnesota** maintains a varied portfolio of R&D on health, defense, fish and wildlife management, and agriculture; **Ohio** has a strong network of federal and industrial labs conducting space and defense research; and **Wisconsin** has the eighth-ranked research university in the nation.
- Midwestern universities are major contributors to the U.S. R&D enterprise. They receive over 16 percent of all federal R&D support to universities, including over 20 percent of NSF's university support. Two universities (Michigan and Wisconsin) are ranked among the top ten university recipients of federal R&D funds, and 11 are in the top 50.
- The Department of Defense is the largest federal supporter of R&D in the Midwest, providing \$1.9 billion in FY 1994, over half of which went to Ohio.
- The Department of Health and Human Services (HHS) is the second-largest sponsor of R&D in the Midwest, with \$1.3 billion in FY 1994. Most of this support (\$1.1 billion) flowed to universities making HHS the largest federal supporter of university R&D in the Midwest.
- The National Science Foundation (NSF) is the second-largest supporter of R&D in Midwestern

universities, obligating \$361 million in FY 1994.

- The Midwest is home to three federally funded research and development centers (FFRDCs), which performed \$665 million in R&D in FY 1994 for the Department of Energy. Argonne National Laboratory and Fermi National Accelerator Laboratory, both in Illinois, performed \$393 million and \$230 million in R&D, respectively, and Ames Laboratory in Iowa performed \$31 million in FY 1994.
- Congressional and Administration budget plans call for nondefense R&D to decline by nearly 25 percent in real terms by 2002. The President's latest budget plan calls for defense R&D to decline by up to a third in real terms over the next six years. If these plans are followed, federal support for R&D in the Midwest could decline significantly.

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## Overview

The seven midwestern states--Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, and Wisconsin--have experienced a strong economic resurgence in the 1990s after a long period of decline. Long associated with smokestack industries, the Midwest now boasts a highly diversified economy including many high-technology industries. Even the automobile industry, the leading industry in the region, relies heavily on cutting-edge technologies in the design and manufacture of its products.

Research and development is an integral part of the Midwest's regional economy. In 1993, the latest year for which comprehensive figures on industrial as well as federal R&D expenditures are available, \$32 billion was spent on R&D in these seven states, accounting for about one-fifth the national effort (see Table 1). This is roughly proportional to the Midwest's one-fifth share of the U.S. population.

Private industrial firms dominate R&D in the Midwest. Of the \$32 billion in R&D performed in the Midwest in 1993, \$25 billion was funded by industry. The Midwest is home to a number of companies with strong R&D investments, such as GM, Ford, Chrysler, 3M, and Motorola, all of which have large R&D laboratories in the region. Over a quarter of the nation's industry-funded R&D, now approaching \$100 billion a year, is performed in the Midwest. Aspects of the region's industrial R&D are discussed in the individual state overviews following the tables and charts in this report.

The Midwest has traditionally relied on industrial R&D for the strength of its R&D enterprise, but the federal role is also vital. In FY 1994, the latest year for which statistics on federal government obligations are available, the federal government obligated \$5.4 billion in funds for R&D to the Midwest. Of this amount, the largest share (\$1.9 billion) went to the region's universities, followed by industrial firms (\$1.5 billion), government labs (\$1.0 billion), and three federally funded research and development centers (FFRDCs) in Illinois and Iowa (\$665 million) (see Table 2).

Although the flow of federal R&D funds to the region is significant, it is less than what one might expect based on the region's population and economic strength. For the past few decades, federal R&D to the Midwest has remained fairly steady at about 8 percent of total federal R&D (see Chart 7). This is less than the Midwest's 19 percent share of the U.S. population and is far less than the Midwest's 25 percent share of industry-funded R&D. A recent report by the Northeast Midwest Institute, which tracks the flow of federal funds to the region, notes that although the seven states of the Midwest or Midwest account for 19.4 percent of the U.S. population, the region receives

only 16.5 percent of total federal spending. The Institute calculates that for every federal tax dollar that the Midwest sends to the federal government, only 84 cents come back to the region, while nearly every state in the South and Great Plains regions receives more from the federal government than it pays in taxes.

