

Observations on the President's Fiscal Year 2001 Federal Science and Technology Budget

Committee on Science,
Engineering, and Public Policy

National Academy of Sciences
National Academy of Engineering
Institute of Medicine

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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 of federal investments in the creation of new knowledge and technologies—what the report referred to as the federal science and technology (FS&T) budget.

COSEPUP is issuing this third annual report in order to identify potential impacts of the President's proposed FS&T budget. The Committee does not make recommendations about specific spending levels, but rather identifies aspects of the proposed budget as they affect the health of the nation's research enterprise.

This report also appears in the AAAS's Intersociety Working Group, *AAAS Report XXV: Research and Development FY2001*, through a cooperative arrangement between our organizations.

The report has been reviewed by persons chosen for their diverse perspectives and technical expertise in accordance with procedures approved by the National Research Council's Report Review Committee. The purposes of the independent review are to provide candid and critical comments that will assist COSEPUP in making its report as sound as possible and to ensure that the report meets institutional standards of 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 participation in the review of this report: Bernard Burke (Massachusetts Institute of Technology), John Gibbons (National Academy of

Engineering), Christopher Hill (George Mason University), Daniel Kelves (California Institute of Technology), Stephen Kohashi (Department of Housing and Urban Development), Kei Koizumu (American Association for the Advancement of Science), Charles Larson (Industrial Research Institute), John Mayo (Lucent Technologies), and Peter Raven (Chair, Report Review Committee).

The production of this report was the result of hard work of the project committee chaired by James Duderstadt. The project was aided by the help of the committee's professional staff: Richard E. Bissell, Peter Henderson, and Vivian Nolan.

Maxine F. Singer, Chair
Committee on Science, Engineering,
and Public Policy

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Observations on the President's FY 2001 Federal Science and Technology Budget

FINDINGS

- The Administration's FY2001 budget proposes a Federal Science & Technology (FS&T) increase of 1.3 percent in constant dollars. The stated goals of the budget are to ensure the health of the nation's research enterprise through steady and balanced growth, and to capture the public imagination by identifying exciting initiatives in research to improve the health and welfare of the American people.
- The 21st Century Research Fund is part of the Administration's strategy to emphasize basic research and knowledge-creating investments. The Fund would increase 5.0 percent in constant dollars. The Fund represents an important step toward identifying those investments aimed at knowledge-creation.
- The budget would sharply increase National Science Foundation (NSF) spending, and would alleviate the disparity in funding growth in the life sciences and other scientific fields. In the committee's opinion, large budget reductions proposed for Department of Defense (DOD) and some other mission agencies may threaten adverse consequences for certain fields of science and engineering. In particular, uncertain funding jeopardizes recruitment and training of the next generation of researchers.
- In the committee's judgment, sharp funding increases in biomedical fields may strain the capacity of existing infrastructure and facilities in some universities and other institutions expected to carry out the increased research in those fields. In the context of such increases, the problems of unreimbursed indirect costs need attention through a simplified formula

that would protect both the interests of research organizations and the government.

- Since 1987, industry R&D has increased 196 percent, and the federal share of total R&D in the U.S. has dropped from 46 percent to 27 percent.

The FY 2001 FS&T budget

The FS&T budget encompasses the federal investment in the creation of new knowledge and technologies, as detailed in earlier reports from the National Academies.¹ The Administration has moved toward this concept by identifying, in addition to the usual R&D budget, a budget known as the 21st Century Research Fund, similar in spirit to the FS&T concept but stressing as well its research priorities. We have compared the R&D, FS&T, and Fund budgets in Figure 2 and in Tables 1, 2, and 3. As can be seen in Table 1, FS&T differs from the Fund by about \$11 billion, of which \$3 billion is the 6.3 budget of DOD, \$4 billion is Human Space Flight and Mission Support in NASA, and \$2.8 billion is DOE Defense Activities. Both the FS&T budget and the Fund provide visibility for the research budget and its change in the context of the overall R&D budget.

