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IV. C. ENHANCING RESEARCH AND DEVELOPMENT AND EXPANDING THE HUMAN FRONTIER

Jeanie -

Please see Table II, page
39. This is the government
summary of R & D.

See discussion beginning
on previous page (38) for
trends. Call if you need to.
-norme

Reprint of pages Two-35 through Two-76 of
the *Budget of the United States Government*,
Fiscal Year 1992

IV.C. ENHANCING RESEARCH AND DEVELOPMENT AND EXPANDING THE HUMAN FRONTIER

Since the beginning of civilization, mankind has sought to explore the frontier and increase its knowledge of the world. Today's frontiers are in space, communications, transportation, energy, manufacturing and materials, and biotechnology. This chapter discusses a range of programs and issues that are related to these frontiers: Federal research and development activities; space; and biotechnology. These endeavors are among America's most important investments in the future.

The budget proposes to allocate about \$76 billion for *research and development*, including

R&D facilities, in 1992. This is an increase of over \$8 billion, or 13 percent over 1991 levels. Within this total, the budget proposes over \$13 billion for basic research, an increase of \$1 billion, or 8 percent, over 1991.

The budget also proposes to allocate over \$16 billion for major *space activities*. This is an increase of \$2 billion, or 15 percent, over 1991 enacted levels.

The budget proposes several crosscutting investments that will build the base for the continuing expansion of the frontier of knowledge:

**Table C-1. ENHANCING RESEARCH AND DEVELOPMENT AND
EXPANDING THE HUMAN FRONTIER—HIGHLIGHTS**

(Dollar amounts in millions)

	Budget Authority			
	1991 Enacted	1992 Proposed	Dollar change	Percent change
Basic Research				
Doubling the NSF budget	2,316	2,722	+406	+18
Increasing Basic Biomedical Research at NIH	4,634	4,968	+334	+7
Human Genome Project	135	169	+35	+26
Agricultural Research Initiative	73	125	+52	+71
Superconducting Super Collider	243	534	+291	+120
Applied Research				
High Performance Computing and Communications	489	638	+149	+30
Energy R&D	676	903	+227	+34
Advanced Manufacturing and Materials	1,316	1,310	-6	—
HIV/AIDS	1,152	1,210	+58	+5
Moving Fusion Energy from Science to Engineering	275	337	+62	+23
Aeronautics R&D	482	543	+61	+13
Expanding R&D at the National Institute of Standards and Technology	215	248	+33	+15
Maintaining National Security: Defense R&D	37,783	43,247	+5,464	+14
Expanding the Geographic Frontier: Space Exploration				
Space Transportation Infrastructure	4,801	5,517	+716	+15
Space Science	1,774	2,141	+367	+21
Mission to Planet Earth (Global Change)	954	1,186	+232	+24
Mission From Planet Earth	2,199	2,470	+271	+12
Expanding the Human Frontier through Biotechnology	3,788	4,107	+319	+8

a new initiative to advance America's high performance computing capacity; an increased emphasis on mathematics and science education; and a further installment in the U.S. effort to lead the world to a greater understanding of global change.

Lastly, the budget proposes to allocate \$4.1 billion as the Federal investment in *biotechnology*. This is an increase of \$319 million or 8 percent over 1991 enacted levels.

HIGHLIGHTS

The budget contains a number of new and expanded programs and initiatives. Examples include:

BASIC RESEARCH

An 18 Percent Increase for the National Science Foundation (NSF).—The budget proposes an increase of 18 percent overall for NSF, including a 16 percent increase for basic research. This will continue the Administration's commitment to double NSF's budget between 1987 and 1994. This increase is targeted primarily toward individual investigators at universities, who are essential to the U.S. scientific enterprise. In addition, a new program is proposed to provide state-of-the-art research instrumentation to academic researchers.

Increasing the Investment in Basic Biomedical Research at the National Institutes of Health.—The budget proposes an increase of \$334 million, or 7 percent over 1991, for basic research supported by the National Institutes of Health (NIH). The overall increase of \$498 million for all of NIH would allow an increase of 9 percent in funding of research project grants. This would permit over 600 additional grants to be funded.

Human Genome Project.—The budget proposes an increase of \$35 million, or 26 percent, to a total of \$169 million in the Departments of Energy and Health and Human Services (National Institutes of Health).

National Agricultural Research Initiative.—The budget proposes a 71 percent increase (\$52 million) to a total of \$125 million as the next installment in a new program in agricultural research, which will be competitive, based on merit, and designed to enhance production efficiency, food safety and environmental quality.

Superconducting Super Collider (SSC).—The budget proposes a \$291 million increase for the SSC to a total of \$534 million. This will support continued work toward the transition from prototype superconducting magnets to production and to begin construction of facilities. The funding level maintains the 10-year design and construction schedule.

APPLIED RESEARCH AND DEVELOPMENT

High Performance Computing and Communications.—The budget proposes an increase of \$149 million, or 30 percent, (to a total of \$638 million) for a new interagency program to help establish American pre-eminence in the fields of high performance computing and communications. This major initiative, involving eight Federal agencies (in addition to the private sector), will focus on the underlying research and the academic training needed to significantly accelerate the availability of the next generation of high performance computing systems and digital communications networks. The goal is to assist in the development of computing capability with roughly 1,000 times improvement over current systems by 1996.

Energy R&D.—The budget proposes an increase of \$227 million, or 34 percent for investments in targeted high-payoff technologies and strategies to increase the efficiency of energy use, to develop alternatives to petroleum and to advance new electricity technologies. This investment is guided by the National Energy Strategy.

Advanced Manufacturing and Materials R&D.—The budget includes over \$1 billion for R&D on advanced manufacturing technologies, including an increase of 15 percent for nondefense-related manufacturing R&D. In addition, the budget proposes \$84 million for the

National Science Foundation for a new initiative in materials synthesis and processing, which will take advantage of new opportunities in electronic and biomaterials. The budget also proposes \$93 million for R&D on all aspects of superconductivity.

