

## Observations on the President's Fiscal Year 2002 Federal Science and Technology Budget

### DETAILS

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**Observations on the  
President's Fiscal Year 2002  
Federal Science and Technology Budget**

Committee on the Federal Science and Technology Budget

Committee on Science, Engineering, and Public Policy

NATIONAL ACADEMY OF SCIENCES  
NATIONAL ACADEMY OF ENGINEERING  
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The National Research Council supported this study. It was prepared by Committee on the Federal Science and Technology Budget under the aegis of the Committee on Science, Engineering, and Public Policy (COSEPUP). COSEPUP is a joint committee of NAS, NAE, and IOM. It includes members of the councils of all three bodies.

Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the organizations or agencies that provided support for the project.

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## PREFACE

In 1995, the National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and National Research Council issued a report entitled *Allocating Federal Funds for Science and Technology*, which recommended tracking federal investments in the creation of new knowledge and technologies—what the report referred to as the federal science and technology budget (FS&T).

The Academies' Committee on Science, Engineering, and Public Policy (COSEPUP) has issued three reports in an annual series tracking the President's proposed FS&T budget and commenting on its potential impact on our ability to meet national goals and sustain global leadership in science and engineering. This report is the fourth in this annual series. It is authored by the Committee on the Federal Science and Technology Budget under the aegis of COSEPUP.

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the NRC's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report: William R. Brinkley, Baylor College of Medicine; Daniel C. Drucker, University of Florida; Susan Fitzpatrick, James S. McDonnell Foundation; Christopher T. Hill, George Mason University; Kei Koizumi, American Association for the Advancement of Science; W. Carl Lineberger, University of Colorado; Ronald F. Probst, Massachusetts Institute of Technology; Paul M. Romer, Stanford University; and Daniel R. Sarewitz, Columbia University.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by Floyd E. Bloom, Scripps Research Institute. Appointed by the National Research Council, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

The production of this report was the result of hard work in a short time period by the study committee, chaired by James Duderstadt and consisting of Lewis Branscomb, Mildred Dresselhaus, Jack Halpern, Ruby P. Hearn, and Anita Jones. The Committee was assisted in this study by Peter Henderson, study director, and Evelyn Simeon, administrative associate, in the NRC's Division of Policy and Global Affairs.

James Duderstadt, Chair  
Committee on the Federal Science and Technology Budget





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## OVERVIEW OF THE REPORT

### ALLOCATING FUNDS FOR SCIENCE AND TECHNOLOGY

In 1994, the U.S. Senate Committee on Appropriations requested the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine to issue a report that addressed “the criteria that should be used in judging the appropriate allocation of funds to research and development activities, the appropriate balance among different types of institutions that conduct such research, and the means of assuring continued objectivity in the allocation process.”<sup>1</sup> *Allocating Federal Funds for Science and Technology*, the resulting report issued in 1995, recommended the Executive Office of the President and Congressional appropriators develop a more coherent budget process for determining the federal investment in programs that create new knowledge and technologies—the federal science and technology (FS&T) budget. The report recommended the President should, as an outcome of this process, present annually a comprehensive FS&T budget that both addresses national priorities and fosters a world-class science and technology enterprise.

Since then, the National Academies have tracked the FS&T budget in a series of annual reports. The Academies have examined FS&T as that part of federal R&D spending, as estimated by the agencies, that creates new knowledge or technologies. At the same time, the Executive Office of the President has developed through the last four budget cycles another method for tracking the federal investment in key science and technology programs that is independent of R&D estimates provided by agencies. In the Administration’s fiscal year 2002 budget, this tabulation was explicitly titled the Federal Science and Technology Budget and it was justified by reference to *Allocating Federal Funds* and its call for highlighting “more consistently and accurately activities central to the creation of new knowledge and technologies.”

The President’s fiscal year 2002 budget, therefore, represents an important opportunity for institutionalizing an annual, concerted focus on the nation’s plans for investing in science and technology. In the interest of sound science policy and an efficient budget process, the science and engineering community and the Administration would be well served by adopting a single method for tracking the FS&T budget. This report endorses the Administration’s approach to examining the federal science and technology budget and accepts its definition of the FS&T budget as an appropriate baseline for further analysis and possible refinement. The Administration’s approach focuses on the largest S&T programs. It includes all costs associated with those programs, including staff salaries. It also includes key science and engineering education programs at the National Science Foundation that are not considered R&D but are critical investments in science and technology. It is comprised of identifiable line items in the budget, permitting easy tracking through the Congressional appropriations process. By contrast, neither R&D nor the Academies’ FS&T can be tracked in this manner, since they are based on agency estimates rather than on budget line items.

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<sup>1</sup> National Research Council, *Allocating Federal Funds for Science and Technology* (Washington, D.C.: National Academy Press, 1995), p. v.

Federal spending in three key program areas that are included in the National Academies' tabulation of the FS&T budget—Advanced Technology (6.3)<sup>2</sup> in the Department of Defense (DOD) (\$4.1 billion), Atomic Weapons Defense Activities in the Department of Energy (DOE) (\$2.9 billion), and Human Space Flight R&D at the National Aeronautics and Space Administration (NASA) (\$2.8 billion)—account for almost all of the \$10 billion difference between it and the way the Administration tracks FS&T. As the Administration's tabulation has evolved, the U.S. Office of Management and Budget (OMB) has made changes from year-to-year in what is included in the Administration's tabulation. The Administration should continue to refine its tabulation, examining further, if it has not already done so, whether other federal programs might also be included, in whole or part, in its FS&T budget calculation. To make the FS&T budget category useful, though, it needs a stable, rational definition. OMB, in consultation with the White House Office of Science and Technology Policy, should prepare a document that provides such a definition and the rationale underlying it.

### THE PRESIDENT'S FY 2002 FS&T BUDGET

The President's FY 2002 budget proposal would increase FS&T spending in constant dollars by \$950 million, or 1.7 percent, according to the Academies' method for tabulating FS&T, and by \$1.44 billion, or 3.0 percent, under the Administration's method. Either way, however, the FS&T budget would decrease substantially from FY 2001 to FY 2002 when the budget for the National Institutes of Health (NIH) is excluded. Indeed, once FS&T at the NIH is excluded, FS&T under the President's budget proposal would be reduced in constant dollars below its level in FY 1994.<sup>3</sup>

With the exception of FS&T at NIH and at the Department of Transportation, which is independently supported by the Federal Highway Trust Fund, FS&T spending would be flat or cut at all other major science and technology agencies. To cite one key example, the budget of the National Science Foundation (NSF), which increased 11.0 percent in constant dollars from FY 2000 to FY 2001, would decrease 0.8 percent from FY 2001 to FY 2002 under the President's proposal. FS&T in NSF's Research and Related Activities account would decrease even further, by 2.9 percent in constant dollars.