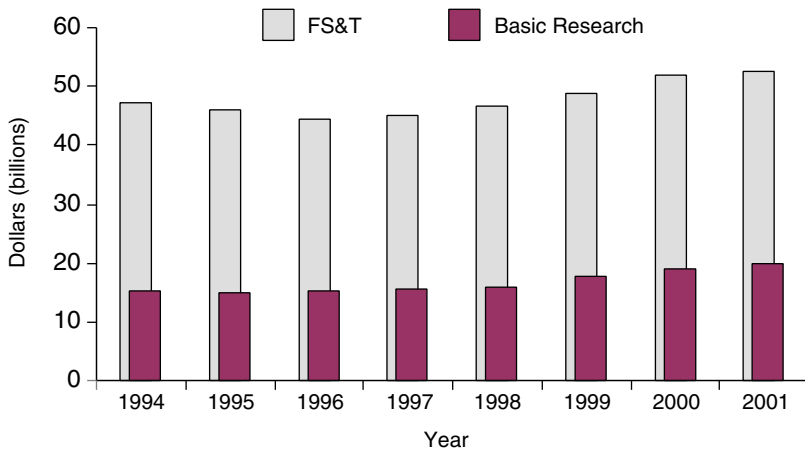


FIGURE 1 FS&T Budget and Basic Research, FY 1994-FY 2001 (budget authority in billions of constant FY 2000 dollars)

¹*Allocating Federal Funds for Science and Technology*, Committee on Criteria for Federal Support of Research and Development, NAP 1995; and the annual “*Observations . . .*” reports from COSEPUP in 1998 and 1999.

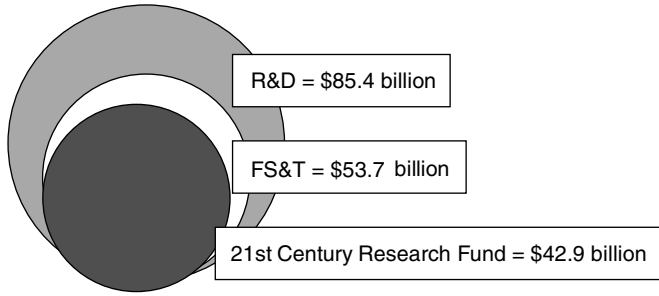


FIGURE 2 FY 2001 R&D, FS&T, and 21st Century Research Fund (in billions)

The FY2001 budget proposes a small increase in FS&T—\$674 million, an increase of 1.3 percent from FY 2000 in constant dollars, to a total of \$52.6 billion.² (See Figure 1) Last year, the administration requested an increase of only 0.4 percent in FS&T spending, but the Congress raised it 6.4 percent in appropriations. (see Table 3). Of particular note in FY2001 are the proposed increases at NSF (17.5 percent), HHS (3.9 percent), and certain programs in DOE (5.9% overall). NASA has a real increase (0.7 percent) for the first time in several years. DOD FS&T spending would be cut 13.9 percent. Aside from large proposed increases at NIH and NSF, proposed FS&T spending in the rest of the federal government would be down 1.4 percent.

The administration proposes to spend \$42.9 billion on the 21st Century Research Fund, an increase of 5.0 percent in constant dollars over FY 2000. This is substantially higher than the 1.7 percent increase in constant dollars proposed by the administration for this fund in FY 2000, but smaller than the 6.5 percent growth actually appropriated by Congress last year. A set of inter-agency initiatives is highlighted this year, with focused efforts in nanotechnology (\$485 million), information technology (\$2.27 billion), clean energy (\$283 million), climate change (\$1.4 billion), and six others, as detailed in Table 4. The emergence of the 21st Century Research Fund is a welcome program descriptive device for some areas of research that are ripe for making dramatic progress, and other areas of current importance to society.

²The GDP deflator, about 2.2 percent a year for 1994-2000 and 2.0 percent for 2001, is used by both COSEPUP and AAAS in calculating constant-dollar figures.

