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Federal Research and Development: Budgeting and Priority-Setting Issues, 108th Congress

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SUMMARY

Federal R&D funding priorities change over time, reflecting Presidential and national preferences. Defense R&D predominated in the 1980s, decreasing to about 50% of federal R&D in the 1990s during the Clinton Administration. In nondefense R&D, space R&D was dominant in the 1960s as the nation sought to compete with the Soviet Union; energy R&D became an additional priority during the energy-short 1970s, and, since the 1980s, health R&D has predominated. Defense R&D has emerged again as priorities have shifted to deal with the war against terrorism. The FY2004 budget request seeks to increase R&D funding by about 4.4% overall, with increases (in descending order of increase) for the Department of Homeland Security, Department of Defense (DOD), Department of Energy (DOE), the, Department of Veterans Affairs, National Science Foundation, National Institutes of Health (NIH), Department of Interior, and National Aeronautics and Space Administration (NASA). R&D funding would decrease in the Departments of Education, Commerce, Agriculture (USDA), Transportation, and Environmental Protection Agency (EPA). If the increase in NIH R&D funding were not counted, civilian R&D funding would fall by 0.3%. Counter terrorism R&D funding is requested at about $3 billion. Congressional appropriations action on FY2003 R&D funding exceeded the requested levels.

National R&D funding continues to grow, but the federal R&D share has declined to 27% of the national total. Scholars and policymakers cite the importance of R&D funding to economic growth. Debates focus on whether federal R&D should be increased across the board; how priorities should be set; and how to determine "balance" in funding between health and nonhealth fields.

Legislative priority-setting initiatives include bills to make permanent the research and experimentation credit (H.R. 428 and H.R. 463, S. 664 .)

The Bush Administration included in its budget request a "Federal S&T" budget, which may presage a future unified science and technology (S&T) budget. The FY2004 budget requested funding for three interagency R&D initiatives, in networking and information technology; climate change science; and nanotechnology. Other proposals made to coordinate R&D include a continuing priority-setting mechanism; a cabinet-level S&T body; functional R&D budgeting; and reestablishment of the Office of Technology Assessment in Congress (H.R. 125). The Administration opposes earmarking for R&D, which it said totaled about $1.8 billion in FY2002 and because the practice distorts agency priorities. The Administration has started to use some performance measures for R&D budgeting, inspired by the Government Performance and Results Act. However, the Administration and critics say better data and concepts are needed to use performance budgeting for basic and applied research. OMB judged agencies that fund R&D using performance management measures, with NSF winning accolades for its financial management procedures.

MOST RECENT DEVELOPMENTS

The FY2004 R&D request, at $122.3 billion, is 4.4% over FY2003. Most of the increases would go to the Department of Homeland Security and DOD. The conference report on the congressional budget resolution for FY2004 raised NSF and DOE science funding above the Administration's request. The House-passed appropriations bill for the Department of Homeland Security would raise R&D funding above the requested level.

BACKGROUND AND ANALYSIS

Federal R&D funding priorities have shifted over time, reflecting Presidential preferences and national priorities. Defense R&D predominated in the 1980s but decreased to about 50% of total federal R&D in the 1990s, reflecting the Clinton Administration policy. In nondefense R&D, space R&D was dominant in the 1960s as the nation sought to meet Presidential pronouncements and to compete with the Soviet Union in the space race; energy R&D joined space as a priority during the 1970s; and since the 1980s, health R&D funding has grown as the cohort of aged population increases and the promise of life sciences and biotechnology affects national expectations. Defense, health, and counterterrorism R&D funding are projected to increase in this budget cycle. See **Figure 1**. (See also CRS Report RL30905, *Federal Research and Development: Budgeting and Priority-Setting, 1993-2000*.)

FY2002 Budget Action

The FY2002 Bush Administration R&D budget request, at $96.5 billion, would have increased R&D funding by 6.1% over the enacted FY2001 level. Funding increases were proposed for the Department of Defense (DOD) and for the National Institutes of Health (NIH), proposed to be increased to 52% of the nondefense R&D budget. R&D funding was to be flat or decline for other agencies. Appropriations action raised FY2002 R&D funding above the requested levels for all agencies and raised total R&D funding to about $103.7 billion. Congress appropriated about $1.5 billion for FY2002 counterterrorism R&D, with about one-half from regular appropriations, and one-half from emergency appropriations[1] in P.L. 107-38. (For additional details, see CRS Report RL31202 and Report RS21270.)

FY2003 Budget Action

The President's R&D request totaled about $112 billion, about 8% more than the appropriated level for FY2002. Similar to the patterns for FY2002, the increases proposed for DOD R&D, at 11% more than FY2002, and for NIH, at about 16% more, accounted for most of the total proposed funding increase, leaving all the other R&D funding agencies

[1] "Federal R&D Climbs to Record High of $103.7 Billion," *AAAS R&D Update*, Dec. 28, 2001.

combined with less money than in FY2002.[2] Total defense R&D funding, spurred in part by anti-terrorist priorities, for DOD and the Department of Energy's (DOE) military/nuclear programs, would have increased by almost 10%. As a result, while overall discretionary spending (from which most all R&D is funded) would rise almost 7% over FY2002, total non-defense, non-NIH R&D funding would decline or be flat. The rise in NIH was attributable to this being the final year of the congressional policy to double NIH's funding by 2003 and in part to increased counterterrorism funding. **See Table 3.** The House Budget Resolution, H. Con. Res. 353, and the Senate Budget Resolution, S.Con.Res. 100, proposed FY2003 discretionary budget authority function totals for Defense and General Science, Space and Technology that were higher than proposed by the President. The resolutions also adopted the President's recommendation to complete the doubling of the NIH budget in FY2003. The House Science Committee's *Views and Estimates* of the request is posted at [http://www.house.gov/science/press/107/107-192views03.pdf].

Because of House/Senate differences on discretionary spending levels, most of the Government was funded by a continuing resolution until February 20, 2003 when the President signed the Consolidated Appropriations Resolution for FY 2003, P.L. 108-7, which appropriated funds for agencies funded by the 11 incorporated appropriations bills (two defense appropriations bill were enacted separately). R&D was funded at about $117 billion. Although civilian agencies' budgets were cut 0.65% across the board for most domestic programs, appropriations were increased significantly for R&D in DOD (+18%), NIH, (+15.5%). DHS (+66%) and NSF (+11.4%). Other R&D programs were increased modestly, except for the Department of Transportation, which was reduced. See **Table 3**.