The increase of 11.3 percent in the NIH budget contributes to the national goal of improving the health of the American people. It also contributes substantially toward advancing life sciences research in the United States, particularly biomedical research. The goal of improving the health of the American people would also be well served by federal investment in fundamental research areas outside the life sciences funded by other agencies.<sup>4</sup> In the past, such investments in the physical sciences and engineering have led to breakthroughs in medical technology such as magnetic resonance imaging, positron emission tomography, and

<sup>2</sup> The Department of Defense has classified activities in its Research, Development, Test, and Evaluation (RDT&E) program into seven categories: Basic Research (6.1), Applied Research (6.2), Advanced Technology (6.3), Demonstration and Validation (6.4), Engineering and Manufacturing Development (6.5), RDT&E Management Support (6.6), and Operational Systems Development (6.7).

<sup>3</sup> Budget amounts for FY 2002 are proposed spending levels under the President's budget request; figures for earlier years are actual or estimated Congressional appropriations.

<sup>4</sup> U.S. House of Representatives, Committee on Science, *Unlocking our Future: Toward a New National Science Policy*, September 1998.

miniaturization in arthroscopic surgery. Similarly, funding for social science research has contributed to an understanding of how modifying individual behavior or social structures can impact both individual health and health care delivery. Under the President's proposal, these investments would be reduced.

As it deliberates the federal budget and agency appropriations, Congress should bear in mind other national priorities and the FS&T expenditures that may be necessary to support them. The Administration's reviews of national goals and policies in national security, energy security, and the climate change carried out since the release of the President's budget proposal, suggest that Congress should take a close look at FS&T funding at the Department of Defense, Department of Energy, and the Environmental Protection Agency, among other agencies, to ensure that our nation's investments in science and technology are sufficient to provide the research necessary to meet our goals in these areas.<sup>5</sup> Similarly, the national goal of a world-class science and technology enterprise, one that has provided the underpinning for recent, sustained economic growth, requires adequate FS&T spending across many fields of science and engineering, a goal that cannot be accomplished if FS&T spending is increased in only one or two agencies.<sup>6</sup> At a minimum, Congress should consider carefully the current and future budgetary requirements for programs that support FS&T at the National Science Foundation, which is critical to providing funding for research across the science and engineering enterprise. Congress should also consider current and future science and technology funding through other federal agencies. These agencies are vital for achieving national goals in defense, energy security, and the environment in addition to fostering a world-class national science and technology enterprise.

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<sup>5</sup> The Administration's budget proposal was released on April 9, 2001. U.S. Office of Management and Budget, *Budget of the U.S. Government, FY 2002* (Washington, D.C.: U.S. Government Printing Office, 2001). The Administration's review of U.S. military posture, which was begun prior to the release of the President's budget proposal in April, was still underway when this report was submitted for external review in late June. This review, and its potential budget implications, are described in Executive Office of the President of the United States, *A Blueprint for New Beginnings: A Responsible Budget for America's Priorities*, pp. 53-54, on the web at <http://www.whitehouse.gov/news/usbudget/blueprint/budtoc.html>. Similarly, the President organized, in late January, a cabinet-level task force, chaired by Vice President Richard Cheney, to develop a national energy policy. The final report of this task force was released after the Administration's budget, on May 16, 2001. National Energy Policy Group, *National Energy Policy: Report of the National Energy Policy Group*, May 2001 (Washington, D.C.: U.S. Government Printing Office, 2001). Since the release of its budget proposal, the Administration has also begun a reassessment of its policies on global climate change. See Letter from the White House to Dr. Bruce Alberts, May 11, 2001, Appendix A, in National Research Council, *Climate Change Science: An Analysis of Some Key Questions* (Washington, D.C.: National Academy Press, 2001), p. 27.

<sup>6</sup> F.M. Scherer, *New Perspectives on Economic Growth and Technological Innovation* (Washington, D.C.: Brookings, 1999). Eugene Wong, "An Economic Case for Basic Research," *Nature* (1996) 381: 187-188. National Research Council, *Harnessing Science and Technology for America's Economic Future* (Washington, D.C.: National Academy Press, 1999).



# OBSERVATIONS ON THE PRESIDENT'S FY 2002 FEDERAL SCIENCE AND TECHNOLOGY BUDGET

## ALLOCATING FUNDS FOR SCIENCE AND TECHNOLOGY

### The Federal Science and Technology Budget

Since World War II, the science and engineering enterprise in the United States has produced enormous benefits for the nation's economy, defense, health, and social well being. Numerous reports over the past decade have documented this key role for science and engineering and have argued persuasively that advancing science and technology in the future is key to sustaining our nation's future health, security, and prosperity.<sup>7</sup>

In *Science, Technology and the Federal Government: National Goals for a New Era* (1993), *Allocating Federal Funds for Science and Technology* (1995), and subsequent reports in this series, the National Academies have called for the nation to continue to invest in science and technology at a level that allows the United States to sustain preeminence in a select number of fields and to perform at a world-class level in all other fields of science and technology. The federal government plays a critical role in funding the science and engineering enterprise in the United States. Since 1980, industry's share of R&D has grown from one-half to two-thirds, but industry spent just 9 percent of its R&D funds in 1999 on basic research, while it spent 20 percent on applied research and 71 percent on development.<sup>8</sup> Thus, in 1999, the federal government provided 50 percent of funding for basic research, compared to 33 percent from industry. Accordingly, the federal government remains a critical source of funds for research that creates new knowledge and enabling technologies and provides the underpinning for the applications fueling a growing high-tech economy.