Only in federal support for university R&D, in which Midwestern universities capture 16 percent of total federal support for university R&D, does the Midwest come close to winning a share of the national total proportional to its share of the U.S. population. Midwestern firms receive only 5 percent of total federal support for R&D, chiefly because the largest defense contractors, who receive over half of all federal support for industrial R&D, are located outside the region, in the South and the West. Similarly, government labs in the region receive only 7 percent of total federal support for government labs. The three Midwest FFRDCs (government-owned labs operated under contract by non-government institutions) account for 11 percent of total federal spending on FFRDCs.

Chart 6 shows that in real terms (after adjusting for inflation), federal R&D funding to the Midwest generally increased from the mid-1970s until FY 1990, paralleling growth in total federal R&D spending during that period. Since FY 1990, federal R&D funding has been in slow decline. A closer look at the chart shows that Ohio accounts for much of the fluctuation over the years. Ohio receives nearly half of its R&D funds from the Department of Defense, and is therefore sensitive to trends in defense spending, which has decreased steadily since the end of the Cold War. The other six states have held fairly steady and have even increased slightly over the past decade, mirroring trends in overall nondefense R&D spending by the federal government.

As Table 3 shows, Ohio receives the most federal R&D funds among the seven states, with a \$1.9 billion inflow to the state economy in FY 1994, placing it 14th among the states, followed by Illinois (16th) with \$1.3 billion. These two states, ranked 7th and 6th respectively in population, account for the majority of federal R&D funds to the Midwest. Iowa received the least of the seven states, \$234 million in FY 1994.

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### Universities and Colleges

Federal support for R&D is especially important to the region's network of large research universities, many of which were founded as land-grant institutions over a century ago. Together, the Midwest's universities received \$1.9 billion in R&D funds from the federal government in FY 1994 (see Table 4), and received even more in federal funds when training grants, student aid, and other non-R&D funds are counted. Over half of the federal funds for university R&D came from the Department of Health and Human Services (HHS), home of the National Institutes of Health (NIH). NIH provides nearly half of federal funding for university research, and that is true for the Midwest as well. In FY 1994, HHS sponsored \$1.1 billion in R&D in Midwestern universities, nearly three times the level of the next-largest sponsor, the National Science Foundation (NSF), with \$361 million. Other important sponsors are the Department of Defense (DOD, \$197 million), the National Aeronautics and Space Administration (NASA, \$71 million), the Department of Energy (DOE, \$93 million), and the U.S. Department of Agriculture (USDA, \$87 million).

The strength of the region's universities at winning federal research grants can be seen in Table 4 and Chart 5. Both the University of Michigan and the University of Wisconsin-Madison rank among the top ten recipients of federal R&D funds, and the breadth of the region's excellence can be seen by the presence of 11 institutions, at least one from each of the seven states, among the top 50 recipients. Six universities in the region receive over \$100 million annually from the federal government for R&D, with another seven receiving between \$60 and \$100 million.



Nationwide, the federal government funds over 60 percent of the R&D conducted at universities. Most of the larger Midwest universities receive at least 50 percent of their total R&D budgets from the federal government, dwarfing other sources such as institutional, state, and local government funds (see Table 5). Industrial contributions to university research have been growing in recent years, but they still account for less than 10 percent of total university R&D. Continued federal support for R&D is vital to the continued strength of research capabilities at these universities.

Table 5 shows the extent to which universities in the Midwest depend on federal R&D funds. The University of Michigan, the 5th largest university recipient of federal funds for R&D, depends on the federal government for over 60 percent of its research. NIH alone is responsible for over half the federal contribution, meaning that more than one-third of the university's R&D is funded by NIH. The trend is similar among the other major research universities in the region. Whether public or private, the federal government is the primary supporter of research at these universities and makes possible not only the bulk of the research done on campus but also faculty support, research training for graduates and undergraduates, and funding for graduate education.

