4. PROMOTING RESEARCH

... We must harness the remarkable forces of science and technology that are remaking our world. ... We can make this age of science and technology a true age of possibility for all the American people, but we must invest in it and do it wisely if we expect to get a return.

President Clinton
December 11, 1996

Technological innovation has accounted for at least half of the Nation's productivity growth in the last 50 years. We enjoy the fruits of this innovation every day in the many technologies that we have come to depend on for our way of life—including lasers, computers, x-rays, teflon, weather and communication satellites, jet aircraft, microwave ovens, solar-electric cells, human insulin, and a plethora of pharmaceutical products. These advances have generated millions of high-skilled, high-wage jobs and significantly improved the quality of life for Americans.

Because our investments in science and technology (S&T) have paid such rich dividends, U.S. leadership in S&T is a cornerstone of the President's vision for America. Thus, the budget continues these vital S&T investments—investments that contribute significantly to many of the Administration's broader goals, including creating new knowledge, training our workers, creating new jobs and industries, solving our many health challenges, enhancing our ability to address environmental issues, improving our ability to teach our children, and maintaining a strong, capable national defense.

Specifically, the budget adds funds for basic research in health sciences at the National Institutes of Health (NIH), for basic research and education at the National Science Foundation (NSF), for research at other agencies that depend on S&T for their missions, and for cooperative projects with industry and universities.

As the President has said, we need to balance the budget in a way that boosts economic growth and encourages public and private investment in innovative S&T. The budget continues the record of S&T investment that has helped to keep the economy strong over the last four years.

The Federal Role in S&T

The post-Cold War era is one of intense global economic competition. The United States also faces new national security challenges, including the proliferation of nuclear and biological weapons, regional conflicts, threats from environmental degradation, and emerging infectious diseases.

Thus, the Federal Government has an indispensable role to play in investing in S&T—a role critical to the country's economy, national security, environment, health, and other social needs. This is especially true when the risk is too great for individual companies to make the needed investment, or when the public benefit is large but private return is small. Our Nation also must support a balanced mix of S&T investments (i.e., basic research, applied research, and technology development), because the steps involved in scientific discovery and technological innovation are so profoundly interwoven.

The Administration has initiated or expanded public-private partnerships to spur innovations with broad economic impact. These partnerships have traditionally served our Nation well, not only in building transportation infrastructure (e.g., highways, airways, harbors, and railroads), but in nurturing new types of technological infrastructure (e.g., the Internet, global positioning satellites, and environmental monitoring systems). They also

enable the private sector to translate new knowledge into novel technologies that benefit its bottom line as well as society at large.

Science and Technology Highlights

As noted above, S&T investments contribute significantly to the Administration's economic, health, environment, national security, and education goals. This chapter describes the contributions in greater detail. Overall research and development investment totals are displayed in Table 4–1, while selected S&T highlights are displayed in Table 4–2.

Table 4–1. RESEARCH AND DEVELOPMENT INVESTMENTS

(Budget authority, dollar amounts in millions)