Given the continuing role of federal funding in meeting our nation's goals for advancing science and technology, *Allocating Federal Funds* specifically recommended that the President and Congress should ensure that federal spending on science and technology is both sufficient and targeted. The report urged that the President, with the advice of the directors of the Office of Management and Budget and the Office of Science and Technology Policy, develop a coherent and comprehensive process for deciding how federal funds should be invested in science and technology. The report also urged that the Administration present to Congress a federal science and technology (FS&T) budget, defined as the federal investment leading to the "creation of new knowledge and enabling technologies."<sup>9</sup> The FS&T budget should, in the aggregate, be sufficient to both meet agency missions and sustain the nation's leadership role in science and technology.

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<sup>7</sup>F.M. Scherer, *New Perspectives on Economic Growth and Technological Innovation*, (Washington, D.C.: Brookings, 1999). Eugene Wong, "An Economic Case for Basic Research," *Nature* (1996) 381: 187-188. National Research Council, *Harnessing Science and Technology for America's Economic Future* (Washington, D.C.: National Academy Press, 1999).

<sup>8</sup>National Science Foundation, *National Patterns of R&D Resources: 2000 Data Update* (NSF 01-309), Arlington, Va.: National Science Foundation, 2001.

<sup>9</sup>*Allocating Federal Funds*, p. 4.



## Tabulating the FS&T Budget

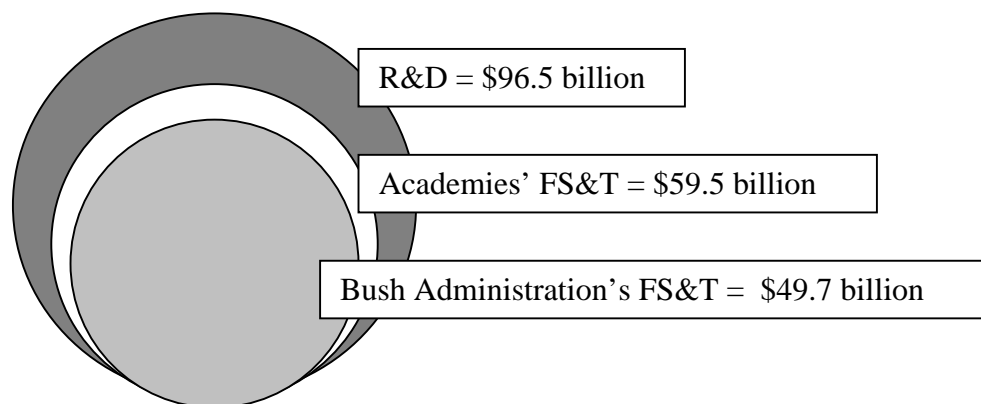
The FS&T budget has been defined by the Academies as federal R&D spending that creates new knowledge and enabling technologies. As a practical matter, FS&T has been calculated by taking as FS&T the R&D budget for most federal agencies. The Department of Defense has more precisely identified that part of its Research, Development, Test and Evaluation (RDT&E) that is explicitly an investment in science and technology, so the Academies method has included for DOD its spending on basic research (6.1), applied research (6.2), and advanced technology (6.3). The Academies method for calculating FS&T has excluded R&D in programs that clearly involve testing, evaluation, or other activities not primarily devoted to the creation of new knowledge or technologies: the Demonstration and Validation (6.4), Engineering and Manufacturing Development (6.5), RDT&E Management Support (6.6), and Operational Systems Development (6.7) programs in the Department of Defense (DOD) budget, as well as the Naval Reactor Program in the Department of Energy (DOE).

The National Academies' Committee on Science Engineering, and Public Policy (COSEPUP) has issued three annual reports providing observations on the Administration's proposed FS&T spending in fiscal years 1999, 2000, and 2001. These reports have provided the Administration, Congressional appropriators, and the science policy community with data on that part of the R&D budget that focuses on science and technology. During that same period, the Clinton Administration moved toward the FS&T concept by identifying, in addition to the R&D budget, the federal investment in an array of major science and technology programs. In its first iteration in fiscal year 1999, this crosscut was presented as the Research Fund for America (RFFA), which focused exclusively on civilian research programs. Over the next two budget cycles, this crosscut was renamed the 21<sup>st</sup> Century Research Fund and expanded to include basic research (6.1) and applied research (6.2) in the Defense budget.

The new Administration's fiscal year 2002 budget proposal represents an important opportunity for institutionalizing an annual, concerted focus on the nation's plans for investing in science and technology. In its budget proposal, the Bush Administration has continued the practice of including a science and technology crosscut in its budget proposal, modifying the 21st Century Research Fund further and renaming it the "Federal Science and Technology Budget." In doing so, moreover, the Bush Administration cited the recommendation in *Allocating Federal Funds* for highlighting "more consistently and accurately activities central to the creation of new knowledge and technologies" as the justification for including the FS&T budget in its budget proposal.<sup>10</sup>

Figure 1 and Table 1 compare the National Academies' tabulation of the FS&T Budget (\$59.5 billion) with both the Administration's method of tabulating FS&T (\$49.7 billion) and the traditional R&D spending crosscut (\$96.5 billion) in the President's FY 2002 budget proposal. As the figure and table show, the Administration's FS&T budget tabulation differs from the Academies' FS&T tabulation by about \$10 billion. The inclusion in the National Academies' FS&T budget of the DOD advanced technology (6.3) budget (\$4.1 billion), the DOE Atomic Weapons Activities (\$2.9 billion), and NASA Human Space Flight R&D (\$2.8 billion) accounts

<sup>10</sup> U.S. Office of Management and Budget, *Budget of the U.S. Government, FY 2002: Analytical Perspectives* (Washington, D.C.: U.S. Government Printing Office, 2001), p. 135.



**FIGURE 1. Proposed FY 2002 federal spending for R&D and FS&T**

for almost all of the numerical difference between the Academies' and Administration's FS&T calculations. In addition, the Academies' FS&T budget includes R&D at all federal agencies, while the Administration's FS&T focuses on the 12 largest R&D agencies.

In addition to differences in the programs included in the tabulation, there are other differences in the ways the Academies and the Administration approach the budgets of the 12 largest R&D agencies. The Academies have constructed the FS&T budget by including only investments that each of these agencies estimates as R&D (excluding DOD 6.4-6.7 and DOE Naval Reactors R&D). The Administration, however, includes the entire budget for each of the major science and technology programs it highlights, not just their R&D components. For example, FS&T at NSF under the Academies' tabulation is \$3.226 billion. The Administration, however, includes salaries, the Inspector General's office, and education and human resources programs at NSF, resulting in FS&T for that agency of \$4.472 billion. Similarly, the entire budgets are also included for NIH, DOE's Energy and Science Programs, the National Institute for Standards and Technology, and the U.S. Geological Survey. The Administration believes the inclusion of the full budget, including salaries for staff who make funding and other programmatic decisions for these agencies and programs, provides a more accurate measure of the nation's expenditures on science and technology.