State and local governments fund 10 to 20 percent of the R&D conducted at many of the major universities, and their indirect support for facilities, operating funds, and other costs associated with running the university is important. In an era when state education budgets are increasingly constrained by other state needs, it seems unlikely that this source will expand significantly. Similarly, institutional funds support a significant part of the research conducted on campuses, but public resistance to tuition increases, especially at the public universities, will make expanding this revenue source difficult. Finally, industry is unlikely to fill any gaps caused by declines in other funding sources because it starts from a such small base, less than 10 percent of total R&D funding. Despite significant increases over the past decade and a variety of innovative partnership strategies to better link university and industrial research, industrial funding of university R&D is likely to remain a relatively small part of the overall funding picture for universities.

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### **Government Laboratories**

Government laboratories received \$1 billion in federal R&D funds in FY 1994, of which two-thirds went to labs in Ohio (Table 2). Over half of these funds came from the Department of Defense, which has labs in each of the seven states. DOD labs perform most of their work in the development and prototype evaluation of new weapons systems. The largest federal laboratory in the region is the NASA Lewis Research Center in Cleveland and Sandusky, Ohio, which received close to \$300 million in R&D funds in FY 1994. Lewis employs over 5,000 people, about half of whom are scientists and engineers.

The Department of Agriculture has a large network of laboratories in the region, with at least one facility in each of the seven Midwest states. These labs, funded through the Agricultural Research Service (ARS) and the Forest Service, are often located on the campuses of the network of land-grant universities in the region, although they operate independently. The largest ARS lab in the region is the National Center for Agricultural Utilization Research in Peoria, Illinois. Its ten research units cover a diverse portfolio of agricultural research issues. Together with other ARS units in Urbana, the Illinois USDA labs received over \$30 million in R&D funds in FY 1994. Other significant labs in the region are the ARS labs in Ames, Iowa, including the National Animal Disease Center and the National Soil Tilth Laboratory, with \$25 million in FY 1994, and several research units in Madison, Wisconsin, receiving \$25 million in FY 1994. The Forest Service maintains labs in Michigan, Minnesota, and Wisconsin to perform forestry research.

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## **Federally Funded Research and Development Centers**

The Midwest is home to three federally funded research and development centers (FFRDCs), which received \$665 million in FY 1994. FFRDCs are government-owned facilities which, unlike government labs, are operated and managed either by universities, industrial firms, or nonprofit organizations to conduct research for the federal government. There are a total of 39 FFRDCs in the United States. The largest in the Midwest is Argonne National Laboratory in Argonne, Illinois, which conducts R&D primarily for the Department of Energy. Operated by the University of Chicago, Argonne received \$393 million for R&D in FY 1994, including funds for R&D facilities, and employs 4,500 people. Its research falls into four broad categories: materials science, energy and environmental science, engineering research, and physical research. Fermi National Accelerator Laboratory, in Batavia, Illinois, specializes in high-energy physics research. Because of its unique facilities, much of the field of high-energy physics conducts its experiments here. FermiLab is operated by a consortium of research universities.

The other FFRDC in the region is Ames Laboratory in Ames, Iowa, operated by Iowa State University of Science and Technology, which received \$31 million from DOE in FY 1994 to perform energy-related research. It employs approximately 650 people.

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## **Outlook and Conclusion**

Over time the Midwest's share of total federal support for R&D has been steady at about 8 percent, as shown on Chart 7. This means that the flow of R&D funds to the region has mirrored national trends in R&D funding. The Midwest's steady share of total R&D is a result of the diversity of the region's R&D institutions and federal funding sources, detailed earlier in this report, and this consistency suggests that the future of R&D in the Midwest will continue to track national trends.

As in the nation as a whole, federal support of R&D in the Midwest has helped to build a strong R&D enterprise. Federal support for R&D has been especially important for the region's universities, which are world-class centers of excellence that not only perform research at the frontiers of knowledge but also attract faculty and students from all over the world. Federal funds have also helped to sustain the region's privately funded R&D, through the support of graduate education of scientists and engineers at the region's universities who go on to staff industrial R&D labs and also through linkages between federal and private R&D, especially evident in the Midwest in the links between commercial agriculture and federally funded agricultural research.