FY2004 Budget

R&D budgets are developed over an 18-month period before a fiscal year begins. Often advisory committees, influenced by professional scientific groups, recommend R&D priorities to agencies, which use this information, internally generated information, and the White House's Office of Management and Budget (OMB) and Office of Science and Technology Policy (OSTP) guidance to determine priorities. Agencies and OMB negotiate funding request levels during the preparation of the budget before it is sent to Congress. After standing committees recommend budget levels for matters within their jurisdiction to the budget committees, Congress passes a budget resolution, which sets spending levels and recommends levels for each budget function that appropriations committees use in setting discretionary (302b)spending allocations for each appropriations subcommittee. The resolution also gives outyear projections based on budget and economic assumptions. Each of the 13 appropriations subcommittees report approved funding levels for agencies within their jurisdiction; appropriations bills, which give agencies spending authority, are sent to the floor, usually beginning in the summer.

The President's FY2004 R&D request totaled about $122.3 billion, about 4.4% more than the appropriated level for FY2003. Similar to the FY2003 funding pattern, counterterrorism has fueled increases for DOD R&D, at 7.1% more than last year, and the

[2] AAAS, "Bush Proposes Large Increase for DOD, NIH R&D: Mix of Cuts and Increases for Other R&D Programs," Feb. 8, 2002.

Department of Homeland Security, at about $1 billion, or almost 50% more than FY2003. Most of the DOD increase would go to technology development, with other science and technology and medical research funding proposed to be cut by 8.3%. The planned doubling of NIH's budget by 2003 is almost complete; NIH's proposed increase has slowed to an estimated 2.7% more than last year. Although legislation was enacted to double NSF's budget over five years, NSF's budget request at 2.8% over FY2003 falls short of the 15% envisioned in the authorizing legislation. Modest increases of less than 5% were proposed for NASA, Interior, NIH, NSF, and DOE. Reductions are proposed for R&D in Commerce, USDA, EPA, and the Department of Transportation. DOD and DOE's military/nuclear programs would constitute about 55% of the R&D budget and would be increased by almost 7.2% over FY2003. Total nondefense R&D would be increased by 1.2% , but nondefense R&D, excluding NIH, would decline by about 0.3% from FY2003. See **Table 3**.

The largest NSF increases would go to mathematical and physical sciences and to major equipment and facilities construction projects. DOE's 4% increase would go largely to defense activities and nanoscale sciences, offset by a planned drop in construction costs of the Spallation Neutron Source. Auto fuel research and hydrogen R&D fuel cell research would increase, balanced by cuts in non-cost fossil fuels R&D and energy conservation R&D. In the Department of Commerce the President would eliminate the Advanced Technology Program (ATP), which had a $179 million budget in FY2003, and the Manufacturing Extension Partnership at NIST. Congress disagreed with the President's proposals to zero out these programs in FY2003.

A conference to resolve the differences between the budget resolutions passed by the House (H.Con.Res. 95) and Senate (S.Con.Res. 23) cleared Congress on April 11, 2003. The conference agreement for function 250, general science space and technology, includes an increase of $324 million above the Administration's request for NSF research activities and $100 million more than the Administration requested for DOE science programs.

Counterterrorism Funding

Counterterrorism R&D funding was requested to be increased from about $1.5 billion in FY2002 to about $3 billion for FY2003. See **Table 1**. Notable increases were for the National Institute of Allergy and Infectious Diseases, at $1.7 billion for bioterrorism R&D and for construction of containment facilities; for the USDA, increased $34 million to $406 million; for NIST, $5 million; for DOD, for anti-terrorism technologies; and for cybersecurity R&D in the Bureau of Export Administration, Department of Commerce, at an additional $20 million. The President requested a reported $176 million for R&D related to anti-terrorism in the FY2002 emergency supplemental appropriation. After the legislation was signed, the President announced that he would not release all funds appropriated, limiting counterterrorism R&D supplemental funding to about $128 million. About $3.2 billion was requested for counterterrorism R&D for FY2004. See CRS Report RS21270.

Public Law 107-296, the Homeland Security Act of 2002, consolidated some federal counterterrorism R&D programs in the new Department of Homeland Security (DHS). DHS's FY2004 R&D budget request was $907 million; the House approved appropriations totaling $1,054 million. See **Table 2**. According to OMB, about 5 % of DHS R&D will be for basic research; about 13% will be for applied research; about 66% will be for

development; and about 16 % will be for facilities and equipment (*Analytical Perspectives, Budget, FY2004*, pp. 183-184). For additional details, see CRS Report RS21270. Dr. Charles McQueary, an engineer, was nominated and confirmed as Undersecretary for Science and Technology in the new DHS. He is recently retired as President of General Dynamics Advanced Technology Systems.

Table 1. Research and Development to Combat Terrorism, By Agency, FY2000-FY2003 (Request)

(Dollars in Millions)

Agency	FY2000 Actual	FY2001 Actual	FY2002 Enacted	Emergency Response Fund	FY2003 Request
Agriculture	$37.3	$51.7	$83.9	$91.3	$48.4
Commerce	9.6	0	6.3	0	20.0
Energy	59.7	66.2	64.9	19.0	99.8
EPA	not available	0	2.8	1.5	75.0
DHHS	109.7	102.8	119.1	180.0	1,770.9 (NIH, $1.75B; CDC, $40M; FDA, $50M)
Justice	45.2	11.4	66.1	0	36.1
NSF	not available	7.0	7.0	0	27.0
National Security	190.0	298.9	385.5	11.0	767.2
Transportation	50.7	50.2	58.3	64.0	59.3
Treasury	2.1	1.2	1.1	0	1.1
Total	**$511.3**	**$589.4**	**$795.2**	**$366.8**	**$2,905.23**

Source: OMB, *Annual Report to Congress on Combating Terrorism, FY2002*, p. 27 for column "FY2000." The rest of the data is from: OMB, *Annual Report to Congress on Combating Terrorism, June 24, 2002*, p. 26. The 2002 report is [http://www.whitehouse.gov/omb/legislative/combating_terrorism06-2002.pdf].