For four years, the National Academies and the Administrations of both President Clinton and President Bush have tracked federal spending on science and technology. The philosophical underpinnings and methods of tabulations used by the Academies and the two Administrations have been converging over time. It is in the interest of both sound science policy and an effective budgetary process that the science and engineering community and the Administration adopt one method of tabulating the Federal Science and Technology Budget.

There is considerable merit to the method for tabulating the federal investment in science and technology developed over the past several years by the U.S. Office of Management and Budget and included in the Bush Administration's FY 2002 budget request. First, the practice of

including the full budget for a program highlights the importance of program management and salary costs that are critical to operating science and technology programs but are not always included in agency estimates of R&D. Incorporating the full budget of an agency, such as NSF, means that its science and mathematics education programs, arguably key investments in science and technology that are not counted as R&D, are included in calculating the federal investment in S&T. Second, the Administration's method of including the full budget for each science and technology program allows each item and the entire FS&T budget to be tracked through the appropriations process, a feature that the R&D budget and the Academies' FS&T budget lack. As a tool for affecting the Congressional appropriations process, therefore, the Administration's approach has considerable advantages.

Given its benefits, the Administration's approach to tabulating the Federal Science and Technology Budget is the preferred method for tracking FS&T. The Administration should continue to tabulate this budget in future years and the science and engineering community should likewise focus its observations on this tabulation. As the RFFA evolved into the 21<sup>st</sup> Century Research Fund and now the Federal Science and Technology Budget, the Clinton and Bush Administrations have made changes from year-to-year in what is included in the Administration's tabulation. The Administration should continue to refine its tabulation of the FS&T budget further to ensure that all federal programs that create new knowledge and technologies and can be tracked through the appropriations process are included. Over time, though, a stable definition of the FS&T budget category will be most useful. OMB, in consultation with the White House Office of Science and Technology Policy, should prepare a document that provides such a definition and the rationale underlying it.

## **THE PRESIDENT'S FY 2002 FS&T BUDGET**

### **The President's FY 2002 Proposal**

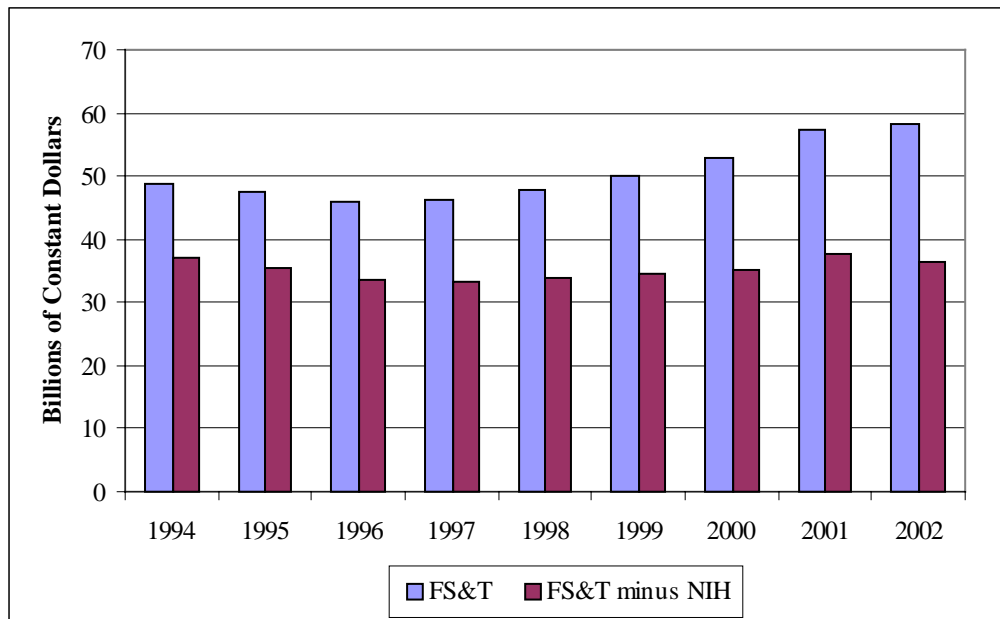
The nation should continue to invest in science and technology at a level that allows the United States to meet agency missions, address important national priorities, and sustain our global leadership in science and technology. Previous volumes in this series of annual *Observations* have expressed concern about our ability to meet these goals, given the overall size of the federal investment in S&T and differing rates of growth in agency S&T budgets and their impact on funding across the range of science and engineering disciplines.

As seen in Table 2 and Figure 2, the overall size of the FS&T budget decreased annually in constant dollars from FY 1994 to FY 1996, before turning up in FY 1997.<sup>11</sup> The Academies method of tabulating FS&T shows that the FS&T budget only surpassed its FY 1994 level in FY 1999. Increases since then have generated an overall increase of 17.3 percent in constant dollars from FY 1994 to FY 2001. The increase of 8.5 percent in FS&T from FY 2000 to FY 2001, however, comprises more than half of the overall increase in FS&T since FY 1994.<sup>12</sup>

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<sup>11</sup> The GDP deflator, which has been about 2.2 percent a year for 1994-2000, 2.0 percent for 2001, and 2.1 percent for FY 2002, is used in calculating constant-dollar figures.

<sup>12</sup> FY 1994 is the earliest year for which we have FS&T data. Since FY 1993 represents a peak year for R&D—and presumably FS&T—funding, FY 1994 can serve as a close approximation and a baseline for comparison.



**FIGURE 2. Federal science and technology budget and federal science and technology budget excluding NIH FS&T, billions of constant FY 2001 dollars, 1994-2002**

Note: FY 1994-2000 is actual Congressional appropriations; FY 2001 is estimated Congressional appropriations; FY 2002 is proposed spending under the President's FY 2002 budget proposal. Figure is based on data in Table 3, which uses the Academies' method for tabulating FS&T.