CONCERNS

Overall U.S. Investment in Research and Development

The FS&T budget is one part of the broader measure of R&D in the federal government, as well as of the total public and private support of R&D. Total R&D spending has been rising as a share of GDP and is now nearing 3 percent—2.8 percent in 1999. While hard and precise targets for total R&D spending and for its composition are hard to establish, there is a wide consensus that U.S. economic growth and scientific preeminence depend on maintaining and possibly increasing the share of GDP devoted to R&D. The administration has suggested a target goal of total R&D as 3.0 percent of the U.S. gross domestic product (GDP).³ Movement in recent decades toward that goal has been achieved through growing private rather than public investment. As seen in Figure 3, there has been a significant divergence of federal and non-federal investment patterns in R&D as shares of GDP since 1987.⁴

Basic research receives its principal support from publicly supported R&D, whereas privately sponsored R&D emphasizes applied research and development. The continued effectiveness of industry expenditures on applied research and development depends on the continued flow of basic research findings and the associated training of scientists and engineers.⁵ Industry benefits from, and invests in, the development of products based on basic research conducted in prior decades. Thus, continued growth of basic research will help sustain continued high returns to private R&D outlays, and ensure a pipeline of new knowledge accessible to future generations.

The growth of industry spending on R&D should, therefore, not lull observers into thinking that the federal research budget can consequently be reduced. This growth does not reduce the need for a strong federal research budget.

Balancing the FS&T Portfolio

The differences in the growth rates of FS&T investments across fields are a concern.⁶ In essence, the life sciences budget has surged ahead while the FS&T

³*Science in the National Interest*, The White House, 1994.

⁴Federal R&D as a percentage of total R&D in the United States reached a high point in 1964 at 66.8 percent, equaled 46.4 percent in 1987, and in 1999 was 26.7 percent. See NSF, *National Patterns of Research and Development Resources 1999 Data Update* (NSF 00-306).

⁵*Capitalizing on Investments in Science and Technology*, COSEPUP, National Academy Press, 1999.

⁶For an NRC review of this problem using data through FY1997, see *Securing America's Industrial Strength*, Board on Science, Technology, and Economic Policy, Appendix A.

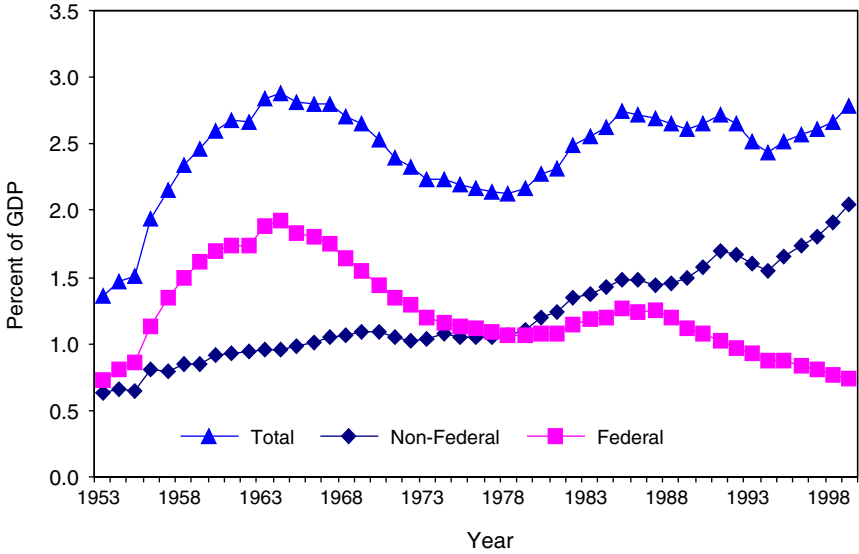


FIGURE 3. Federal, Non-Federal, and Total Support for R&D as a Percent of GDP, 1953-1999

Source: National Science Foundation, *National Patterns of Research and Development Resources: 1999 Data Update* (NSF 00-306).

budgets for other fields have increased only slightly or have decreased with the cuts in the DOD budget. FS&T at NIH provided an increase to life sciences research between FY1998 and FY2000 that is greater than all of FS&T proposed for NSF for FY2001.