Priority-Setting Issues

Current priority-setting debates focus on the functions and size of federal R&D funding as a part of national R&D and on how to balance priorities in the portfolio of federal nondefense R&D, especially between health and nonhealth R&D.

Role of the Federal Government in Supporting R&D

A core issue is to reconcile the presumed benefits of R&D — the projected high rates of return to the economy and society from investments in R&D — with a FY2004 R&D budget request that focuses on defense and health R&D spending and level funding in most other areas, and also long-term economic and budget projections of deficits, decreasing outyear federal R&D budgets and reductions in domestic discretionary spending. President Bush's FY2002 budget said, "More than half of the Nation's economic productivity growth in the last 50 years is attributable to technological innovation and the science that supported it" (p. 29). In Spring 2000, President Clinton's Committee of Advisors on Science and Technology (PCAST), in *Wellspring of Prosperity*, described some of the payoffs from

federal investments in R&D, which it said "underscores the need for sustained and cooperative support in the 21st century to avoid the dangers and seize the opportunities."[3]

Table 2. AAAS Table. Department of Homeland Security: House Action on R&D in the FY 2004 Budget

(budget authority in millions of dollars)

			Action by House				
	FY 2003 Estimate	FY 2004 Request*	FY 2004 House	Chg. from Request		Chg. from FY 2003	
				Amount	Percent	Amount	Percent
DHS R&D:							
Border & Transportation Security (TSA)	110	75	126	51	67.2%	16	14.1%
Emergency Preparedness	0	0	0	0	—	0	0
Information Analysis and Infra.	15	5	5	0	0.0%	-10	-66.7%
Science and Technology	521	803	900	97	12.1%	379	72.8%
Biological ctrmeasures	—	*365*	*293*	*-72*	*-19.6%*	—	—
Nuclear & Radiological ctrmeasures.	—	*137*	*130*	*-7*	*-5.1%*	—	—
Chemical ctrmeasures	—	*55*	*52*	*-3*	*-5.5%*	—	—
High Explosives ctrmeasures	—	*10*	*20*	*-1*	*-5.0%*	—	—
Threat & vulnerability assessments	—	*90*	*86*	*-5*	*-5.0%*	—	—
Conventional missions	—	*55*	*112*	*57*	*103.6%*	—	—
Rapid Prototyping / TSWG	—	*-30*	*80*	*59*	*166.7%*	—	—
Standards / state and local	—	*25*	*39*	*24*	*56,0%*	—	—
Emerging threats	—	*22*	*21*	*-1*	*-4.5%*	—	—
Critical infrastructure protection	—	*5*	*5*	*-1*	*-10.0%*	—	—
University programs / HS fellowships	—	*10*	*35*	*25*	*250.0%*	—	—
Salaries & expenses 1/	—	*0*	*39*	*39*	—	—	—
Coast Guard	23	23	23	0	0.7%	0	0.7%
Total DHS R&D	669	907	1054	148	16.3%	385	57.5%
Selected non-R&D items: Biodefense countermeasures (BioShield)	*0*	*890*	*890*	*0*	*0.0%*	*890*	—
Total DHS Discretionary Budget	28875	28372	29411	1039	3.7%	536	1.9%

Source: *AAAS R&D Funding Update, DHS in FY2004 House Appropriations, June 25, 2003*
AAAS estimates based on FY 2004 appropriations bills. Includes conduct of R&D and R&D facilities.
FY 2003 and FY 2004 request figures based on OMB R&D data and supplemental agency budget data.
Figures are rounded to the nearest million. Changes calculated from unrounded figures.
* FY 2004 request figures have been revised since the February 2003 release of the President's budget.
1/ The House Homeland Security would move salaries and expenses for federal employees in the S&T Directorate from program line items to a consolidated Salaries & Expenses account.
These figures reflect amendments on the House floor.

[3] See also: Steven Parson and John Jankowski, "Sixth Year of Unprecedented R&D Growth Expected in 2000," *NSF Data Brief*, Nov. 29, 2000, p. 1. NSF 01-310.

Trends in Federal R&D Support. Given these assessments of the importance of federal R&D, a key priority-setting issue is how large should the federal R&D budget be in relation to its functions and the funding provided by such other R&D supporters as industry?

Federal R&D funding, while rising in terms of absolute (or nominal) dollars, is declining as a part of the national R&D total, which has grown overall to $292 billion in FY2002, the latest year for which data are available.[4] In constant 1996 dollars, total national R&D increased 50% between the years 1993 and 2002, with industrial support for R&D increasing 74% and federal government support increasing 14%. OMB historical trend data indicate that R&D funding has declined from about 17% of total federal discretionary outlays in FY1965 to about 12% today. In part because of economic pressures and budgetary caps, during the years FY1994 to FY2000, federal R&D funding was below the previous constant-dollar high of FY1993. As a result of Congressional action, constant-dollar R&D appropriations started to eclipse the FY1993 level beginning with FY2001. However, concerns that had been raised about the declines in federal R&D funding have not abated because of current projections of economic slowdown, spending to combat terrorism, and a return to deficit spending, which could reduce discretionary R&D spending.

Industry is the largest supporter and performer of national R&D, funding 67% of total R&D (the government funds 27%) and conducting 72% of the total. Most industrial R&D is for near-term applied work and product or prototype development. The government funds about 10% of R&D performed by industry. Federal support for development, which totals about 44% of federal R&D, goes largely to industry and to defense R&D.[5] The federal government, in contrast to industry, focuses more on supporting basic research and academic R&D. The federal government funded almost half of all national expenditures for long-term basic research (largely in universities and federal laboratories), while industry funded about 30%.[6] After industry, universities and colleges are the second-largest performer of national R&D, funded mostly by the federal government (56%). As for research per se, about 42% of federal research dollars go to universities and 24% to mission-oriented work in federal laboratories, largely at DOD, NIH, and USDA.