SOURCE: U.S. Office of Management and Budget, *Budget of the U.S. Government, FY 2002: Analytical Perspectives*; AAAS, *AAAS Report XXVI: Research and Development, Fiscal Year 2002*, (Washington, D.C.: AAAS, 2001), Table I-16. FS&T figures for 1994-1999 carried forward from *Observations on the President's FY 2001 Federal Science and Technology Budget*.

The President's FY 2002 budget proposal returns to a pattern of slower FS&T growth.<sup>13</sup> As seen in Table 3, the Academies' method of tabulating FS&T shows an increase of \$950 million, or 1.7 percent in constant dollars from FY 2001 to FY 2002. This compares to an average annual increase of 4.5 percent from FY 1996 to FY 2001. This increase is also less than the overall increase in discretionary spending requested by the Bush Administration (4.0 percent in current dollars; 1.9 percent in constant dollars). If one uses the Administration's tabulation of FS&T, that budget fares slightly better than discretionary spending as a whole, but the proposed 3.0 percent increase in FS&T in constant dollars is smaller than the 9.2 percent increase enacted last year, as seen in Table 4.

The overall increase in FS&T since FY 1994, as tabulated using the Academies' method, masks important differences in rates of growth for FS&T among agencies. While FS&T in the NIH budget increased 88.2 percent in constant dollars from FY 1994 to FY 2001, FS&T at all other agencies increased only 1.7 percent during the same period. Indeed, as seen in Figure 2 and

<sup>13</sup> Budget amounts for FY 2002 are proposed spending levels under the President's budget request; figures for earlier years are actual or estimated Congressional appropriations.

Table 2, the FS&T budget excluding NIH declined after FY 1994 and only surpassed the FY 1994 level in FY 2001.

The President's FY2002 budget proposal continues a pattern of substantially differing growth rates for the various science and technology programs in the federal government. In the Academies FS&T tabulation as seen in Table 3,<sup>14</sup> FS&T in NIH would increase more than \$2.2 billion, or 11.3 percent in constant dollars, from FY 2001 to FY 2002. FS&T without NIH would decrease by 3.4 percent from FY 2001 to FY 2002 and would, in constant dollars, return to a level below that of FY 1994. The only other major Department with a substantial increase would be the Department of Transportation (DOT), whose FS&T budget benefits from a dedicated source of revenue in the Federal Highway Trust Fund and would increase 4.6 percent in constant dollars. FS&T spending in all other departments and agencies with major FS&T programs would be flat or decrease in constant dollars from FY 2001 to FY 2002. FS&T at the National Science Foundation, which increased 9.6 percent from FY 2000 to FY 2001 in constant dollars, would decrease by 3.4 percent from FY 2001 to FY 2002. FS&T at NASA would decrease 1.7 percent; at DOE by 6.8 percent; at Commerce and Agriculture by 9.5 and 9.9 percent respectively.<sup>15</sup>

### The FS&T Budget and National Goals

The Administration developed its FY 2002 budget so that it would address key national goals articulated by the President during last fall's presidential campaign: enacting a \$1.6 trillion tax cut,<sup>16</sup> holding discretionary spending to an overall increase of four percent, and funding Administration initiatives in education, biomedical research, and defense. The Administration's FY 2002 Federal Science and Technology Budget proposal is a derivative of these fiscal and policy objectives. In reviewing the President's proposed FS&T budget, Congressional appropriators should bear in mind the range of our national goals in defense, energy security, environmental protection, health, the economy and other areas and ask whether the Administration's proposed investment in science and technology research is sufficient to address these goals in the short run and help achieve them in the long run.

First, the proposal for a large increase in funding for NIH to keep it on track for doubling its budget by FY 2003 was an important goal articulated by the President in the campaign and is now the centerpiece of the Administration's proposal for science and technology. The Administration sees the increase of \$2.2 billion, in constant dollars, in FS&T at NIH as an important step in improving the health of the nation's citizens.<sup>17</sup> NIH is a potent contributor to medical innovation and the growth of biotechnology and, thus, is one of several important means for addressing the most significant health problems of the U.S. population.<sup>18</sup>

<sup>14</sup> Agency trends are essentially the same whether one uses the Academies' or the Administration's FS&T budget.

<sup>15</sup> As of this writing, the final budget proposal of the Department of Defense has not been released, pending a strategic review of the Department's programs. In the meantime, DOD FS&T is assumed to be level-funded in constant dollar terms.

<sup>16</sup> Congress has since passed a tax cut of approximately \$1.3 trillion over 10 years.

<sup>17</sup> Executive Office of the President of the United States, "Continued American Prosperity: Increased Investments in Science and Technology," in *The President's FY 2002 R&D Budget*, April 9, 2001.

<sup>18</sup> Many critical health problems in the U.S. population are rooted in individual behavior and access to services and may not be directly addressed through advances in medical technology alone.

It is important for appropriators to understand, however, that the path of discovery from original research to application is highly uncertain and technological advances, whether in biomedical applications or other technology areas, can result from investments in fundamental research in a variety of areas. Federal funds that supported the “War on Cancer,” for example, led to dramatic gains in AIDS research, including identification of the Human Immunodeficiency Virus (HIV) and AZT, as well as critical new breakthroughs in molecular biology.<sup>19</sup> At the same time, many of the improvements in medical technology seen in the past decades are the result of the advancement of knowledge that comes from research outside the life sciences in such fields as physics or engineering and often funded by agencies other than NIH. Examples would include magnetic resonance imaging, positron emission tomography, and miniaturization in arthroscopic surgery. Similarly, funding for social science research has contributed to an understanding of how modifying individual behavior or social structures can impact both individual health and health care delivery.

Second, the constraints imposed on discretionary spending in the President’s proposal, especially once the Administration’s initiatives in education, biomedical research, and defense are funded, limit FS&T in agencies other than NIH to flat budgets at best, and large decreases at worst. This raises concerns about whether proposed FS&T spending in these agencies is sufficient for addressing national needs beyond improving the health of Americans.

The Administration argues that most FS&T programs are financially sound since many FS&T programs enjoyed unusually large increases in FY 2001. Even many agencies with decreases from FY 2001 to FY 2002, their argument continues, would have substantial average annual budgetary increases from FY 2000 to FY 2002. The Administration notes, for example, that the NSF budget would be 15 percent larger, in current dollars, in FY 2002 compared with FY 2000.<sup>20</sup> This would be an increase of 10 percent in constant dollars over the two-year period, even with a decrease of 0.8 percent from FY 2001 to FY 2002.