	1993 Actual	1997 Estimate	1998 Proposed	Dollar Change: 1997 to 1998	Percent Change: 1997 to 1998
By Agency:					
Defense	38,898	37,461	36,780	–681	–2%
Health and Human Services	10,472	12,933	13,478	+545	+4%
National Aeronautics and Space Administration	8,873	9,314	9,603	+289	+3%
Energy [1]	6,896	6,186	7,312	+1,126	+18%
National Science Foundation	2,012	2,458	2,553	+95	+4%
Agriculture	1,467	1,545	1,485	–60	–4%
Commerce	793	1,050	1,115	+65	+6%
Interior	649	581	605	+24	+4%
Transportation	613	639	754	+115	+18%
Environmental Protection Agency	511	504	555	+51	+10%
Other	1,308	1,150	1,229	+79	+7%
Total	**72,492**	**73,821**	**75,469**	**+1,648**	**+2%**
By R&D Theme:					
Basic Research	13,362	14,885	15,303	+418	+3%
Applied Research	13,608	14,529	15,159	+630	+4%
Development	42,795	42,153	41,636	–517	–1%
Equipment [2]	NA	937	960	+23	+2%
Facilities [1,2]	2,727	1,317	2,411	+1,094	+83%
Total	**72,492**	**73,821**	**75,469**	**+1,648**	**+2%**
By Civilian Theme:					
Basic Research	11,951	13,747	14,112	+365	+3%
Applied Research	9,130	10,469	11,125	+656	+6%
Development	7,269	7,860	8,117	+257	+3%
Equipment [2]	NA	492	506	+14	+3%
Facilities [2]	1,979	984	1,128	+144	+15%
Subtotal	**30,329**	**33,552**	**34,988**	**+1,436**	**+4%**
By Defense Theme:					
Basic Research	1,411	1,138	1,191	+53	+5%
Applied Research	4,478	4,060	4,034	–26	–1%
Development	35,526	34,293	33,519	–774	–2%
Equipment [2]	NA	445	454	+9	+2%
Facilities [1,2]	748	333	1,283	+950	+285%
Subtotal	**42,163**	**40,269**	**40,481**	**+212**	**+1%**
By R&D Share:					
Defense	42,163	40,269	40,481	+212	+1%
Civilian	30,329	33,552	34,988	+1,436	+4%
Total	**72,492**	**73,821**	**75,469**	**+1,648**	**+2%**
Civilian (percent)	42	45	46	NA	NA
R&D Support to Universities	**11,674**	**12,979**	**13,268**	**+289**	**+2%**
Merit (Peer) Reviewed R&D Programs	**NA**	**22,220**	**22,717**	**+497**	**+2%**

NA = Not applicable.

[1] 1998 estimates reflect an extra $1 billion for Department of Energy (DOE) facilities acquisition (primarily in defense) as part of DOE's move to fully funding acquisitions up front.

[2] Equipment and Facilities were not collected separately in 1993.

Table 4–2. SELECTED SCIENCE AND TECHNOLOGY HIGHLIGHTS

(Budget authority, dollar amounts in millions)

	1993 Actual	1997 Estimate	1998 Proposed	Dollar Change: 1997 to 1998	Percent Change: 1997 to 1998
National Science Foundation	2,734	3,270	3,367	+97	+3%
National Institutes of Health	10,326	12,741	13,078	+337	+3%
Environmental Protection Agency:					
Particulate matter in ambient air research	NA	19	26	+7	+37%
Science to achieve results	NA	95	115	+20	+21%
National Aeronautics and Space Administration:.					
International Space Station	2,262	2,149	2,121	–28	–1%
Mission to Planet Earth	1,062	1,362	1,417	+55	+4%
Space science	1,756	1,971	2,044	+73	+4%
X-33 reusable launch vehicle technology program	NA	245	330	+85	+35%
Aeronautics initiative	129	417	456	+39	+9%
Department of Energy:					
Science-based stockpile stewardship	NA	1,439	1,444	+5	+*%
Civilian basic science programs	2,583	2,035	2,067	+32	+1%
Large Hadron Collider project	NA	15	35	+20	+133%
Department of Commerce:					
Advanced Technology Program	68	225	275	+50	+22%
Manufacturing Extension Partnerships	18	95	129	+34	+36%
National Information Infrastructure	NA	22	36	+14	+64%
Department of Defense: Dual Use Application Program	NA	181	225	+44	+24%
Department of Agriculture: National Research Initiative	98	94	130	+36	+38%
Department of Transportation: Intelligent Transportation Infrastructure	143	235	250	+15	+6%
National Science and Technology Council initiatives:					
High performance computing and communications: [1]					
Defense	298	334	357	+23	+7%
Health and Human Services	47	90	97	+7	+8%
National Aeronautics and Space Administration	82	114	128	+14	+12%
Energy	100	117	152	+35	+30%
National Science Foundation	233	278	294	+16	+6%
Commerce	12	32	35	+3	+9%
Transportation	NA	20	25	+5	+25%
Education	NA	12	12	+*	+*%
Veterans	NA	22	22	+*	+*%
Environmental Protection Agency	NA	6	6	+*	+*%
Subtotal	772	1,025	1,128	+103	+10%
U.S. global change research program: [2]					
Health and Human Services	1	4	4	+*	+*%
National Aeronautics and Space Administration	1,062	1,362	1,417	+55	+4%
Energy	118	112	110	–2	–2%
National Science Foundation	124	164	166	+2	+1%
Agriculture	55	57	61	+4	+7%
Commerce	66	60	62	+2	+3%
Interior	38	29	29	+*	+*%
Environmental Protection Agency	NA	14	21	+7	+50%
Smithsonian	NA	7	7	+*	+*%
Tennessee Valley Authority	NA	1	1	+*	+*%
Subtotal	1,464	1,810	1,878	+68	+4%
Partnership for a new generation of vehicles	NA	263	281	+8	+7%
Construction and building	NA	176	203	+27	+15%
Educational technology	NA	499	524	+25	+5%
Emerging infectious diseases research	NA	260	280	+20	+8%