Observations and Recent Legislative Initiatives. The federal government is the major supporter of the nation's basic research, which generates much of the knowledge that industry uses for innovative R&D, and of university research that enriches the knowledge base. As a result, some observers argue that federal support for research should be funded at increasingly higher levels as a public good to enhance the U.S. ability to advance scientifically, technologically, and economically; to broaden the knowledge base that industry uses; and to train science and technology (S&T) personnel.[7] Related issues are

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[4] B. Shackelford, "Slowing R&D Growth Expected in 2002," *SRS InfoBrief*, Dec. 2002, NSF 03-307.

[5] Data on R&D funding by sector based primarily on NSF, *National Patterns of R&D Resources: 2000 Data Update*. See also, Ronald L. Meeks, "Federal Survey Shows Defense Funding of Industry Is Largest Share of Federal R&D in FY2000," NSF Data Brief, February 11, 2000, NSF 00-309.

[6] Expenditures do not equal outlays or budget authority. NSF, *National Patterns, 2000 Data Update. See also* Elisa Eiseman, Kei Koizumi, and Donna Fossum, *Federal Investment o in R&D,* RAND, Sept. 2002, MR-1639.0-OSTP.

[7] The National Science Board is assessing "Workforce Policies for Science and Engineering."

whether incentives should be increased for states[8] and industry to augment support of basic and academic research, or whether too much support from these sources would overwhelm academic research with pressure to conduct short-term applied studies.[9] Among the legislative options in this area[10] is to make permanent the Research and Experimentation (R&E) tax credit that provides tax benefits and credits for industrially funded basic research in universities and is due to expire on June 30, 2004.[11] The Administration seeks to have it made permanent and estimates it would cost about $33 billion over the period 2004-2008. Bills introduced on this topic include H.R. 428, H.R. 463, S. 664

Priorities Among Fields of Federally Funded Research

An important question is what should be the balance among fields of federally supported research, and specifically, since health/life sciences research has consistently received priority in the non-defense area, should more funding go to support other fields of science?[12] Some are concerned that the emphasis on health R&D may presage a scarcity of knowledge and personnel in physical sciences, math, and engineering. Some observers maintain that funding should be increased for all R&D fields, and others cite the need to assess reallocating federal funding from health to nonhealth R&D. As shown in **Figure 1**, health sciences R&D has grown as a priority for about 20 years. Over the period FY1993 to FY2004, requested, it is estimated that R&D funding at NIH increased almost 118% in constant dollars compared to NSF, 61%; DOD, about 30%; the Department of Commerce, 17%; and USDA, about 7%. R&D funding was about level or decreased in constant dollars for EPA, NASA, and DOE. NIH received about 73% of the increase in federal basic research funding between FY1993 and FY2004, requested. For FY2004, it is estimated that federally funded health-related R&D, primarily at NIH, would receive 52% of the civilian R&D budget. In terms of funding by field, federal obligations for life sciences increased from $9.9 billion in FY1992 to $22.2 billion in FY2002 estimated, or about 125%, while at the same time, between those years funding for physical sciences increased 16%; mathematics and computer sciences, 125%; and engineering, 41%. (Based on NSF data and AAAS data.)

In 1998, the Senate passed S.Amdt. 2272 to S.Con.Res. 86, the approved Senate budget resolution. The amendment expressed the sense of the Senate that the NIH budget should double within the next five years. Beginning with FY1999, Congress started appropriating NIH funding at levels that would accomplish this task by 2003. While the doubling is almost complete, some say that because the FY2004 increase requested for NIH is small, at 2.7%, gains made in biomedical R&D will erode.

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[8] The NAS held "Planning Meeting on the Role of State Funding of Research," July 13, 2001. See RAND/OSTP, *Discovery and Innovation: Federal R&D Activities in the Fifty States,* June 2000.

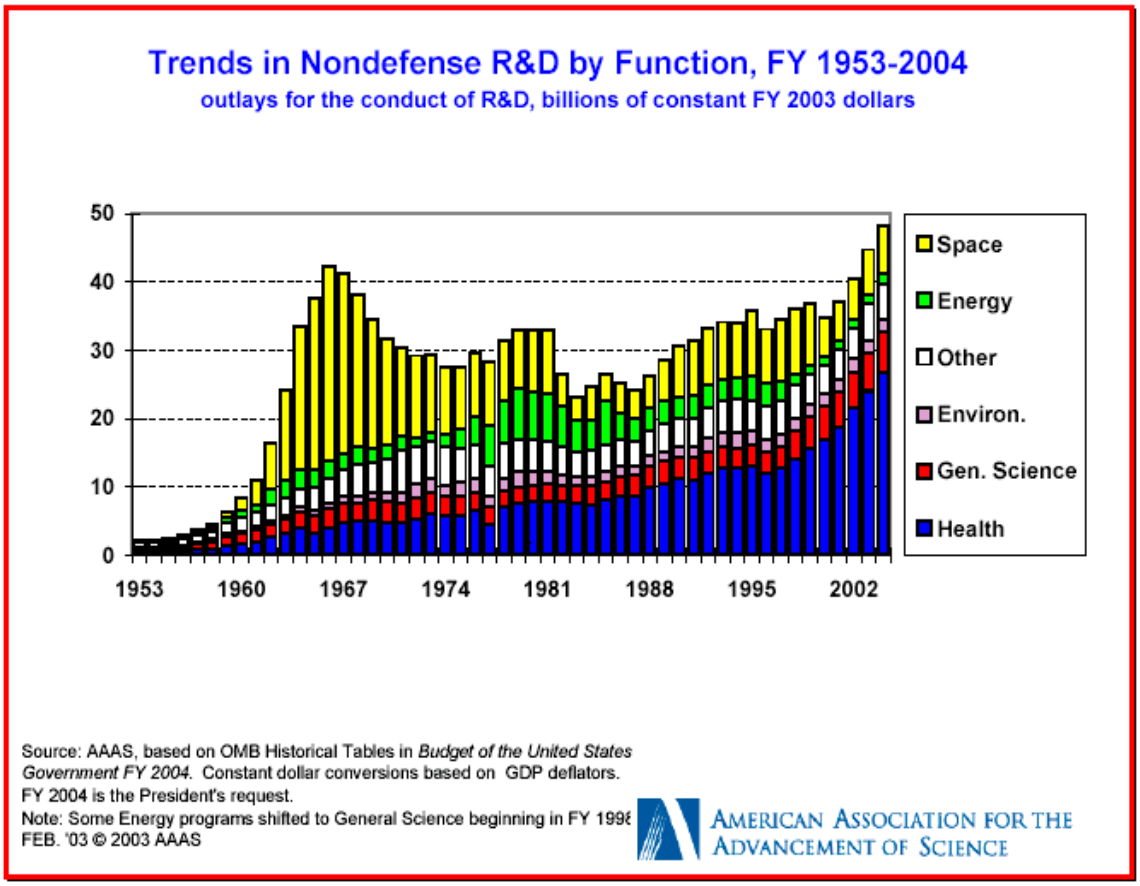
[9] NSTC, *Implementation of the NSTC Presidential Review Directive-4: Renewing the Federal Government-University Research Partnership....,* Jan. 2001.