However, the Administration’s budget, developed in a time of transition from one Administration to another and from the presidential campaign to governance, may require adjustments to bring proposed FS&T spending more closely in line with national goals in such diverse areas as national security, energy, environmental protection, and excellence in science.

Since submitting its budget proposal, the Administration has undertaken program and policy reviews in areas in which science and technology play a key role in addressing national goals, but FS&T is either level funded or slated for reductions in FY 2002. The Administration is conducting a strategic review of the Department of Defense and may provide a new budget proposal for DOD FS&T, as well as for other DOD spending, that may bring spending in this area more in line with national goals for defense once the review is completed. The Administration has also reviewed, since submitting its budget proposal, our national energy goals and policies. Among the Administration’s energy proposals, for example, is increased use of nuclear energy to

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<sup>19</sup> J. Groopman, “The Thirty Years War,” *The New Yorker*, June 4, 2001, pp. 52-63.

<sup>20</sup> Briefing by Marcus Peacock, Associate Director for Natural Resource Programs, U.S. Office of Management and Budget, to Washington Science Policy Alliance, April 12, 2001. See also in handout from briefing, U.S. Office of Management and Budget, “Continued American Prosperity: Increased Investments in Science and technology,” in *The President’s FY 2002 R&D Budget*, April, 2001, p. 2.

generate electric power, though nuclear energy R&D was slated for a substantial budget reduction in the Administration's budget proposal. This policy shift suggests that Congress should review the Administration's proposed spending on the range of science and technology programs from nuclear energy R&D to sustainable energy R&D at the Department of Energy to determine if it is sufficient for both meeting national goals for energy security and the Administration's energy program. Similarly, the Administration has begun a re-examination of our nation's policies with regard to global climate change. Our ability to understand the phenomenon of global climate change is critical to forming policy in this area. Congress should fund scientific research at a level that would allow it to provide that understanding at this time of policy review and reformulation.<sup>21</sup>

Science and technology investments across the life sciences, physical sciences, and engineering have enabled much of the innovation that has been the source of our recent, sustained economic growth and are, therefore, critical to also addressing national economic goals. Research has continually led to promising commercial opportunities throughout the last 50 years. One of the key reasons for sustaining global leadership in science and technology is to generate further such opportunities and sustain economic growth and global competitiveness as well as meet our goals in national security, energy, the environment, and health.

Since we cannot predict which investments made today in science and technology will result in the key technologies and innovations of the future, this suggests a pattern of broadly supporting science and technology across fields, particularly in the area of basic research where the federal government plays a central funding role. In this regard, differing growth rates in FS&T investments across agencies and fields of science and engineering are of concern, particularly since FS&T in agencies other than NIH would fall below their FY 1994 level under the Administration's budget proposal. The Administration and Congress should examine spending plans carefully to ensure that the federal government is investing adequately not only in biomedical research, but in other areas that generate technological innovation such as information technology research, materials science, nuclear physics, or nanoscale science and technology.

A sense of our national goals and the role that a vital science and technology enterprise can play in addressing those goals in the short run and meeting them in the long run can provide a basis for evaluating the adequacy of agency spending on science and technology research. The Administration and Congress should pay attention to the long-run health of the science and engineering enterprise and its ability to help meet our national goals, particularly as they may shift in the future. In this latter regard, much greater attention needs to be given to the impact of budget reductions in agencies other than NIH on both research and human resources across science and engineering fields.<sup>22</sup>

While there are many indicators of productivity, it is worth noting, as one example, that while federal funding for physics research at our nation's universities decreased by more than one-fifth from 1993 to 1997, the number of article submissions by U.S. researchers to *Physical*

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<sup>21</sup> See footnote 5 on page 3 for details of these three program and policy reviews.

<sup>22</sup> National Research Council, *Trends in Federal Support of Research and Graduate Education* (Washington, D.C.: National Academy Press, July 2001) provides an in-depth statistical review of how trends in federal funding affect both research and graduate enrollment by field of science and engineering.

*Review* and *Physical Review Letters*—the two leading physics journals—peaked in 1993 and has been declining since.<sup>23</sup> At the same time, the number of such submissions by authors from Europe and the rest of the world has increased, indicating vitality of the field worldwide. These trends raise questions about whether we are continuing to sustain our global leadership in important fields such as physics.<sup>24</sup>

Federal research funding also supports the training of the next generation of scientists and engineers, and cuts in such funding send a discouraging signal to current and prospective graduate students. In fields with decreased federal support for university research between 1993 and 1997, there was also decreasing graduate enrollment from 1993 to 1999. For example, federal funding for university research in physics decreased 20.9 percent in constant dollars from 1993 to 1997 and graduate students with federally funded research assistantships in that field decreased 20.8 percent from 1993 to 1999 (graduate enrollment in physics decreased 22.1 percent during that period and has yet to turn up again). There were similar trends for mathematics, chemistry, chemical engineering, and astronautical engineering.<sup>25</sup>

Gauging future trends in the demand and supply of doctoral scientists and engineers is a complex exercise that cannot be undertaken lightly. Nonetheless, these trends in graduate enrollment raise questions about whether we are making an investment that is adequate for maintaining the vitality of our science and engineering human resources needed in the future. Federal policymakers and appropriators need to be cognizant of potential unintended consequences for the human resource base across fields necessary to a vibrant science and engineering enterprise as they craft budgets to meet agency missions.<sup>26</sup>

## CONCLUSIONS

In the interest of sound science policy and an efficient budget process for science and technology, it is time for the science and engineering community and the Administration to adopt one method for tabulating the Federal Science and Technology Budget. The Administration's approach has several merits: it focuses on the largest science and technology programs, including all costs associated with them; it also includes key science and engineering education programs at the National Science Foundation that are not considered R&D but are critical investments in science and technology; and it is comprised of identifiable line items in the budget, permitting easy tracking through the Congressional appropriations process. Because of this, the Administration's approach is preferred and OMB should continue to track the FS&T budget in this manner in future budget cycles. OMB should further revise its tabulation, as it has in the past, to ensure that programs that are primarily dedicated to the creation of new knowledge and

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<sup>23</sup> American Institute of Physics.