Research in the life sciences is motivated by a need to improve health. Yet many of the improvements seen in the past decades are due to advancement of knowledge that comes from other fields. Examples would include magnetic resonance imaging, positron emission, and miniaturization in athroscopic surgery. As Harold Varmus, former Director of NIH, has often explained, discoveries in biology and medicine depend on progress in physics, chemistry, engineering, and many allied fields. The FY2001 budget recognizes the need for balanced expansion of research with substantial increases proposed for the National Science Foundation in particular.

While reallocation of funds within a limited budget is inescapable, abrupt decreases can raise difficult problems. Among major programs, for instance, a cut of 14 percent is proposed for DOD FS&T. DOD has been and remains a major sponsor of academic research in the physical sciences and engineering. Much greater attention needs to be given to the impact of such reductions on fields, as available retrospectively in NSF data, where multi-year trends may sig-

nal the erosion of U.S. capability. Analysis could assess whether those trends affect U.S. global leadership in science and engineering.

Swings in FS&T levels pose difficulties for those planning careers in science and engineering. Federal research funding directly and indirectly supports the training of the next generation of scientists and engineers. Only rarely do budget decisions take into account those effects of the various agencies funding research. A recent National Research Council review of major fields with substantial declines in federal research support (chemical engineering, mechanical engineering, and electrical engineering) in the 1990s shows a strong correlation with reduced graduate enrollments in those fields.⁷

Mission agencies contribute substantially to fields not readily identifiable in the stated missions. The cuts in programs at NASA, DOE, and DOD are especially notable. These declines, accumulated over a period of years, can be damaging to a research infrastructure that takes years to build and to maintain at state-of-the-art condition.

The adequacy of physical infrastructure also requires close attention.⁸ The rapid, recent increases in FS&T funding for the life sciences challenge the capacity of research institutions to respond to the demands for expanded programs. Construction lead time for buildings and laboratories can be long. Without such physical capital, ambitious research programs may be needlessly costly or simply unattainable. Recent FS&T proposals have inadequately reflected the long-term costs to research institutions of raising the funds and building the human and physical infrastructure to maintain an adequate research capacity.⁹

Rising levels of federal support for research programs increase tension between the government and universities over indirect cost recovery. Universities are presently contributing substantially toward making this investment effective with their own resources as a result of incomplete cost recovery and other forms of cost-sharing.¹⁰ Unless universities can find additional revenue, this cost burden will cause tradeoffs with other university functions. The successful completion of efforts to reform rules governing reimbursement for indirect costs deserves high priority.

⁷*Securing America's Industrial Strength*, Board on Science, Technology, and Economic Policy, National Academy Press, 1999, pp. 89-93.

⁸An example of the analysis needed has been done for information technology: National Research Council, *Funding A Revolution: Government Support for Computing Research Infrastructure*, CPSMA, National Academy Press, 1999.

⁹The federal government directly paid for 9 percent of construction, renovation, and repair of academic research facilities in 1998, with the rest of the funds coming from state/local governments (about 30%) and internal university funds (about 60%). National Science Foundation, *Scientific and Engineering Research Facilities at Colleges and Universities: 1998: An Overview* (NSF 99-413), Arlington, VA: NSF, 1999, pp. xii-xiii.

¹⁰See National Science and Technology Council, *Presidential Review Directive 4*, Chapter 5, April 27, 1999.

CONCLUSIONS

The Administration has made progress in FY2001 in the strategy and presentation of the federal science and technology budget. Some areas of FS&T have increased with generally positive impacts, and other programs have been cut. The strong increase proposed for NSF (17.5 percent) represents an important investment in basic research and a step toward better balance in federal support among the various research fields. Overall, the proposed increase in constant dollars is only 1.3 percent. The initiatives highlighted in the President's budget and the 21st Century Research Fund are useful, and may fuel the kind of research that fosters public support for research as well as improvements in the quality of life.