[10] See CRS Report 95-50 SPR, *The Federal Role in Technology Development,* by Wendy Schacht.

[11] CRS Report RL31181, *Research Tax Credit: Policy Issues for the 108th Congress*, by Gary Guenther.

[12] See also CRS Report RL31031, *The Changing Composition of the Federal Research and Development Portfolio,* by Michael E. Davey and Richard E. Rowberg.

Figure 1. Trends in Nondefense R&D Funding, FY1953-FY2004



Congressional Views About the Balance in Federal R&D Funding. There are various perspectives in Congress on the issue of balance. In the House, the Science Committee, in *Views and Estimates, Fiscal Year 2004*, said it is "...concerned that the biomedical sciences, in general, and the National Institutes of Health (NIH), in particular, continue to dwarf the remainder of the R&D budget. While the budget documents acknowledge the need to increase support for the physical sciences, the proposed spending levels would not allow that to occur, especially when compared to the enacted levels for FY03. Similarly, while Defense Department development programs are critical to our national society, those programs alone cannot crate a stable and secure American society or even ensure our protection from energy attacks of ver the long-term. Yet while the Pentagon is slated to receive a 12 percent increase, basic and applied research in the defense Department would decrease substantially from FY03 requested levels." Former Senate Budget Committee Chairman Domenici was reported to have said during a Senate Budget Committee hearing that " ... you can't increase one piece of science ... and leave the other kinds of research in the doldrums.... In about five years, you're going to have the medical scientists clamoring for where are the physical scientists, ... the people that work on the

newest physics of machinery and engineers and nano-engines and the like?"[13] Thirty-two Nobel laureates and industry executives wrote a letter to President Bush in April 2003, urging increased funding for physical sciences, mathematics and engineering in the 2005 budget [http://www.aps.org/media/pressreleaes/041403.html].

Professional Groups' Views About Balance

Professional groups have recommended increasing both funding and balance in support among federally funded research fields. In one of the most recent analyses of this issued, the President's Council of Advisors on Science and Technology (PCAST) released *Assessing the U.S. R&D Investment*, January 2003. The draft of this report, which had been issued in August 2002, called for doubling federal budgets for physical sciences and electrical, mechanical, chemical, and metallurgical and materials engineering, and endorsed doubling the NSF budget. Reportedly, the OSTP director objected to singling out any agency or field for doubling,[14] so the report recommended targeting physical sciences and engineering to bring "them collectively to parity with the life sciences over the next 4 budget cycles" in order to better balance budget allocations. The U.S. Commission on National Security 21st Century, in *Road Map for National Security: Imperative for Change, The Phase III Report* ...., 2001 concluded that threats to the nation's scientific and educational base are distinct new dangers to U.S. national security. It recommended doubling the federal R&D budget by 2010 to about $160 billion and improving the competitiveness of the less capable R&D institutions. A National Academy of Engineering report, *Trends in Federal Support of Research and Graduate Education*, 2001, recommended that the Administration and Congress should evaluate federal funding for research by field and assess its implications for knowledge generation and industrial growth, and increase budgets for underfunded disciplines. *New Foundations for Growth: The U.S. Innovation System Today and Tomorrow*, released by the National Science and Technology Council on January 10, 2001, recommended funding across the portfolio because "[I]t's not possible to anticipate where exciting new developments will arise. Increased funding across a carefully constructed 'portfolio' of investments will help ensure the health of the national innovation system" (pp. 12-13). The Alliance for Science and Technology Research in America (ASTRA), reportedly modeled after Research! America, an advocacy group for medical research, focuses on physical sciences. Its goals are: "To provide a strong, collaborative, political voice for math, physical sciences and engineering before the federal government that results in substantial and sustained investment; to promote strong, compelling, and mutually reinforcing messages across all groups lobbying for improved vitality of the U.S. research enterprise for those fields; and to nurture support for research for those fields among the voting public."[15]

An applications-oriented approach to setting federal R&D priorities was recommended in *Science for Society, Cutting-Edge Basic Research in the Service of Public Objectives*, May 2001, sponsored by the Packard and Sloan Foundations. It recommended that federal R&D

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[13] Richard M. Jones, "Reaction to the FY2002 Bush Administration S&T Request," *AIP Bulletin of Science Policy News*, FYI #26, Mar. 7, 2001.

[14] "PCAST Releases Report on U.S. R&D Investment," *CFR Weekly 'Wrapup*, Feb. 14, 2003.

[15] John T. Softcheck, "New Advocacy Organization Will Promote Funding for Research in the Non-biological Sciences," *Washington Fax*, Feb. 26, 2001. See also David Malakoff, "Perfecting the Art of the Science Deal," *Science*, May 4, 2001, pp. 830-835.

support should include "basic science that is targeted in an area of important societal objectives, or 'Jeffersonian Science.'" This applications-oriented science would "speed societal progress"and enhance public support for science because it would more clearly link basic research and public objectives (pp. 69-70).