HIV/AIDS.—The budget proposes a 5 percent increase to \$1.2 billion for biomedical and behavioral research on Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome. (The budget also proposes a total increase of \$558 million, or 15 percent, for HIV/AIDS research, treatment, prevention and income support.)

Aeronautics R&D.—The budget proposes an increase of \$61 million, or 13 percent, for aeronautics R&D in NASA, not including high-performance computing. The increase will support continued high-priority R&D on environmental issues associated with supersonic flight, as well as a new initiative in high-temperature propulsion materials. This work is intended to enable an informed decision by industry on future high-speed civil transports. In addition, a new program to address the phenomenon of aging aircraft will be initiated. Technology development for the joint NASA/DOD National Aerospace Plane program will be continued, leading to a future decision on a flight research vehicle.

Expanding R&D at the National Institute of Standards and Technology.—The budget proposes a 15 percent increase to a total of \$248 million for NIST. The long-term budget projection will result in a budget for NIST that is approximately doubled by 1996. The 1992 proposal will continue an effort begun in 1991 to expand NIST's ability to perform generic applied research and technology development and to address a growing number of important standards and measurement issues. In addition, the budget proposes \$36 million for the Advanced Technology Program.

Defense R&D.—The budget proposes a total of \$43 billion for R&D for national security. This amount includes more than \$40 billion for R&D supported by the Department of Defense, and nearly \$3 billion for defense-related R&D supported by the Department of Energy.

R&E Tax Credit.—The budget proposes to make the Research and Experimentation tax

credit permanent, and to reformulate the credit to increase its effective rate.

Encouraging R&D by Multinational Companies.—The budget proposes a 1-year extension in the rules for allocation by multinational companies of R&D expenditures incurred outside the U.S.

SPACE EXPLORATION

Space Transportation Infrastructure.—The budget proposes \$5.5 billion, an increase of 15 percent, for the critical elements of space transportation, including the Space Shuttle and expendable launch vehicles. The budget also proposes a major new program, jointly funded by NASA and DOD to develop a new launch system. This new capability was recommended by the Advisory Committee on the Future of the U.S. Space Program.

Space Science.—The budget proposes \$2.1 billion, an increase of \$367 million, or 21 percent, over 1991. This will support a broad range of space science activities, including astronomy, unmanned planetary exploration, advanced space communications research, and life sciences. These increases are consistent with NASA's space science strategic research plan and the recent recommendations of the Advisory Committee on the Future of the U.S. Space Program.

Mission to Planet Earth and the U.S. Global Change Research Program (USGCRP).—The budget proposes a total of \$1.2 billion for the USGCRP, a \$232 million or 24 percent increase over the 1991 enacted level. The 1992 increase will be used to continue a broad range of research efforts, including NASA's Mission to Planet Earth/Earth Observing System (EOS) and high priority, ground-based programs such as the World Ocean Circulation Experiment. EOS is a program designed to develop and fly a number of Earth-orbiting instruments that will collect important data from space on critical global change issues such as global warming, deforestation and desertification. During 1991, an external engineering review will be conducted on the implementation of the EOS program.

Mission from Planet Earth.—The budget proposes a total of \$2.5 billion, a 12 percent increase, for activities that will eventually lead

to exploration of the Moon and the planets, including Space Station Freedom. In 1992, activities will focus on continued development of the Space Station and increased investments in long-lead exploration technologies such as nuclear power, nuclear propulsion and life support.

BIOTECHNOLOGY

The budget proposes nearly \$4 billion for biotechnology R&D.—Biotechnology offers unprec-

edented opportunities for improving the Nation's health, food supply and environment. In medicine, biotechnology is responsible for a generation of new products that will prevent and treat disease. Significant agricultural advances and environmental techniques are also underway. Twelve Federal agencies are working on biotechnology-related R&D and are developing priorities for future Federal investments.

ENHANCING RESEARCH AND DEVELOPMENT

Research and development (R&D) yields new knowledge, products and processes that, over the long term, result in economic growth and an improved quality of life for all Americans. Investment in research and development is a top priority for an Administration that believes in investing in the future. Investments in research and development form the foundation for the exploration of all of the new frontiers of today and tomorrow.

BACKGROUND: INCREASED INVESTMENTS IN R&D PROVIDE BENEFITS TO THE NATION

R&D investment provides both direct and indirect productivity benefits to society. In addition to the economic benefits associated with R&D, many studies suggest that private (industrial) R&D spending has a very high social rate of return. This social return appears to be much higher than the rate of return to the individual company funding the R&D, giving R&D spending the character of what economists call a "public good." One researcher estimated a social rate of return of 56 percent and a private rate of return of 25 percent for a specific group of innovations. Several decades of econometric research have demonstrated that private sector R&D investments are a strong positive stimulus for private productivity. There is also evidence that Federal R&D spending stimulates private R&D. This appears to be especially true for basic research or pre-competitive, generic applied research that contributes to many industrial sectors.

It is not possible to determine analytically the "optimal" level for total national investment in R&D or the best mix of R&D investments. However, the evidence that increased R&D investment adds to the productivity of the Nation, and that Federal investments are important, provides ample justification for increased Federal investment in R&D as well as for Federal action to increase the level of private R&D investment.

THE 1992 FEDERAL R&D BUDGET: OVERVIEW AND TRENDS

The budget proposes to allocate about \$76 billion for R&D, including R&D facilities. This is an increase of over \$8 billion, or 13 percent, over 1991 levels. Within this total, \$13 billion will be allocated for basic research, an increase of \$1 billion, or 8 percent, and \$12 billion for applied research, an increase of \$903 million, or 8 percent, over 1991. Federal civilian R&D will increase by 10 percent while defense-related R&D will increase by 14 percent.

The ratio of Federal R&D outlays to GNP has been holding steady in recent years at about 1.2 percent, after a sharp drop in the 1970s due to the end of the Apollo project and slower growth in defense. During the 1980s, defense R&D recovered considerably. Federal civilian R&D (excluding defense and space activities) has been nearly level for 30 years at about 0.4 percent of GNP. The budget provides increases and incentives designed to increase Federal R&D investment as a percent of GNP.