The budget causes concerns about the effects of proposed cuts in Defense and other mission agencies. A continuing need exists to analyze possible imbalances among the fields of science and engineering—at a time when many fields are increasingly interdependent for achieving optimal results in the productivity of the economy and the pursuit of knowledge.

FS&T TABLES

TABLE 1 Alternative Perspectives on the President's FY 2001 Science and Technology Budget (millions of current dollars)

Agency	21st Century Fund	FS&T	R&D
Dept. of Defense	4,361	7,609	38,576
Basic research (6.1)	1,217	1,217	1,217
Applied research (6.2)	3,144	3,144	3,144
Advanced technology development (6.3)	—	3,182	3,182
Medical research	—	66	66
Test and evaluation	—	—	30,967
NASA	5,165	10,040	10,040
Space, Earth, and Life & Microgravity Sci.	4,107	4,107	4,107
Aerospace Technology	1,058	1,193	1,193
Other Science, Aeronautics, and Technology	—	629	629
Human Space Flight and Mission Support	—	4,111	4,111
Dept. of Energy	4,221	6,882	7,639
Solar and Renewable Energy R&D	410	376	376
Nuclear Energy R&D	—	92	92
Fossil Energy R&D	—	293	293
Energy Conservation	660	465	465
Science Programs	3,151	2,969	2,969
Atomic Energy Defense Activities	—	2,647	3,405
Radioactive Waste Management	—	40	40
Dept. of Health & Human Services	18,813	19,168	19,168
National Institutes of Health	18,813	18,094	18,094
Other HHS programs	—	1,074	1,074
National Science Foundation	4,572	3,432	3,432
Research and Related Activities	3,541	3,183	3,183
Major Research Equipment	139	139	139
Education and Human Resources	729	110	110
Salaries, Expenses, and Inspector General	164	—	—
Dept. of Agriculture	1,649	1,824	1,824
Dept. of the Interior	895	590	590
Dept. of Transportation	899	778	778
Environmental Protection Agency	758	673	673
Dept. of Commerce	862	1,148	1,148
Dept. of Veterans' Affairs	321	655	655
Dept. of Education	379	271	271
Other Agencies	—	632	632
TOTAL	42,895	53,702	85,427

Source: OMB, *Budget of the U.S. Government FY 2001* and AAAS, Tables II-1, II-2, II-7, II-8, II-11, and II-12.

TABLE 2 Federal Science and Technology (FS&T) Budget, by Agency, FY 1999-FY2001 (millions of constant FY 2000 dollars)

	1994 Actual	1999 Actual	2000 Est.	2001 Bdgt.	Percent Change	
					FY 1999- FY 2000	FY 2000- FY 2001
Dept. of Defense	9,129	7,726	8,667	7,460	12.2	-13.9%
Basic Research (6.1)	1,299	1,080	1,161	1,193	7.5%	2.8%
Applied Research (6.2)	3,560	3,103	3,410	3,082	9.9%	-9.6%
Adv. Tech. Dev. (6.3)	4,270	3,505	3,826	3,120	9.2%	-18.5%
Medical Research (other)	—	39	270	65	600.1	-76.0
NASA	10,367	9,862	9,776	9,843	-0.9%	0.7%
Hum. Space Flight R&D	n.a.	2,357	2,333	2,093	-1.0%	-10.3%
Sci., Aero., and Tech.	n.a.	5,738	5,581	5,813	-2.7%	4.2%
Mission Support R&D	n.a.	1,767	1,862	1,937	5.4%	4.0%
Dept. of Energy	6,530	6,315	6,372	6,747	0.9%	5.9%
Energy Supply	n.a.	364	364	459	-0.1%	26.1%
Fossil Energy R&D	n.a.	299	328	287	9.6%	-12.4%
Energy Conservation	n.a.	387	431	456	11.5%	5.8%
Science	n.a.	2,712	2,638	2,911	-2.7%	10.3%
Atomic Energy Defense	n.a.	2,490	2,556	2,575	2.7%	1.5%
Radioactive Waste Mgt.	n.a.	63	55	39	-12.6%	-28.7%
Dept. of HHS	12,481	16,061	18,082	18,792	12.6%	3.9%
NIH	11,544	15,219	17,102	17,739	12.4%	3.7%
Other	937	842	980	1,053	16.3%	7.4%
NSF	2,472	2,710	2,864	3,365	5.7%	17.5%
Res. and Rel. Act. R&D	n.a.	2,526	2,649	3,121	4.9%	17.8%
Maj. Res. Equipment	n.a.	91	94	136	2.9%	45.0%
Educ. & Hum. Res. R&D	n.a.	92	121	108	31.0%	-10.9%
Dept. of Agriculture	1,684	1,670	1,763	1,788	5.6%	1.4%
Dept. of the Interior	780	506	573	578	13.1%	0.9%
Dept. of Transportation	706	616	606	763	-1.6%	25.9%
EPA	648	679	647	660	-4.7%	2.0%
Dept. of Commerce	1,126	1,100	1,073	1,125	-2.5%	4.9%
Veterans Affairs	*	654	655	642	0.2%	-2.0%
Dept. of Education	*	208	233	266	12.0%	14.0%
Other Agencies	1,471	763	664	620	-13.0	-6.7%
FS&T TOTAL	47,396	48,865	51,975	52,649	6.4%	1.3%