NSF Funding. The National Science Foundation funds research across all disciplines and is the main federal source for much nonhealth-related academic research. Pleas were made during the 107th Congress to double the NSF budget. For instance, the Coalition for National Science Funding (CNSF), which represents many universities and professional science associations, in a February 7, 2002 press release, recommended a 15% increase for NSF and doubling of its budget by FY2006. The Federation of American Societies for Experimental Biology endorsed doubling of the NSF budget as critical to biomedical research advances.[16] The enactment of H.R. 4664, the NSF authorization bill for FY2003, as P.L. 107-368, increases NSF's budget by 15% for each of FY2003, FY2004, and FY2005, which according to the sponsors, would "put the NSF on the track to double its budget within five years," similar to the NIH doubling track in an effort to increase federal support for science fields which, in recent years, have not experienced the larger percentage increases which have gone to biomedical R&D. The law also requires increased oversight of NSF facilities programs. FY2003 appropriations action set NSF on a course to double its budget over the next five years. There is still concern that the Administration's FY2004 NSF R&D request, at 2.8%, is not large enough to meet the authorization's doubling goals.

Federal R&D Priority-Setting Structures

Some observers recommend more centralized priority-setting for R&D in Congress and in the executive branch. Some cite a need for an executive branch mechanism to determine a unified R&D budget and to evaluate the total government R&D portfolio in terms of progress toward meeting national objectives. Others say that congressional jurisdiction for R&D is split among a number of committees and subcommittees, preventing examination of the R&D budget as a whole. This means that R&D funding can serve particular local or program interests, but may not be appropriate for a national R&D agenda. Opponents see value in a decentralized system in which budgets are developed, authorized, and appropriated separately by those most familiar with the needs of specific fields of R&D — the department or agency head and the authorizing and appropriations subcommittees with jurisdiction.

Unified Federal Science and Technology (FS&T) Budget

In a 1995 report, *Allocating Federal Funds for Science and Technology*, the National Academies recommended that the President use and that the Congress consider the R&D budget as a unified whole before its separate parts for each agency are considered by individual congressional committees. It recommended that R&D requested in the budget be reconfigured as a S&T budget, excluding defense development, testing and evaluation activities, to denote basic and applied R&D and the creation of new knowledge. Since the FY2002 budget request, OMB has used a modified version of the format proposed by the Academy, and identified a "Federal Science and Technology (FS&T) budget table," which,

[16] See *Federal Funding for Biomedical and Related Life Sciences Research FY2002.*

for FY2004, includes less than half of total federal R&D spending and some non-R&D funding, such as education and dissemination of information.[17] FS&T funding would increase about 2.0% from FY2003 to FY2004. It is possible that the OMB will continue to use this alternative format, paving the way for congressional consideration of a realigned and unified S&T budget. S.Amdt. 2235 to the Senate budget resolution (S.Con.Res. 86) for FY1999 expressed the sense of the Senate that for FY2000-2004, all federal civilian S&T spending should be classified under budget function 250. This has not occurred.

Interagency R&D Initiatives

Executive Order 12881, issued by President Clinton, established the National Science and Technology Council (NSTC) with cabinet-level status. Located in the Executive Office of the President, it recommends agency R&D budgets to help accomplish national objectives, advises OMB on agency R&D budgets, and coordinates presidential interagency R&D initiatives. Beginning with the FY1996 budget request, NSTC identified interagency R&D budget priorities. The FY2004 budget identified agency funding for two interagency R&D initiatives whose reporting is required by statute,"Networking and Information Technology R&D," at $2,179 million, a 6% increase over FY2003, and "Climate Change Science Program," which incorporated the U.S. Global Change Research Program, with level funding. Another interagency Administration initiative deals with nanotechnology, funded at $849 million, a 9.8% increase over FY2003. Other FY2004 interagency R&D initiatives enunciated by the Administration were in combating terrorism R&D, molecular-level understanding of life processes; and education R&D. For FY2005, the education initiative was replaced by an initiative in "environment and energy." [18]

Proposals to Coordinate Federal R&D

The National Science Board (NSB) report, *Federal Research Resources: A Process for Setting Priorities*, October 11, 2001, (NSB 01-160) recommended a *"continuing advisory mechanism"* in Congress and the executive branch and a strengthened OMB/OSTP relationship to coordinate R&D priorities. It said that federal R&D funding should be looked at as a five-year planned portfolio, rather than as the sum of the requirements and programs of departments. AAAS President Mary Good, recommended creating a *cabinet-level post for S&T* to help achieve balance in R&D and coordinate federal R&D and handle research policy issues.[19] The Commission on National Security recommended empowering the President's science advisor to establish *"functional budgeting,"* to identify nondefense R&D objectives that meet national needs, strengthen the OSTP, NSTC and PCAST, and improve coordination with OMB to enhance stewardship of national R&D. The congressional science policy report, *Unlocking Our Future*, 1998, spearheaded by Representative Vernon Ehlers, called for more balance in the federal research portfolio and said that while OMB can fulfill the coordination function in the executive branch, "no such mechanism exists in the

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[17] Sec. 8, *FY2004 Budget, Analytical Perspectives.*

[18] *FY2004 Interagency R&D Priorities*, Memorandum, from Director, OSTP and Director, OMB, May 30, 2002 and *FY2005 Interagency R&D Priorities*, Memorandum, June 5, 2003.

[19] Rebecca Spieler, "AAAS President Concerned About Imbalances in Nation's R&D Portfolio...," *Washington Fax*, Feb. 21, 2001.

Congress. ...[I]n large, complex technical program, ... committees should ... consider holding joint hearings and perhaps even writing joint authorization bills" (p. 7).