**Table C-2. THE BUDGET PROPOSES AN \$8.4 BILLION INCREASE
IN FEDERAL INVESTMENT IN RESEARCH AND DEVELOPMENT**
(Dollar amounts in millions)

	Budget Authority				Outlays			
	1991 Enacted	1992 Proposed	Dollar change	Percent change	1991 Enacted	1992 Proposed	Dollar change	Percent change
Governmentwide totals:								
Conduct of R&D:								
Basic Research	12,320	13,320	+1,000	+8	11,597	12,414	+818	+7
Civilian	11,296	12,278	+982	+9	10,623	11,362	+739	+7
Defense ¹	1,024	1,041	+17	+2	973	1,052	+79	+8
Applied Research and Develop- ment	51,791	58,758	+6,967	+13	51,839	55,650	+3,811	+7
Civilian	15,031	16,552	1,521	+10	14,045	15,503	+1,458	+10
Defense ¹	36,760	42,206	+5,447	+15	37,794	40,147	+2,353	+6
Subtotal, Conduct of R&D	64,111	72,078	+7,967	+12	63,436	68,065	+4,629	+7
R&D Facilities	3,082	3,545	+464	+15	2,845	3,264	+419	+15
Total, Conduct of R&D and Fa- cilities ²	67,192	75,623	+8,431	+13	66,281	71,329	+5,048	+8
Conduct of R&D by Agency:								
Defense-military	35,176	40,479	+5,303	+15	36,142	38,421	+2,279	+6
Health and Human Services	9,273	9,836	+564	+6	8,704	9,235	+531	+6
Energy	6,149	6,410	+260	+4	5,810	6,273	+463	+8
National Aeronautics and Space Administration	7,271	8,602	+1,330	+18	6,974	7,767	+793	+11
National Science Foundation	1,828	2,112	+284	+16	1,675	1,897	+222	+13
Agriculture	1,224	1,261	+37	+3	1,152	1,198	+46	+4
Interior	584	562	-22	-4	572	567	-5	-1
Environmental Protection Agency ..	433	491	+59	+14	418	450	+33	+8
Commerce	517	538	+22	+4	454	499	+45	+10
Transportation	407	435	+28	+7	373	411	+38	+10
Agency for International Develop- ment	385	413	+28	+7	337	445	+108	+32
Veterans Affairs	219	219	—	—	215	219	+4	+2
Other Agencies ³	645	720	+75	+12	611	684	+73	+12

¹Includes military-related programs of the Departments of Defense and Energy.

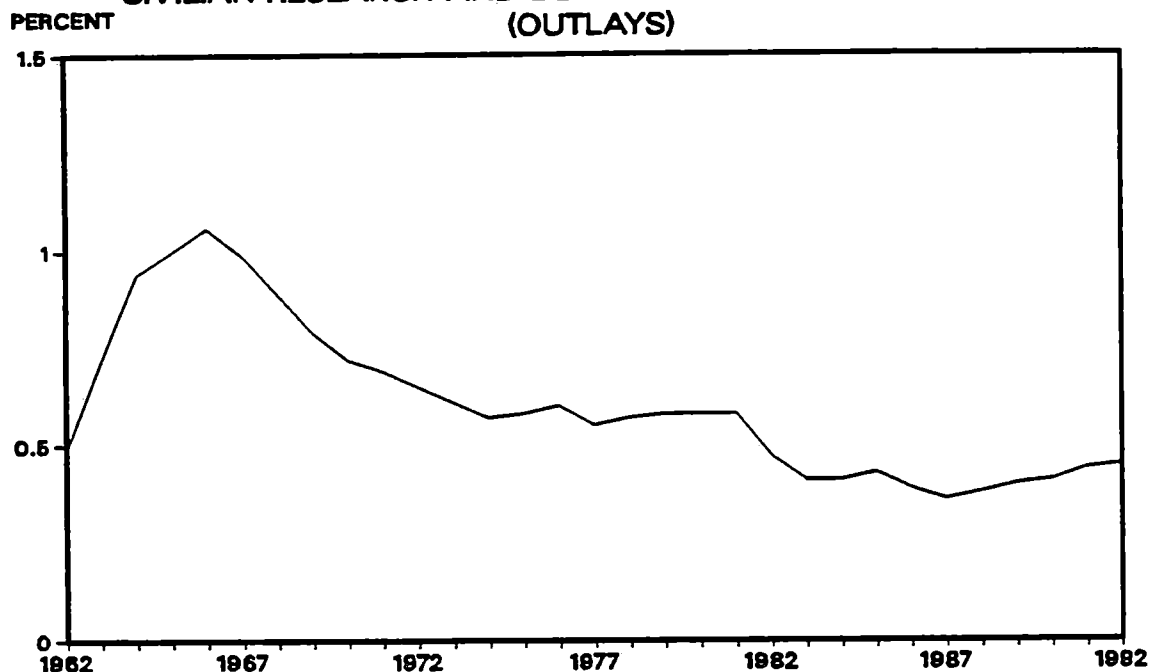
²Components may not add to totals because of rounding.

³Includes the Departments of Education, Justice, Housing and Urban Development, Labor, the Treasury, the Nuclear Regulatory Commission, Tennessee Valley Authority, Smithsonian Institution, and the Corps of Engineers.

As a percentage of total Federal domestic discretionary spending, total civilian R&D has declined from a peak of 25 percent in the Apollo years to about 13 percent in recent years.

Excluding space R&D, civilian R&D has remained relatively constant at about 10 percent of the domestic discretionary budget. Again, the budget seeks to increase this share.