n.a. = not available

*Dept. of Veterans Affairs and Dept. of Education included in "Other Agencies" in FY 1994.

Source: AAAS Tables II-1, II-2, II-7, II-8, II-11, and II-12.

TABLE 3 Trends in FS&T and R&D, FY 1994-FY 2001 (millions of constant FY 2000 dollars)

Fiscal Year	FS&T		R&D	
	Current	Constant	Current	Constant
1994	43,002	47,396	71,074	78,338
1995	42,688	46,079	70,948	76,581
1996	42,162	44,649	71,206	75,407
1997	43,340	45,132	73,934	76,987
1998	45,191	46,464	75,942	78,080
1999*	48,151	48,869	80,172	81,370
2000*	51,975	51,975	83,334	83,334
2001*	53,702	52,649	85,427	83,751
Chg., FY 1994-FY 2001	24.9%	11.1%	20.2%	6.9%
Chg., FY 1999-FY 2000	7.9%	6.4%	3.9%	2.4%
Chg., FY 2000-FY 2001	3.3%	1.3%	2.5%	0.5%

* Note: Changes in DOE accounting for Atomic Energy Defense Activities have resulted in a modification in the calculation of FS&T beginning with FY 1999.

Source: AAAS Tables I-16 and II-1; FS&T figures for 1994-1998 carried forward from *Observations on the President's FY 2000 Federal Science and Technology Budget*.

TABLE 4 Cross-Cutting National Science and Technology Council Initiatives, President's FY 2001 Budget (millions of constant FY 2000 dollars)

	1999 Actual	2000 Est.	2001 Budget.	Percent Change	
				FY 1999- FY 2000	FY 2000- FY 2001
Nanotechnology Initiative	251	270	485	7.7%	79.7%
Information Technology R&D	1,320	1,721	2,270	30.3%	31.9%
Clean Energy	198	196	283	-1.0%	44.6%
Climate Change Technology Initiative	1,036	1,099	1,404	6.1%	27.7%
Partnership for a New Generation of Vehicles	239	226	250	-5.2%	10.6%
Integrated Science for Ecosystem Challenges	639	657	732	2.8%	11.5%
U.S. Global Change Res. Program	1,682	1,701	1,706	1.1%	0.3%
Interagency Education Research Initiative	30	38	49	24.8%	29.0%
Critical Infrastructure Prot. R&D	457	461	594	0.9%	28.9%
Weapons of Mass Destruction Preparedness R&D	325	473	491	45.6%	3.8%

Source: U.S. Office of Management and Budget, *Budget of the United States Government, Fiscal Year 2001*.