Legislation on Technology Assessment

The aforementioned NSB report also recommended that Congress develop "an appropriate mechanism to provide it with independent expert S&T review, evaluation, and advice" (p. 16). Some believe that this could pertain to reestablishing the Office of Technology Assessment (OTA), which was active between 1972 and 1995 as a congressional support agency. It prepared in-depth reports and policy options about the consequences of S&T and was eliminated as part of the reductions Congress made in a FY1996 appropriations bill. In June 2001, a conference was held to assess ways to "resurrect" OTA or variants of it. Advocates cited the need for better congressional support for S&T analysis.[20] The OTA is still authorized, but funds would have to be appropriated for it. During the 107th Congress, H.R. 2148, a bipartisan bill, would have authorized OTA funding at $20 million annually for five years. Title XVI of H.R. 4, in the 107th Congress, an energy bill as passed by the Senate on April 25, 2002, would have created a Science and Technology Assessment Service within the legislative branch. It was to have a congressional Board and Director. This language was not in the version of the bill passed in House (on August 2, 2001). The conference was not finished on this bill. H.Rept. 107-259, the conference report that accompanied H.R. 2647, which was signed as P.L. 107-68, appropriated $500,000 to GAO for a technology assessment pilot project and report, which GAO issued as *Technology Assessment: Using Biometrics for Border Security*, GA)-03-174, 2002. Another GAO assessment, to be funded at $1 million was called for in S.Rept. 107-209, which accompanied S. 2720, the Senate version of the FY2003 Legislative Branch appropriations bill. The House version did not contain this language. Legislative branch appropriations funding was enacted as part of the Consolidated Appropriations Act, P.L. 108-007 (H.J.Res. 2). GAO initiated a technology assessment on cybersecurity technologies for critical infrastructure in response to the Senate language. H.R. 125, introduced in the 108th Congress, is similar to H.R. 2148, 107th Congress and would authorize funding for OTA at $20 million annually to 2009. The House Legislative Branch Appropriations Report for FY2004 endorses GAO continuing to conduct technology assessment studies (H. Rept. 108-186, July 1, 2003, on H.R. 2657).

Earmarking

There is controversy about congressional designation of R&D funding for specific projects, also called earmarking. When using this practice, Congress, in report language or law, directs that appropriated funds go to a specific performer or designates awards for certain types of performers or geographic locations. Typically an agency has not included these awards in its budget request and often such awards may be made without prior competitive peer review. Critics say that earmarking undermines the authorization process and distorts agency R&D priorities. Supporters believe the practice helps to develop R&D capability in a wide variety of institutions, that it compensates for reduced federal programs

[20] Wil Lepkowski, "The Mummy Blinks," *Science and Policy Perspectives*, June 25, 2001; D. Malakoff, "Memo to Congress: Get Better Advice," *Science*, June 22, 2001: 2229-2230; and M. Davis, "A Reinvented Office of Technology Assessment May Not Suit Congressional Information Requirement...," *Washington Fax*, June 18, 2001.

for instrumentation and facilities renewal, and that it generates economic benefits in targeted regions since R&D capacity may generate industrial growth. Section 8 of *Analytical Perspectives, FY2004 Budget* reported that R&D funded at congressional direction for FY2002 totaled $1.824 billion, up almost 4% over FY2001. The *Chronicle of Higher Education,* September 27, 2002, reported that for FY2002, Congress earmarked $1.8 billion for universities and colleges, most of it for R&D. According to AAAS, FY2002 R&D earmarks totaled $1.5 billion, with most for USDA, DOD, the DOE, and NASA, in that order.[21] The Administration seeks to discourage earmarking saying that it distorts agency priorities. A conference on the pros and cons of earmarking was held on October 3, 2001[22]

Government Performance and Results Act (GPRA)

The Government Performance and Results Act of 1993 (GPRA), P.L. 103-62, is intended to produce greater efficiency, effectiveness, and accountability in federal spending and to ensure that an agency's programs and priorities meet its goals. It also requires agencies to use performance measures for management and, ultimately, for budgeting. All major R&D funding agencies have developed performance measures to assess the results of their R&D programs. Recent actions have required agencies to identify more precisely R&D goals and measures of R&D outcomes. As underscored in *The President's Management Agenda,* beginning in FY2001 and in each year thereafter, the Bush Administration has emphasized the importance of performance measurement, including for R&D. In a memorandum dated April 24, 2002, from the OMB Director, regarding planning for the FY2004 budget requests, the Administration announced that its effort to base budget decisions on program performance would continue and be expanded (M-02-06.) Section 8 of OMB's *Analytical Perspectives, Budget of the U.S. Government, FY2004,* discusses requirements for agencies to use specific OMB-defined criteria to measure the outcomes of basic and applied research, focusing on measures of relevance, quality, and performance. R&D projects relevant to industry are to meet additional criteria relating to the appropriateness of public investment, demonstrate a capability to measure benefits, and identify decision points to transition the activity to the private sector. Several agencies, including NASA, NSF, and NIH, are revising their strategic plans, annual performance plans, and annual performance reports required by GPRA, to describe their activities in terms of the new criteria. The Administration is also assessing some R&D programs by use of a new Program Assessment Rating Tool (PART) which uses the R&D criteria. PART results were published in *Performance and Management Assessments, Budget of the United States Government, Fiscal Year 2004*. Commentators have pointed out that it is particularly difficult to define priorities for most research and to measure the results quantitatively, since research outcomes cannot be defined well in advance and often take a long time to demonstrate. Many observers say that refinement of R&D goals and measures is needed before performance measures can be used with confidence to recommend budget levels for most R&D. The minority staff of the House Science Committee criticized the Administration's use of performance metrics in making budgetary decisions, faulting the

[21] AAAS, "Senate Earmarks Approach $1 Billion in FY2003 Budget," Aug. 26, 2002.

[22] See Jeffrey Brainard, "Supporters an Criticism of Congressional Earmarks Meet to Seek Consensus," *Chronicle of Higher Education,* Oct. 4, 2001, and David Malakoff, "White House Asks Community to Oppose Earmark Projects," *Science,* Sept. 28, 2001, p. 2364.

judgments that are used to rate programs and the fact that political decisions appear to supercede the use of metrics in some decision-making.[23]

The Department of Energy, has started to use the results of the R&D investment criteria, according to OMB, to help analyze its portfolio of investments in relation to producing public benefits. The National Academies [of Science] (NAS) issued two reports to assist agencies in developing performance measures for research. The most recent is entitled *Implementing the Government Performance and Results Act for Research: A Status Report, 2001*. As for Congressional interest, the House Science Committee's science policy report, *Unlocking Our Future*, 1998, commonly called the Ehlers report, recommended that a "portfolio" approach be used when applying GPRA to basic research. P.L. 106-531 mandated that an agency head assess the completeness and reliability of performance data used in reports to Congress and the House adopted a rule with the passage of H. Res. 5 (106th Congress) requiring all "committee reports [to] include a statement of general performance goals and objectives, including outcome-related goals and objectives for which the measure authorizes funding." (See CRS reports RS20257, *Government Performance and Results Act: Brief History and Implementation Activities* and RS20938, *Performance Management and Budgeting: Benchmarks and Recent Developments*.)