<sup>24</sup> National Academy of Sciences, National Academy of Engineering, Institute of Medicine, *Experiments in International Benchmarking of U.S. Research Fields* (Washington, D.C.: National Academy Press, 2000).

<sup>25</sup> NRC, *Trends in Federal Support of Research and Graduate Education*. Differing periods were used for research funding (1993-1997) and graduate enrollment (1993-1999) to account for the time lag in the effect of research funding changes on the hiring of graduate research assistants.

<sup>26</sup> National Research Council, *Forecasting Demand and Supply of Doctoral Scientists and Engineers: Report of a Workshop on Methodology* (Washington, D.C.: National Academy Press, 2000).



technology are included in it. To make the FS&T budget category useful, though, it ultimately requires a stable, rational definition. OMB should prepare a document that provides such a definition and the rationale underlying it.

The President's FY 2002 FS&T budget proposal presents a strong NIH budget that provides one avenue among many to move the nation toward achieving the goal of improved health for the American people. Proposed budgetary decreases in FS&T at other federal agencies are of concern for several reasons: breakthroughs in medical technology, which also improve the health of the American people, have often been the result of investments in areas outside the life sciences, such as physics, chemistry, engineering, and the social and behavioral sciences; national goals in defense, energy, the environment and other areas now under review may be well served by increases, rather than flat funding or decreases, for FS&T in other federal agencies; and the national goal of global leadership in science and technology, which continues to provide the underpinning for sustained economic growth, will require funding that ensures a world-class science and engineering enterprise across all fields. That FS&T in agencies other than NIH has been reduced in the President's budget proposal below that of FY 1994 suggests that a careful Congressional review of proposed FS&T spending across federal agencies is warranted as the appropriations process moves forward this year.

## **TABLES**



**TABLE 1 Alternative Perspectives on the President's FY 2002 Science and Technology Budget (millions of current dollars)**

Agency	Bush Admin.	Academies'	R&D
	FS&T	FS&T	
<b>Dept. of Defense*</b>	<b>5,086</b>	<b>9,589</b>	<b>45,855</b>
Basic research (6.1)	1,345	1,345	1,345
Applied research (6.2)	3,741	3,741	3,741
Advanced technology development (6.3)	--	4,082	4,082
Medical research (not included in 6.1-6.3)	--	421	421
Test and evaluation (6.4-6.7)	--	--	36,266
<b>National Aeronautics and Space Administration</b>	<b>7,038</b>	<b>9,966</b>	<b>9,966</b>
Science, Aeronautics, and Technology	7,038	7,141	7,141
Human space flight	--	2,825	2,825
<b>Dept. of Energy</b>	<b>4,682</b>	<b>6,733</b>	<b>7,399</b>
Science programs	3,160	2,930	2,930
Energy supply	494	284	284
Energy conservation	484	316	316
Fossil energy R&D	544	296	296
Radioactive waste management	--	31	31
Atomic defense programs (excl. Naval Reactors)	--	2,876	2,876
Naval reactors	--	--	666
<b>Dept. of Health &amp; Human Services</b>	<b>23,112</b>	<b>23,496</b>	<b>23,496</b>
National Institutes of Health (R&D)	22,395	22,395	22,395
National Institutes of Health (Non-R&D)	717	--	--
Other HHS R&D	--	1,101	1,101
<b>National Science Foundation</b>	<b>4,472</b>	<b>3,226</b>	<b>3,226</b>
Research and related activities	3,327	2,991	2,991
Major research equipment	96	96	96
Education and human resources	872	139	139
Salaries, Expenses, and Inspector General	177	--	--
<b>Dept. of Agriculture</b>	<b>1,759</b>	<b>1,803</b>	<b>1,803</b>
<b>Dept. of the Interior</b>	<b>814</b>	<b>593</b>	<b>593</b>
<b>Dept. of Transportation</b>	<b>631</b>	<b>798</b>	<b>798</b>
<b>Environmental Protection Agency</b>	<b>679</b>	<b>569</b>	<b>569</b>
<b>Dept. of Commerce</b>	<b>671</b>	<b>1,110</b>	<b>1,110</b>
<b>Dept. of Veterans' Affairs</b>	<b>361</b>	<b>722</b>	<b>722</b>
<b>Dept. of Education</b>	<b>368</b>	<b>259</b>	<b>259</b>
<b>Other Agencies</b>	<b>--</b>	<b>663</b>	<b>663</b>
<b>TOTAL</b>	<b>49,673</b>	<b>59,527</b>	<b>96,459</b>

\*The final Department of Defense budget has not yet been released, pending completion of a departmental strategic review. In the meantime, OMB has assumed increases in DOD science and technology (6.1-6.3) equal to inflation; the DOD R&D initiative would largely fall into the 6.4-6.7 categories.

Source: U.S. Office of Management and Budget, *Budget of the U.S. Government, FY 2002: Analytical Perspectives*, Table 7-3; AAAS, *AAAS Report XXVI: Research and Development, Fiscal Year 2002* (Washington, D.C.: AAAS, 2001).

**TABLE 2 National Academies' FS&T Budget, National Academies' FS&T Budget Excluding NIH FS&T, and Research and Development Budget, FY 1994-FY 2002 (millions of constant FY 2001 dollars)**

Fiscal year	FS&T		
	FS&T	Minus NIH	R&D
1994	48,910	36,997	80,839
1995	47,521	35,541	78,980
1996	46,013	33,545	77,710
1997	46,398	33,319	79,150
1998	47,700	33,863	80,159
1999	50,116	34,507	83,451
2000	52,846	35,246	85,548
2001	57,353	37,643	90,887
2002	58,303	36,369	94,475
Chg, FY1994-FY2001	17.3%	1.7%	12.4%
Chg, FY2000-FY2001	8.5%	6.8%	6.2%
Chg, FY2001-FY2002	1.7%	-3.4%	3.9%

Source: U.S. Office of Management and Budget, *Budget of the U.S. Government, FY 2002: Analytical Perspectives*; AAAS, *AAAS Report XXVI: Research and Development, Fiscal Year 2002* (Washington, D.C.: AAAS, 2001), Table I-16. FS&T figures for 1994-1999 carried forward from *Observations on the President's FY 2001 Federal Science and Technology Budget*.