NA = Not collected in this year.
* Less than $500 thousand or 0.5 percent.
[1] Listing by agency required by law; estimates include $100 million in 1998 for the Next Generation Internet.
[2] Listing by agency required by law.

Increasing Total Support for Science and Technology: This budget marks the fifth straight year that the President has proposed increases in research and development (R&D)—at $75.5 billion, $1.6 billion or two percent more than in 1997.[1] Continuing previous efforts, the budget also provides an increasing share for civilian R&D investments, with those investments at 46 percent of the total.

Boosting Funding for Basic Research and Applied Research: The budget proposes $15.3 billion for basic research and $15.2 billion for applied research—increases of $418 million and $630 million over 1997, respectively. These investments, which include increases of three percent each for NIH and NSF, reflect the Administration's commitment to create new knowledge that will pay economic dividends down the road and address many of the health challenges that face the nation, such as breast cancer.

Strengthening University-Based Research: University-based research (a mixture of basic, applied, development R&D, equipment, and facilities) is key to America's future; simultaneously, it provides new knowledge and new technology, and it trains the next generation of scientists and engineers. The budget proposes $13.3 billion for university-based research, an increase of $289 million over 1997. It also proposes $22.7 billion for merit-reviewed research (two percent more than in 1997), comprising 18 percent of the R&D budget. Increases in merit-reviewed research ensure that the Nation receives the highest quality return on these investments.

Investing in Innovation to Create New Jobs and Industries: Many of the new jobs created under this Administration have been high-tech, high-wage jobs in industries like biotechnology and computing—jobs that didn't exist a decade or two ago. The budget maintains a strong investment in technology to foster these high-priority civilian S&T industries and jobs. Funding continues or expands for high-performance computing research; for the Advanced Technology Program, which works with industry to develop high-risk, high-payoff technologies; for Manufacturing Extension Partnerships to help small businesses battle foreign competition by adopting modern technologies and production techniques; and for other programs.

Investing in Environmental Research: S&T investments are critical for enhancing environmental quality and assuring a sustainable future. While the Nation is making progress on many pollution fronts, emerging global environmental problems pose new risks. The budget maintains vital research to provide safe food, clean air, and pure water. It supports programs to increase energy efficiency and the development of renewable energy sources that cut demand for foreign oil and reduce greenhouse emissions, and partnerships with industry to develop cars that use less fuel. The budget invests in programs that preserve biological diversity and help us understand and prepare for changing climate conditions and natural disasters. These investments also provide a sound scientific basis for rational rule-making on, and cost-effective implementation of, environmental regulations. (For information on energy efficiency and renewable energy R&D programs, see Chapter 3.)