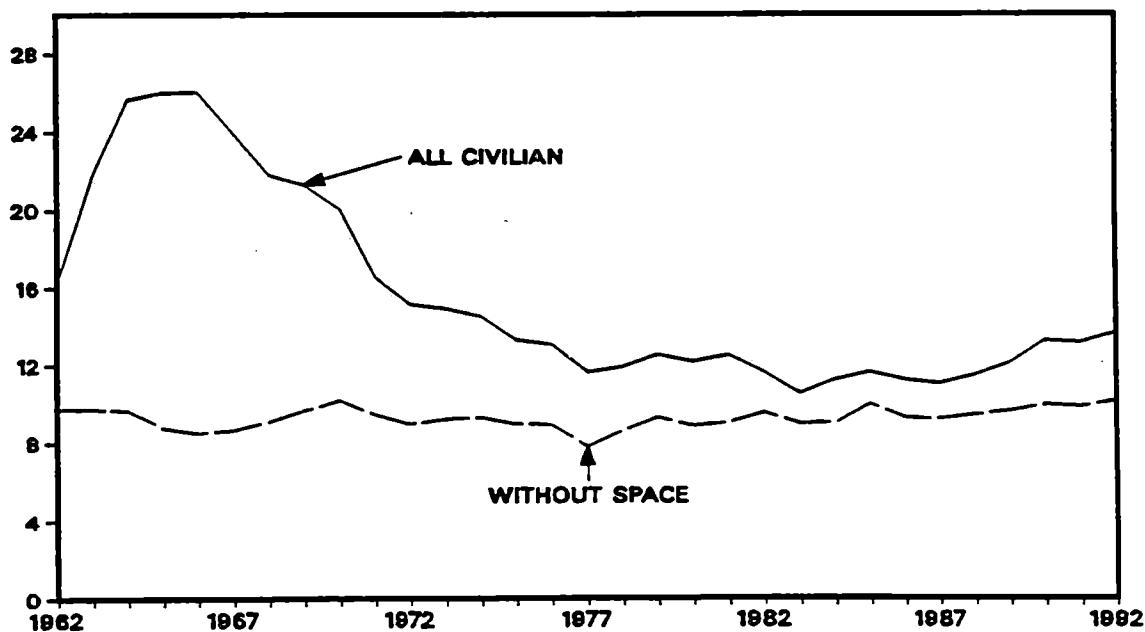
**THE 1992 BUDGET WILL INCREASE THE RATIO OF FEDERAL
CIVILIAN RESEARCH AND DEVELOPMENT OUTLAYS TO GNP
(OUTLAYS)**



Sources: National Science Foundation, Office of Management and Budget.

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**THE BUDGET WILL INCREASE INVESTMENT IN CIVILIAN
RESEARCH AND DEVELOPMENT AS A PERCENTAGE OF
DOMESTIC DISCRETIONARY SPENDING**



The Federal Government currently accounts for about 44 percent of the total U.S. investment in R&D. Industry, academia, and non-profit organizations make up the remaining 56 percent. In 1991, it is estimated that total U.S. R&D expenditures, Federal and non-Federal, will be \$152 billion, an increase of 4 percent

over 1990, with Federal investments accounting for most of the increase. In total, the U.S. investment in R&D is about 3 percent of GNP. Trends in industry R&D funding, including initiatives to spur increased industry investment through the tax credit for research and experimentation, are discussed later in this chapter.

EXPANDING THE FRONTIER OF KNOWLEDGE THROUGH BASIC RESEARCH

Basic research provides the new knowledge that leads to new products and processes. Basic research, especially at universities, is an essential investment in the Nation's scientific and technological future, including its future scientists and engineers. For this reason, the budget places a major emphasis on increasing basic research. In total, the budget proposes an increase of 8 percent, or \$1 billion, above 1991 for Federal basic research support.

The strength of U.S. investment in basic research is illustrated by several recent achievements:

- The NASA/NOAA Antarctic Ozone Expedition, combining satellite, aircraft, and ground-based research, discovered and documented the problem of the "ozone hole" in the Antarctic, and is currently investigating similar phenomena in the Arctic environment.
- An NSF-supported Presidential Young Investigator discovered a way to make large-pore molecular sieves. These molecular sieves are critical as catalysts for a wide variety of industrial processes, particularly petroleum processing and chemical separation. The new large-pore sieves have the potential to revolutionize the industrial processing of chemicals.
- NIH scientists successfully transferred genetically engineered cells to human subjects, paving the way for the world's first attempts at human gene therapy. The first gene therapy experiments involved placing a normal gene that helps the immune system develop normally into the white blood cells of a young girl who lacked this vital gene. It is hoped that this inserted gene

will enable the formation of a working immune system.

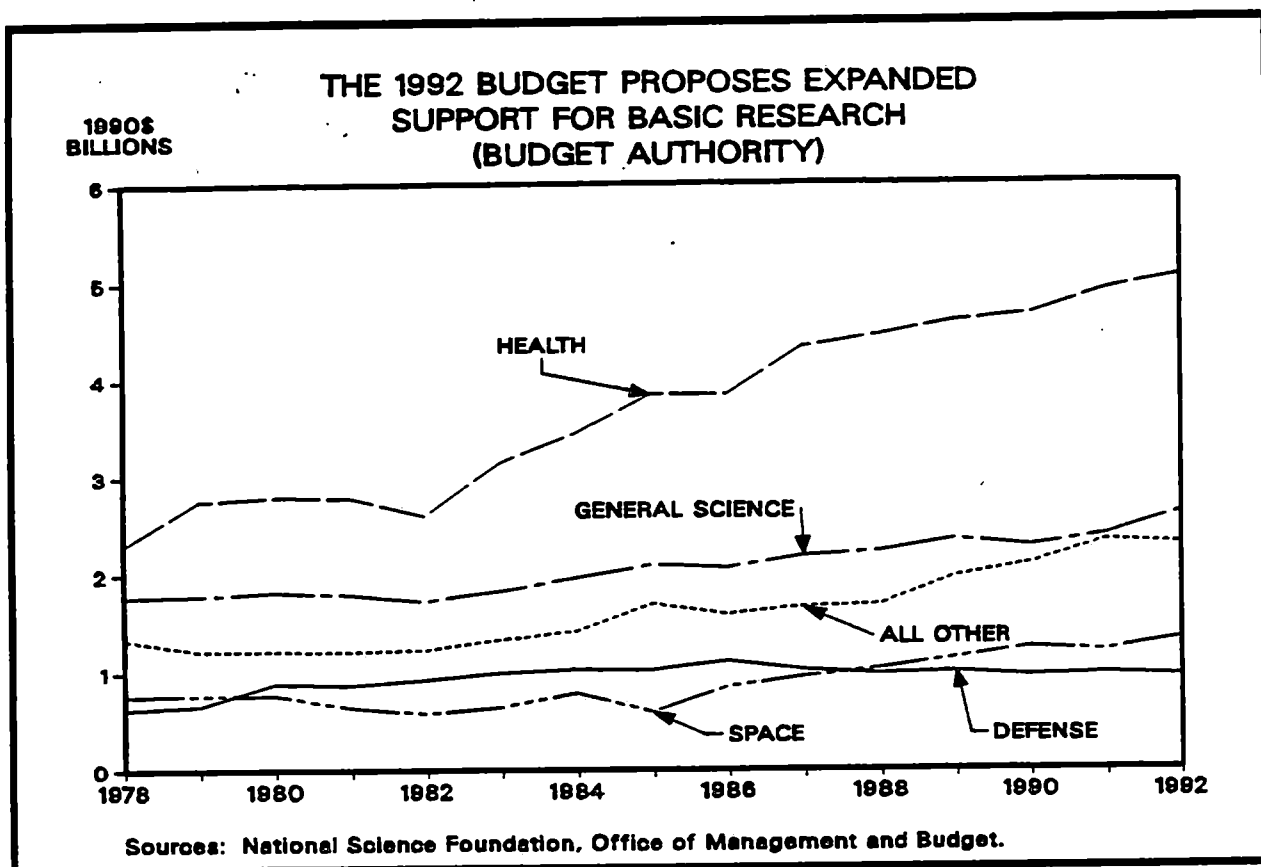
- NASA's Cosmic Background Explorer made unprecedented measurements of background radiation, giving scientists critical new evidence on the origin of the universe.
- Biomedical researchers have discovered the long-sought gene for cystic fibrosis, a fatal disease of children and young adults, opening the way to a host of new therapeutic approaches.