**TABLE 3 The National Academies' Federal Science and Technology (FS&T) Budget, by Agency, FY 1999-FY 2002 (millions of constant FY 2001 dollars)**

Agency	1999 Actual	2000 Actual	2001 Est.	2002 Budget	Percent Change	
					FY 2000- FY 2001	FY 2001- FY 2002
<b>Dept. of Defense*</b>	7,923	8,784	9,392	9,392	6.9%	0.0%
Basic research (6.1)*	1,107	1,160	1,317	1,317	13.5%	0.0%
Applied research (6.2)*	3,182	3,477	3,664	3,664	5.4%	0.0%
Advanced technology dev. (6.3)*	3,594	3,846	3,999	3,999	4.0%	0.0%
Medical research (not in 6.1-6.3)*	40	301	412	412	36.8%	0.0%
<b>NASA</b>	10,113	9,694	9,925	9,761	2.4%	-1.7%
Science, Aeronautics, and Technology	7,697	6,616	7,024	6,994	6.2%	-0.4%
Human space flight	2,417	3,077	2,901	2,767	-5.7%	-4.6%
<b>Dept. of Energy</b>	6,476	6,434	7,076	6,595	10.0%	-6.8%
Science programs	2,781	2,718	2,955	2,870	8.7%	-2.9%
Energy supply	374	340	409	278	20.3%	-32.0%
Energy conservation	397	419	441	310	5.3%	-29.8%
Fossil energy R&D	307	296	396	290	33.7%	-26.8%
Radioactive waste management	65	61	45	30	-26.5%	-32.5%
Atomic defense (excl. naval reactors)	2,553	2,600	2,830	2,817	8.9%	-0.5%
<b>Dept. of Health &amp; Human Services</b>	16,471	18,564	20,859	23,013	12.4%	10.3%
National Institutes of Health	15,607	17,596	19,710	21,934	12.0%	11.3%
Other	864	968	1,149	1,078	18.7%	-6.1%
<b>National Science Foundation</b>	2,779	2,993	3,280	3,160	9.6%	-3.7%
Research and related activities R&D	2,591	2,764	3,018	2,929	9.2%	-2.9%
Major research equipment	94	95	122	94	28.5%	-22.9%
Education and human resources R&D	95	134	140	136	4.7%	-2.8%
<b>Dept. of Agriculture</b>	1,712	1,813	1,961	1,766	8.1%	-9.9%
<b>Dept. of Commerce</b>	1,128	1,199	1,201	1,087	0.2%	-9.5%
<b>Dept. of Transportation</b>	632	620	747	782	20.5%	4.6%
<b>Dept. of Veterans Affairs</b>	670	659	703	707	6.7%	0.6%
<b>Dept. of the Interior</b>	519	631	631	581	0.0%	-8.0%
<b>Environmental Protection Agency</b>	696	570	609	557	6.9%	-8.5%
<b>Dept. of Education</b>	213	243	265	254	9.1%	-4.3%
<b>Other Agencies</b>	783	643	704	649	9.4%	-7.8%
<i>FS&amp;T Total</i>	50,116	52,846	57,353	58,303	8.5%	1.7%
<i>National Institutes of Health</i>	15,607	17,596	19,710	21,934	12.0%	11.3%
<i>FS&amp;T Total minus NIH</i>	34,509	35,249	37,643	36,368	6.8%	-3.4%
<i>NIH as % of FS&amp;T</i>	31%	33%	34%	38%	--	--

\*The final Department of Defense budget has not yet been released, pending completion of a departmental strategic review. In the meantime, OMB has assumed increases in DOD science and technology (6.1-6.3) equal to inflation; the DOD R&D initiative would largely fall into the 6.4-6.7 categories.

Source: U.S. Office of Management and Budget, *Budget of the U.S. Government, FY 2002: Analytical Perspectives*; AAAS, AAAS Report XXVI: Research and Development, Fiscal Year 2002 (Washington, D.C.: AAAS, 2001).

**TABLE 4 The Administration's Federal Science and Technology (FS&T) Budget, by Agency, FY 2000-FY 2002 (millions of constant FY 2001 dollars)**

Agency	2000 Actual	2001 Est.	2002 Budget	Percent Change	
				FY 2000- FY 2001	FY 2001- FY 2002
<b>Dept. of Defense</b>	4,637	4,981	4,981	7.4%	0.0%
Basic research (6.1)	1,160	1,317	1,317	13.5%	0.0%
Applied research (6.2)	3,477	3,664	3,664	5.4%	0.0%
<b>NASA</b>	6,523	6,957	6,893	6.6%	-0.9%
Science, Aeronautics, and Technology	6,523	6,957	6,893	6.6%	-0.9%
<b>Dept. of Energy</b>	4,445	4,910	4,586	10.5%	-6.6%
Science programs	2,847	3,179	3,095	11.7%	-2.6%
Energy supply	596	661	484	10.9%	-26.8%
Energy conservation	589	625	474	6.1%	-24.2%
Fossil energy R&D	412	445	533	7.9%	19.7%
<b>Dept. of Health &amp; Human Services</b>	18,202	20,361	22,637	11.9%	11.2%
National Institutes of Health	18,202	20,361	22,637	11.9%	11.2%
<b>National Science Foundation</b>	3,979	4,416	4,380	11.0%	-0.8%
<b>Dept. of Agriculture</b>	1,776	1,831	1,723	3.1%	-5.9%
<b>Dept. of Commerce</b>	836	809	657	-3.3%	-18.8%
<b>Dept. of Transportation</b>	660	621	618	-5.9%	-0.5%
<b>Dept. of Veterans Affairs</b>	328	350	354	6.8%	1.0%
<b>Dept. of the Interior</b>	830	883	797	6.4%	-9.7%
<b>Environmental Protection Agency</b>	697	732	665	5.0%	-9.1%
<b>Dept. of Education</b>	324	363	360	12.2%	-0.7%
<i>FS&amp;T Total</i>	43,236	47,214	48,651	9.2%	3.0%
<i>NIH</i>	18,202	20,361	22,637	11.9%	11.2%
<i>FS&amp;T Total minus NIH</i>	25,034	26,853	26,015	7.3%	-3.1%
<i>NIH as % of FS&amp;T</i>	42%	43%	47%	--	--

Source: U.S. Office of Management and Budget, *Budget of the U.S. Government, FY 2002: Analytical Perspectives*, Table 7-3.