Investing in a 21st-Century Education: Information technology has revolutionized America's businesses, but it has not been widely adopted in America's classrooms. We must use this new technology to help children prepare for the challenges of the 21st Century. Building on the experience of earlier Federal investment in educational technology, the budget includes a second installment for the President's new five-year, $2 billion Technology Literacy Challenge Fund to encourage States and communities, working with private sector partners, to develop and implement plans for fully integrating educational technology into their school curricula. (For more information, see Chapter 2.)

Enhancing Programs to Keep Our Nation Secure: While the budget continues investments in defense research that ensure our strong, future military capabilities, it also fosters key programs to keep nuclear weapons out of the hands of terrorists, to comply with the Comprehensive Test Ban Treaty by using science-based techniques to ensure the safety and reliability of our nuclear weapons stockpiles, and to bolster strong international S&T

[1] Research and Development (R&D) is a widely-accepted measure of investment in S&T.

cooperation to improve global stability. The budget also supports the Dual Use Applications Program (DUAP), which puts the technical know-how and economies of scale from commercial industry at the service of national defense.

Agency Highlights

National Science Foundation: NSF, recognized world-wide for its high standards of quality and efficiency, funds proposals based on a rigorous, competitive process of merit review. Reflecting the high quality of NSF-backed science, NSF supported five of the six 1996 U.S. Nobel prize winners early in their careers. Alone among Federal agencies, NSF has the broad mission of promoting science and engineering research and education across all fields and disciplines. It supports nearly half of the non-medical basic research conducted at academic institutions, and provides 30 percent of Federal support for mathematics and science education. Because most NSF awards go to colleges and universities, they generate knowledge and train the next generation of scientists and engineers. The budget proposes $3.4 billion for NSF, three percent more than in 1997.

National Institutes of Health: The budget continues the President's commitment to biomedical research, which promotes the health and well-being of all Americans. NIH support for biomedical research grew by $2.4 billion, or by 23 percent, between 1993 and 1997. For 1998, the budget proposes $13.1 billion for NIH, a three-percent increase over 1997. NIH's highest priority continues to be funding investigator-initiated, peer-reviewed research project grants. The budget proposal would enable NIH to increase HIV/AIDS-related research, research into breast cancer and other health concerns of women, minority health initiatives, high performance computing, prevention research, spinal cord injury, and developmental and reproductive biology.

Environmental Protection Agency (EPA):

Particulate Matter (PM) in Ambient Air Research: The budget proposes $26.4 million for PM research, a 37-percent increase over 1997. To reduce the great uncertainty about PM's health effects, EPA will continue its efforts to identify the mechanisms by which particles affect human health. It will launch research into three areas: (1) evaluating the relationship between health effects and PM exposures; (2) determining the amount and size of particles inhaled and retained in the lungs; and (3) investigating biological mechanisms by which PM concentrations in outdoor air may induce health effects and, in doing so, evaluating potential links between PM exposures and health effects.

Science to Achieve Results (STAR) Program: The budget proposes $115 million (21 percent more than in 1997) for EPA's STAR program, which awards grants and fellowships on the basis of rigorous peer review. The program funds research proposals from scientists outside the Federal Government that focus on the most pressing environmental concerns. EPA funds the proposals independently or in cooperation with NSF and other Federal agencies.

National Aeronautics and Space Administration (NASA):

NASA has been on the forefront of Administration efforts to reshape the Federal Government—to make it work better, cost less, and better service its customers, the American people. The budget proposes balanced and sustainable funding for NASA over the next five years, permitting NASA not only to continue improving its operations but also to support important strategic research efforts, including the efforts highlighted below:

Space Science: The space science program has achieved impressive successes this past year—meteoric evidence of possible life on ancient Mars, the possible detection of water on the Moon and a moon of Jupiter, and the identification of possible planets around other stars. To build on these successes and implement the President's directives in his recently-released space policy, the Administration proposes $2 billion for space science, a four-percent increase over 1997. The additional funding will enhance NASA's Origins program, which seeks to understand the creation of the universe, stars, solar system, and life, and determine if life once existed or still exists beyond Earth.