The continued strength of the region's R&D institutions as we prepare to enter the 21st century, however, is in doubt because the national funding outlook for R&D is one of uncertainty mixed with pessimism. As Chart 6 shows, real federal support for R&D in the Midwest peaked in FY 1990 and has been headed downward ever since, the same as for the nation as a whole. Growth in federal support for R&D has failed to keep pace with inflation during the 1990s, especially on the defense side where defense R&D now stands at 70 percent of the peak Cold War spending level in FY 1987. Even federal support for nondefense R&D will fail to keep pace with inflation in the current fiscal year (1996).

Congress in 1995 passed a Concurrent Budget Resolution laying out its plans to eliminate the federal deficit in seven years. The resolution marked most nondefense discretionary programs for sharp cuts in FY 1996, followed by progressive reductions in subsequent years out to FY 2002. Although most R&D programs were not targeted for cuts greater than the norm, and NSF and NIH, two key basic research agencies, were given relatively favorable treatment, the net result was a projected cut of one-third in real (inflation-adjusted) spending for nondefense R&D over the

seven-year period.

Fortunately, the details of the budget resolution are not binding on the Appropriations Committees (which are responsible for the actual spending legislation), and when the dust settled on the budget for FY 1996, the reductions in many R&D areas were smaller than had been called for in the resolution. Overall, nondefense R&D in FY 1996 was down about one percent relative to FY 1995—nothing for the R&D community to celebrate, but better than had been anticipated by many observers.

The FY 1996 budget battle, however, was only the beginning of what is likely to be a lengthy process. In their FY 1997 budget plans, both the President and Congress have projected spending patterns that would eliminate the deficit by FY 2002, primarily by reducing discretionary spending. Once again, R&D programs are at risk of serious reductions. Indeed, because (as agreed to in last January's "treaty" between the President and Congress) the two plans use the same Congressional Budget Office economic assumptions, they both reach approximately the same end-point. By FY 2002, nondefense R&D would be down about 19 percent under the President's plan and about 23 percent under the congressional plan. (The main reason these numbers look somewhat less draconian than the projections in last year's budget resolution is that expectations of future inflation have declined from an annual rate of about 3.0-3.5 percent last year to a rate of about 2.2 percent currently.)

A major difference between the President's plan and that of Congress is in FY 1997. The President proposes to increase some areas of discretionary spending, including most nondefense R&D, in FY 1997 before starting on the downward path toward FY 2002. Congress, under the FY 1997 Budget Resolution, would cut nondefense discretionary spending immediately, making the slope of the curve in subsequent years a bit less steep, but also making it more difficult to return to earlier spending levels, should political leaders wish to do so in future years.

Defense R&D figures prominently in support for industrial R&D in the Midwest; support for mathematics, computer science and engineering in midwestern universities; and for Ohio's many DOD laboratories. The President's latest budget plan for FY 1997 calls for the RDT&E account (which makes up 98 percent of DOD's R&D) to fall from \$34.7 billion in FY 1997 (itself a drop from the \$35.8 billion FY 1996 appropriation) to \$31.7 billion in FY 2002. After factoring in expected inflation, this amounts to a more than 25 percent drop between FY 1996 and FY 2002. Barring unusual changes in the allocation of DOD's R&D, the Midwest can expect a proportional share of the cut if the President's plan is enacted.

The Midwest's strength in privately funded R&D may shelter the region's economy somewhat from federal R&D cutbacks, but the region's universities, dependent on the federal government for over half of their research funding, are likely to feel the full impact of any cuts. The region's federal labs and FFRDCs, of course, are dependent on federal funds for all of their research.

These projections are, of course, not cast in concrete. As noted above, when push came to shove last year, congressional appropriators provided more money for R&D programs than had been called for in the FY 1996 budget resolution. This could well happen again in future years. However, with both Congress and the President committed to balancing the budget by FY 2002 without raising taxes and without seriously tackling the growth of entitlement programs, substantial reductions in overall discretionary spending seem inescapable. R&D is part of the discretionary component of the federal budget. It has grown in tandem with increases in discretionary spending. It is likely to decline as the discretionary pie shrinks. The consequences for the future of the Midwest's R&D institutions, both government and private, and for the region's economy could be profound.



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