Key Indicators of the Vitality of Basic Research

Most basic research is performed in universities, and more than half of the R&D that universities perform is basic. The vitality of the "academic research enterprise" has been nearly impossible to measure. However, in recent years, scientists and policymakers have expressed serious concerns about its current and future vitality. Many experts argue that over the past several years, and despite large real increases in Federal funding, the activity level and research productivity of university researchers have not appeared to increase.

Funding Trends.—The historical trend in Federal support for basic research shows that during the 1980s such support increased overall by 50 percent in real terms, with significantly larger increases in health-related basic research. The figure below shows that real support for basic research has continued to climb in the early 1990's, particularly in health and space.

Measuring the Direct Economic Benefits.—Until recently, there has been no way



to gauge reliably the impact of academic R&D on industrial innovation.

Recent work (Mansfield), however, indicates that in several key industrial sectors, notably information processing, drugs and instruments, a significant proportion of new products and processes would not have reached the market had it not been for the contribution of recent academic R&D. A recent, but very preliminary, estimate of the average social rate of return to past investments in academic R&D was calculated to be 28 percent. It is important to note, however, that this figure must be viewed with caution as it is based on a large number of assumptions and simplifications.

In any case, the contribution of academic research to industrial innovation in several important sectors appears to be considerable, even apart from its more traditional benefits to the education of students, and to the acquisition of knowledge for its own sake.

Support for University Researchers.—One indicator of the Federal Government's commitment to research is the total number

of research grants made to individual researchers, a figure that has been growing for two decades. Since most grants are for periods ranging from 2–7 years, in any given year only a portion (less than 25 percent) of an agency's grants are competitively renewed, or become, for that year, "new grants". Thus, rather than using the number of total grants as an indicator, some advocates prefer to use a measure based on just this "new grant" ratio. This indicator, or "funded rate of new grants" is defined here as the number of awards as a percent of the number of proposals. By this measure, the funded rate for new grants for the two largest Federal supporters of university research, the Department of Health and Human Services (National Institutes of Health) and the National Science Foundation, have declined over the 1980's from about 40 percent to about 30 percent (adjusted to exclude both multiple submissions by any one individual and for awards for research centers, which may serve many investigators).

A partial explanation may be that since 1970, for HHS, the total pool of biomedical

researchers (extramural) has grown by 140 percent, outpacing the 75 percent growth in principal investigators funded by HHS. In fact, it has been estimated that about 80 percent of all the American scientists in all fields who ever lived are alive today.

Funding rates for new grants have also dropped because of increases in the amount of money per grant (both direct and indirect cost components) and the average length of grants. Increasing award sizes, award lengths, or both, may tend to provide increased stability and productivity for a given investigator, but these actions also depress the number of subsequent new grants that are made.

While individual investigator awards are still the predominant form of support, awards to groups of investigators (either small groups or larger centers) have been increasing, driven primarily by the need for interdisciplinary approaches to scientific problems. Each of these group or center awards is counted as a single grant, even though many researchers may be served. Thus, considering only the absolute numbers of awards is somewhat misleading. A more appropriate consideration should be the total number of researchers supported. By this measure, there are many more researchers supported by research grants today than at any previous time.

Although support for university researchers is most often cited as the key indicator of the health of overall Federal support for basic research, a number of other measures that have traditionally been used to measure research output (new knowledge). None of these is, by itself, a definitive indicator of the vitality of academic research, and none is universally accepted as an adequate output measure, since the "amount" of new knowledge contained in a research finding has no natural unit of measure. Taken together with information on support for researchers, these measures provide some insight into the overall strength of academic research. Several such measures are (1) numbers of publications, (2) "quality" of publications as measured by citation indices, (3) patents and (4) Nobel and other prizes.

Publications and Citations.—As an indicator of overall productivity, the number of science articles published by U.S. academic researchers (which produce about two-thirds of

all U.S. science and engineering articles in major journals) has increased markedly. By this measure, the U.S. is maintaining its large share of world scientific and engineering literature. In all fields, the U.S. has a greater percentage of world publications than does any other country. As an indicator of the impact that publications have on other research, citation data are often used. The level of citation of U.S. papers by foreign researchers suggests that U.S. researchers continue to exert a substantial impact on foreign publications, and thus on the world's store of scientific knowledge.