International Space Station: The Administration continues to support the development of the International Space Station—a U.S.-led collaborative effort with the European Space Agency, Canada, Japan, and Russia—that will provide an unique laboratory to explore innovative research on materials and biological processes, on promising new technologies, and on how people can live and work in a low-gravity environment. The budget proposes $9 billion in advanced, multi-year appropriations to complete the $17.4 billion Space Station development and assembly, helping to ensure that the program is completed, as promised, within budget and on schedule.

Mission to Planet Earth (MTPE): MTPE is NASA's effort to observe, understand, and predict natural and human-induced changes to the environment. The budget proposes $1.4 billion for MTPE, four percent more than in 1997. MTPE programs include the Earth Observing System satellites, the Landsat satellite, and a broad range of scientific research and data analysis activities.

X-33 Reusable Launch Vehicle (RLV) Technology: The budget proposes $719 million in advanced multi-year appropriations to complete development of the RLV X-33 test vehicle, that should dramatically cut the cost of getting into space by demonstrating the use of new materials, reusable components, and new operations management approaches.

Aeronautics Initiative: The budget proposes $456 million for NASA's aeronautics initiatives, a nine-percent increase over 1997. These initiatives are partnerships with industry and include advanced subsonic technology and high speed research that may revolutionize the next generation of commercial aircraft.

Department of Energy (DOE):

Stockpile Stewardship: The President's commitment to a Comprehensive Test Ban Treaty (CTBT) is closely linked to the Administration's plan to maintain the safety and reliability of the nuclear weapons stockpile through scientific experiments and computer modeling (i.e., no explosive testing of nuclear weapons). The budget proposes $1.4 billion for Stockpile Stewardship activities in 1998, plus $1.3 billion for related construction projects. Among these projects, $900 million would go to build the National Ignition Facility at the Lawrence Livermore National Laboratory. The President, who plans to submit the CTBT for Senate ratification in 1997, also is committed to funding a comprehensive R&D program over the next decade to improve treaty monitoring capabilities and operations.

Civilian Basic Science Programs: The Administration has designated High Energy and Nuclear Physics, Basic Energy Sciences, and Biological and Environmental Research as high-priority areas of DOE basic science in 1998. These programs, which have a large university-based component, contribute to both our national basic research enterprise and to DOE's core activities. In addition, these programs build and operate large user facilities that serve over 15,000 university, government, and industry scientists. The budget proposes $2.1 billion in 1998 for these activities.

Large Hadron Collider Project: When it comes on-line in 2005, the Large Hadron Collider (LHC) at the European high-energy physics laboratory CERN, in Switzerland, will be by far the world's most powerful accelerator. Its scientific goals are to search for the origin of mass, to explore in detail the structure and interactions of the top quark (the heaviest of the known subatomic particles), and to probe high-energy conditions beyond the Standard Model—the remarkably successful physics theory that describes all the forces of nature, except gravity. Hundreds of U.S. high energy physicists plan to participate in the LHC project. The Administration proposes $394 million in advanced, multi-year appropriations over eight years for DOE, which it designated as the lead Federal agency for U.S. participation. U.S. funding for the LHC would support U.S. scientists and technicians, and support the purchase of U.S. goods and services necessary for our contribution to constructing the accelerator and two detectors.

Department of Commerce:

Advanced Technology Program (ATP): ATP is a rigorously competitive, industry-led, and cost-shared R&D program that fosters technology development, promotes industrial alliances, and creates jobs. ATP pursues technologies that are critical to the competitive position of U.S. industries, but where the risk

is so high that industries will not likely invest enough to ensure continued U.S. leadership. The projects have led to significant technology advances that have improved our daily lives. With ATP funding, for example, a consortium of several large and small companies recently developed techniques to make better cars, thus increasing customer satisfaction. The budget proposes $275 million in 1998 for ATP, growing to $500 million by 2002.