108th Congress Legislation

H.R. 125, To reestablish the Office of Technology Assessment, Introduced by Rep. Rush D. Holt, 1/7/2003, Referred to the House Science Committee.

H.R. 428, To amend the Internal Revenue Code of 1986 to make the credit for increasing research activities permanent, Introduced by Rep. James F. Sensenbrenner, 1/28/2003, Referred to House Ways and Means Committee.

H.R. 463, To amend the Internal Revenue Code of 1986 to permanently extend the research credit, to increase the rates of the alternative incremental credit, and to provide an alternative simplified credit for qualified research expenses, Introduced by Rep. Nancy L. Rep Johnson, Nancy, 1/29/2003, Referred to House Ways and Means Committee.

H.R. 175, To abolish the Advanced Technology Program, Introduced by Rep. Edward R. Royce, 2/20/2003, Referred to House Science Committee.

S. 664, to amend the Internal Revenue Code of 1986 to permanently extend the research credit, to increase the rates of the alternative incremental credit, and to provide an alternative simplified credit for qualified research expenses, Sen Orrin G. Hatch , 3/19/2003.

[23] Committee on Science, Democratic Caucus, "Additional Democratic Views and Estimates on the FY2004 Budget for Civilian science and Technology Programs," Mar. 5, 2003.

Table 3. R&D in the Budget and Outyear Budget Projections, By Agency, Based Largely on AAAS Data

(Budget authority in millions of dollars)

SELECTED AGENCIES & PROGRAMS	FY2000 actual	FY2001 actual	FY2002 actual	FY2003, Approved, AAAS Est.	FY2004 Request	FY2004, House or Apps. Comm.(C)	FY2004 Senate Apps. Comm.	% Change FY2003-FY2004
Dept. of Agr. Total	$1776	$2181	$2112	$2166	$1943			-10.3%
(Agr. Res. Service)	—	*(1012)*	*(1234)*	—	—			
(CSREES)	—	*(594)*	*(532)*	—	—			
(Forest Service)	—	*(245)*	*(265)*	—	—			
Dept. of Commerce Total	1174	1030	1328	1389	1150			-17.2%
(NOAA)	*(643)*	*(561)*	*(611)*	*(825)*	*(724)*			*-12.2%*
(NIST)	*(471)*	*(413)*	*(460)*	*(527)*	*(411)*			*-22.0%*
(ATP) (Within NIST)	*(116)*	*(118)*	*(150)*	—	—			
Dept. of Defense Total	39959	42740	49877	58724	62821	65953(C)		12.3%
(S&T (6.1-6.3+ medical))	*(8632)*	*(9365)*	*(10337)*	*(11232)*	*(10297)*	*(12316)(C)*		*9.7%*
Dept. of Education	238	264	265	315	275			-12.8%
Dept. of Energy Total	6956	7733	8078	8205	8535			4.0%
(Atomic/Defense)/(NNSA+Defense)	*(3201)*	*(3462)*	*(3855)*	*(4339)*	*(4695)*			*8.2%*
(Energy & Science)	*(3755)*	*(4271)*	*(4224)*	*(3866)*	*(3840)*			*-0.7%*
Dept. of HHS Total	18182	21045	23696	27566	28203	(28203)(C)	28576	3.7%
(NIH)	*(17234)*	*(19807)*	*(22714)*	*(26245)*	*(26946)*	*(26946)(C)*	*(27254)*	*3.8%*
Dept. of Homeland Security*	—	—	266	669	907	1054		57.5%
Dept. of Interior Total	618	621	641	647	661			2.2%
(U.S. Geological Survey)	—	(566)	(583)	—	—			—
Dept. of Transportation Total	607	718	778	72	693			-1.2%
(FAA)	*(220)*	*(301)*	*(359)*	—	—			—
(FHA)	*(261)*	*(294)*	*(275)*	—	—			—

SELECTED AGENCIES & PROGRAMS	FY2000 actual	FY2001 actual	FY2002 actual	FY2003, Approved, AAAS Est.	FY2004 Request	FY2004, House or Apps. Comm.(C)	FY2004 Senate Apps. Comm.	% Change FY2003-FY2004
(NHTSA)	*(51)*	*(58)*	*(59)*	—	—			—
(TSA)	*new*	*agency*	*(14)*	—	—			—
Dept. of Veterans Affairs	645	719	756	800	822			2.8%
Environmental Protection Agency	558	574	592	641	607			-5.3%
NASA Total	9494	9887	10224	10999	11025			0.2%
(Human Space Flight)	*(3014)*	*(2901)*	*(2461)*	—	—			—
(Science, Aeronautics, Tech.)	*(6481)*	*(7024)*	*(7840)*	—	—			—
National Science Foundation	2931	3320	3525	3927	4035			2.8%
All other R&D	630	702	912	1322	792			-66.0%
TOTAL	83769	91534	102899	117106	122259			4.4%
NonDefense	40609	45332	49167	54121	54744			1.2%
NonDefense Minus NIH	*23374*	*25525*	*26453*	*27875*	*27798*			*-0.3%*
Defense	43160	46202	53731	62986	67515			7.2%

Source: Based largely on American Association for the Advancement of Science, with tables appearing at [http://www.aaas.org/spp/dspp/rd/fy03.htm] and AAAS, "FY'04 Budget Proposes defense and Homeland Security Increases, Modest Growth or Cuts for Other R&D Programs," Feb. 25, 2003, revised. AAAS bases its tables on OMB data, agency budget justifications, information from agency budget offices, and appropriations action. Data in italics in parentheses are parts of the total and have been included in agency totals. Final figures for FY2003 are AAAS estimates of congressional appropriations. See also CRS Issue Brief IB10100, *Federal Research and Development Funding: FY2003.* DOD FY2003 figures are adjusted to reflect rescissions and supplementals enacted in P.L. 108-2 and P.L. 108-11.
*FY2002 data for comparison purposes only. DHS was to begin operations in FY2003. DHS figures include programs to be transferred from other agencies.