Patents.—University patenting increased greatly during the 1980s, due in part to the 1980 change in U.S. law that allowed universities and small businesses to retain title to inventions developed with Federal funds. U.S. universities received 2 percent of patents awarded to U.S. inventors in 1988, more than double the share in 1978.

Nobel and Other Major Prizes.—The U.S. continues to dominate the Nobel lists, and Americans often win other major, internationally-recognized prizes such as the Fermi Award in physics, the Wolf Award in chemistry and the Lasker Award in medicine. However, care must be taken with this measure as these selections are often made on the basis of research done many years (10–30) before. Thus, this indicator may have more value with respect to past support for research than present or future support.

The budget recognizes that support for principal investigators is an important measure of the vitality of the Nation's basic research effort. Thus, this support is the major theme underlying the initiatives in basic research proposed for 1992.

1992 Budget Initiatives in Basic Research

The budget proposes a number of major increases or new programs reflecting the President's support for basic research. These increases are intended to bolster basic research funding, especially that which supports individual investigators, and to provide those researchers with state-of-the-art equipment. Overall, the budget proposes over \$13 billion for basic research, an increase of \$1 billion, or 8 percent, over 1991.

Table C-3. THE BUDGET INCREASES FUNDING FOR BASIC RESEARCH¹
(Dollar amounts in millions)

Department or Agency	Budget Authority				Outlays			
	1991 Enacted	1992 Proposed	Dollar change	Percent change	1991 Enacted	1992 Proposed	Dollar change	Percent change
Health and Human Services	5,101	5,477	+376	+7	4,786	5,097	+311	+7
(National Institutes of Health)	(4,634)	(4,968)	(+334)	(+7)	(4,372)	(4,622)	(+250)	+6
National Science Foundation	1,719	1,987	+268	+16	1,560	1,784	+223	+14
Energy	1,726	1,759	+32	+2	1,650	1,654	+3	—
National Aeronautics and Space Administration	1,698	1,960	+262	+15	1,612	1,800	+188	+12
Defense-military	992	1,010	+17	+2	942	1,021	+79	+8
Agriculture	563	598	+36	+6	539	553	+14	+3
Other Agencies ²	521	529	+8	+2	507	506	-1	—
Total	12,320	13,320	+1,000	+8	11,597	12,414	+818	+7

¹Amounts reported in this table are included in totals for conduct of R&D.

²Includes the Departments of Interior, Commerce, Veterans Affairs, Education, Labor, the Treasury, Justice, the Agency for International Development, the Smithsonian Institution, Environmental Protection Agency, Tennessee Valley Authority, and the Corps of Engineers.

Doubling Basic Research Support Through the National Science Foundation.

The President remains committed to doubling the budget of the National Science Foundation (NSF) between 1987 and 1994. The budget proposes an overall increase of 18 percent, which would restore the doubling path for NSF. Over 70 percent of NSF's budget supports basic research, primarily at the Nation's colleges and universities. These funds go directly, through a competitive, merit-based process, to the best researchers and to the most talented young scientists and engineers. Individual investigators are a key element in maintaining the U.S. preeminent position in science and basic research. NSF also plays a major role in the governmentwide initiative to improve the quality of science, mathematics and engineering education, particularly at the pre-college level.

In addition to the large proposed increase aimed primarily at individual investigators, \$50 million is proposed to fund a new initiative to provide new, state-of-the-art instrumentation to university researchers. This initiative will be implemented through a competitive, merit-based program, and will be targeted toward instrumentation costing more than \$200,000, but less than \$4 million. The Federal funding for this initiative will be matched at least 50:50 by non-Federal sources.

Increasing the Investment in Basic Biomedical Research at NIH by 7 Percent.

The budget proposes a \$334 million increase for basic biomedical research supported by the National Institutes of Health (NIH), the primary source of basic biomedical research discoveries in the world. The overall increase of \$498 million, or 6 percent, for all of NIH will allow an increase of 9 percent in the funding for research project grants awarded to individual investigators. This will permit over 600 additional grants to be funded.

Unlocking the Secrets of Human Heredity—the Human Genome Project.

The budget proposes a 26 percent increase for the third year of this 15-year effort to decode the information locked in the chemical building blocks that form human genetic inheritance. This \$35 million increase reflects a commitment to develop "maps" of human chromosomes and human DNA sequence data that will allow scientists to develop new diagnostic tests, therapies, or cures for some of the 4,000 known disorders in which genes are the dominant cause. Such diseases include cystic fibrosis, sickle cell disease, and muscular dystrophy. The genome project also will produce increased knowledge about how specific genes function and malfunction, and will help increase understanding of diseases characterized

by gene-governed chemical reactions, such as heart disease, cancer, and AIDS.

This project is being conducted jointly by the Departments of Energy and Health and Human Services. The budget requests a total of \$169 million for the project, \$59 million at Energy and \$110 million at Health and Human Services.

Concurrent with the project's efforts to advance the state-of-the-art in genetic "mapping," the project is also exploring safeguards that may be necessary as new genetic information is put to practical uses, addressing issues related to privacy of such information and fairness in its use.

This landmark project will allow the next generation to benefit from the knowledge gained through this investment. Future scientists will have tremendous amounts of new information about the structure of human genetic make-up available to assist them in their search for therapies and cures for the diseases that afflict this generation. The 1992 budget ensures that this project is able to forge ahead expeditiously.

Improving the Productivity of the Nation's Agriculture (the National Research Initiative).—The budget continues the commitment to the National Research Initiative (NRI), first proposed in the 1991 budget, by proposing \$125 million, an increase of \$52 million, or 71 percent, over the 1991 enacted level. In 1991, \$100 million was proposed as the initial installment, to be expanded by \$50 million each year to the extent that funds were awarded competitively and not earmarked for specific sites or institutions. Six categories of research will be funded: natural resources and the environment; nutrition, food quality and health; plant systems (including mapping of plant genomes); animal systems; markets, trade, and policy; and processes antecedent to adding value and developing new products.