The Manufacturing Extension Partnerships (MEP): MEP gives the Nation's 381,000 smaller manufacturers the technological information and expertise to improve their operations. Extension centers are helping to improve the performance of small manufacturers across the country, leading to more sales, more jobs, and savings in labor and materials. The budget proposes $129 million in 1998 to support 78 extension centers and over 300 field offices nationwide.

National Telecommunications and Information Administration National Information Infrastructure (NII) Grants Program: The budget proposes $36 million for grants to help develop the NII, which provides the infrastructure that enables computers to connect to one another and to information systems across the country. These grants help fund innovative demonstration projects to show how information technology can improve the delivery of educational, health, and other social services.

Department of Defense Dual Use Applications Program: The budget proposes $225 million for DUAP, which will build on previous Federal dual-use technology development programs and allow the military services to develop and use technologies, processes, and products available to the commercial sector. Dual-use technologies can enhance the performance and reduce the costs of military applications.

Department of Agriculture (USDA) National Research Initiative: The budget proposes a 38-percent increase, to $130 million, for the National Research Initiative (NRI), USDA's major peer-reviewed competitive grants program. The NRI supports fundamental research on key agricultural problems that will help our Nation's farmers retain their technological edge, such as research in food safety, plant and animal genetics, water quality, integrated pest management, and sustainable food and fiber production systems. Of particular concern is the need to expand the science base for reducing food-borne illness due to microbial pathogens and to the many food and fiber production practices that contribute to environmental degradation, such as the excessive use of pesticides, fertilizers and tillage. As a result, the Administration proposes to target $4 million to expand research in food safety, $10 million to expand research in environmentally sound production practices, and $22 million to expand research on enhancing plants through genetics.

Department of Transportation Intelligent Transportation System (ITS) Initiative: The budget proposes $250 million for the ITS initiative—a package of technologies designed to enhance the efficiency of our surface transportation infrastructure. The request includes $100 million for a new Deployment Incentives program to encourage integrated implementation of ITS. The Administration also proposes to make ITS projects eligible for surface transportation funds and, in 1997, to complete 77 operational tests of ITS standards and technology and a demonstration of the technical feasibility of the Automated Highway System.

National Science and Technology Council Interagency Initiatives

Next Generation Internet (NGI) Program: The budget proposes $100 million for each of the next three years to support the NGI, which seeks to develop a research network that can reach speeds 100 to 1,000 times faster than today's Internet and greatly improve the quality of service. The NGI proposal is a part of an overall request for $1.1 billion, 10 percent more than in 1997, for research and development in computers and communications technologies under the rubric of the Administration's High Performance Computing and Communications initiative.

U.S. Global Change Research Program (USGCRP): The budget continues strong Administration support for the USGCRP, proposing $1.9 million for 1998. Program priorities include research on seasonal to interannual climate variability, climate change over decades

to centuries, and on changes in atmospheric chemistry and ecosystems. The program also will continue to increase its focus on understanding the consequences of change, particularly at regional levels.

Emerging Infectious Diseases: The budget proposes $280 million, eight percent over 1997, for research on the development of new tools to detect and control emerging infectious diseases and on the biology and pathology of infectious agents. Focus areas include: surveillance; screening and quarantine; diagnostics, treatment, and prevention measures; training; antibiotic resistance; zoonotic infectious agents; and health effects of climate change.

Partnership for a New Generation of Vehicles: The budget proposes $281 million, a seven-percent increase over 1997, for research to: (1) develop advanced manufacturing techniques that make it easier to get new automobiles and auto components into the marketplace quickly; (2) use new technologies for near-term improvements in auto efficiency, safety, and emissions; and (3) lead to production prototypes of vehicles that are three times more fuel efficient than today's cars, with no sacrifice in comfort, performance, or price.

Construction and Building: The budget proposes $203 million, a 15-percent increase over 1997, for research to develop better construction technologies to improve the competitive performance of U.S. industry, raise the life cycle performance of buildings, and protect public safety and the environment.

Educational Technology: The budget proposes $524 million, a five-percent increase over 1997, for research and development on education and training to improve learning in schools, workplaces, and homes.