Agriculture in the 1990s must emphasize the environment, more rational use of natural resources, the quality and nutrition of food, and economically stabilized production systems which benefit producers as well as consumers. The NRI responds to the major issues facing agriculture such as food safety, water quality, global climate change, pest management, sci-

entific human capital development, and farm income. The NRI will allow U.S. agriculture to broaden the science and technology base to meet demanding needs and exploit new opportunities more effectively. These imperatives coincide with recent advances in biological sciences and other new tools in science that present unique research opportunities to improve agriculture nationally.

Federal funding for the NRI is necessary because: (1) the issues and opportunities are national in scope; the Nation as a whole is the beneficiary, not just individual states or industries; (2) the NRI undertakes research that does not, in general, produce specific patentable or marketable products, but knowledge that will be broadly applicable; (3) the need is urgent; the issues to be addressed require action now and cannot be delayed or taken up piecemeal; and (4) there are broader benefits, which are difficult to quantify, related to protection of the environment and public health.

The Administration is concerned about recent Congressional action which placed a cap of 14 percent on the recovery of indirect costs associated with grants made under the NRI. This action threatens the viability of the initiative.

Unlocking the Secrets of Matter and Energy—The Superconducting Supercollider and High Energy and Nuclear Physics:

- ***The Superconducting Super Collider.***—The Superconducting Super Collider (SSC) will provide a collision energy 20 times greater than the current capability, resulting in new fundamental knowledge of matter and energy. The SSC Laboratory, under construction in Ellis County, Texas, will comprise a 54-mile circular tunnel in which superconducting magnets will accelerate counter-rotating proton beams. The SSC will employ 2,500 scientists, engineers, and technicians, and host an additional 500 visiting scientists.

The budget provides \$534 million for the SSC, an increase of \$291 million over the 1991 level. Much of the current effort focuses on research and development of the superconducting magnets. Work on other SSC components is also progressing. The

first segment of tunnel will be under construction by the end of 1992.

Even though the budget proposes a substantial increase for the SSC, this funding will not come at the expense of other science programs. In particular, the budget proposes a 16 percent increase in basic research, principally for individual investigators, at the National Science Foundation.

The total cost of the SSC has been estimated at \$8.2 billion. One-third of the total is expected to be contributed by non-Federal sources. The State of Texas has committed up to \$1 billion for construction of on-site facilities and other SSC systems, as well as the land required for the SSC laboratory.

Foreign partners are expected to contribute substantially to the construction and operation of the SSC, as well as to the experimental program. During 1992, follow-up delegations will continue discussions already underway with Japan, Korea, Europe and Canada.

The SSC holds the potential for new breakthroughs in science, technology and education. Although the primary purpose of the SSC is to acquire new knowledge, such knowledge has always resulted in developments in technology and practical products which profoundly affect the quality of life for all Americans and which enhance the economic competitiveness of the Nation. U.S. world leadership in high energy physics will be maintained far into the next century by the scientific and tech-

nological advances emanating from the SSC.

- *High Energy and Nuclear Physics.*—Research in high energy and nuclear physics is directed at understanding the nature of matter and energy at the most fundamental level and the basic forces which govern all processes in nature. Much of the research program is aimed at verifying and explaining the particles, or "building blocks", that comprise the interior of atoms and the forces acting on them.

Research is conducted at universities and national laboratories. Experiments usually involve controlled collisions between particles travelling at speeds approaching the speed of light and examination of the interactions that occur.

Existing high energy accelerator facilities include the Tevatron at Fermi National Laboratory near Chicago, the Stanford Linear Collider at Stanford University in California, and the Alternating Gradient Synchrotron at Brookhaven National Laboratory on Long Island. Improvements to the Tevatron will be completed in 1992 which will greatly enhance the capability of the machine. Additional improvements in the form of a new Main Injection Ring at Fermilab will be initiated in 1992.

Construction will continue on two nuclear physics facilities. The Continuous Electron Beam Accelerator Facility in Newport News, VA is on schedule and nearing completion. At Brookhaven National Laboratory, construction is well underway on the Relativistic Heavy Ion Collider.

Table C-4. THE BUDGET PROPOSES A 35 PERCENT INCREASE FOR AN AMBITIOUS PROGRAM IN HIGH ENERGY AND NUCLEAR PHYSICS

(Dollar amounts in millions)

	Budget Authority			
	1991 Enacted	1992 Proposed	Dollar change	Percent change
Superconducting Super Collider	243	534	+291	+120
High Energy and Nuclear Physics	906	1,015	+109	+12
Total	1,149	1,549	+400	+35

APPLIED R&D: EXPANDING THE FRONTIER OF TECHNOLOGICAL DEVELOPMENT

Traditionally, the Federal Government has supported a broad spectrum of applied civilian R&D in support of agency missions. Unlike basic research, where the Federal role has been stable and widely acknowledged, the appropriate Federal role in applied civilian R&D has been the subject of debate and has changed significantly over time. Past Federal investments in civilian R&D have led to major technological advances (e.g., computers, new aircraft) while others have been major failures (e.g., synfuels plants).

The Administration believes that appropriate Federal investments in applied civilian R&D can result in high payoff to the economy, and the budget provides for R&D funding increases across a wide range of technology areas. In total, the budget proposes about \$17 billion, an increase of \$1.5 billion or 10 percent.

The principal strategy for the Federal applied civilian R&D programs is to invest in R&D areas that support agency mission requirements, but also where some of the R&D has broad applications in the private sector ("dual use" technologies), even though these commercial applications would not necessarily be funded by the government. In such cases, the Government's role is to support generic or enabling technologies at the pre-competitive stage of R&D:

- generic or enabling technologies have the potential to be applied to a broad range of products or processes across many firms;
- pre-competitive R&D is the stage of the R&D process where the results can be shared widely within and between industrial sectors, without reducing the incentive for individual firms to develop and market commercial products and processes based upon the results.

There are a number of different mechanisms that agencies may use to support generic applied research and technology development. These include: cost-sharing of individual projects; creation of R&D consortia (often in-

volving government, industry and university laboratories; and more informal government/university/industry collaboration). Overall, the budget provides increased funding for all major civilian applied research and development areas.

Increased investments in applied civilian R&D will support technology development across a number of agencies and programs in support of both agency mission needs and a broad technology base for potential future commercial applications. This increased emphasis on federally supported technology development should not be confused with industrial policy. The Administration remains opposed to efforts to target specific industries (e.g., consumer electronics) for R&D assistance to develop new products (e.g., high-definition television).

1992 Budget Initiatives in Applied Research and Development

High Performance Computing and Communications.—The budget proposes \$638 million for Federal support for R&D focused on high performance computing and communications. High performance computing systems (i.e., hardware, software, networks, etc.) are likely to have a significant positive impact on productivity. For example, supercomputers have been credited with bringing the Ford Taurus, currently the best-selling American-made car, to market much sooner, with higher quality, and at significantly lower cost than would have been possible without them. While the supercomputer industry has grown from \$89 million in worldwide revenues in 1980 to over \$1.1 billion in 1990, it is still a very small market (less than one percent of the worldwide computer market) and traditionally limited to very complex public and private high-risk, high-return ventures (e.g., oil and gas exploration, defense and aerospace systems, etc.). A similar situation exists with high-capacity, high-speed digital networks. Because of the small scale of the market and the high-cost of research, high performance computing has not attracted the private sector R&D investments typically seen in the broader computer industry.

The Federal Government has played a significant role in the development of the supercomputer and network industry. A lead-

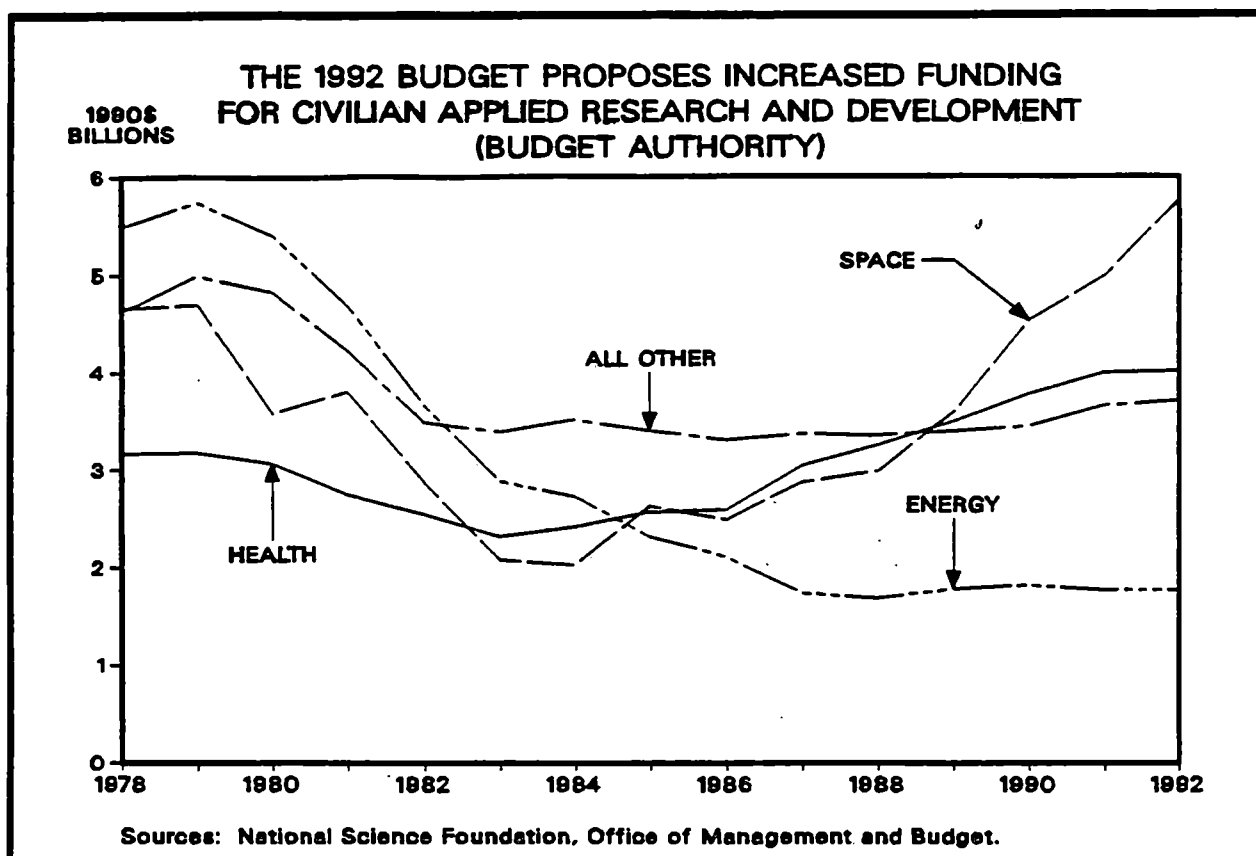


**Table C-5. THE BUDGET INCLUDES INITIATIVES IN SEVERAL KEY
AREAS OF APPLIED R&D**

(Dollar amounts in millions)

Initiative	Budget Authority			
	1991 Enacted	1992 Proposed	Dollar change	Percent change
High Performance Computing and Communications	489	638	+149	+30
Advancing New Energy Technologies	676	903	+227	+34
Enabling New Products and Processes: Advanced Manufactur- ing and Materials	1,316	1,310	-6	—
HIV/AIDS Research	1,152	1,210	+58	+5
Moving Fusion Energy from Science to Engineering	275	337	+62	+23
Improving the Air Transport System: Aeronautics R&D	482	543	+61	+13
Expanding Applied R&D at the National Institute of Standards and Technology	215	248	+33	+15

ing computer industry executive has stated that "If it weren't for the U.S. government, there would be no U.S. supercomputer industry." The role of government R&D in develop-

ing innovative computer technologies has its roots in the World War II research that became the foundation for the UNIVAC system. Many of today's commercial high performance

computing system and network advances are attributable to research supported by Federal agencies.

Through the Office of Science and Technology Policy's Federal Coordinating Council on Science, Engineering, and Technology (FCCSET), eight agencies have developed a new integrated research initiative in High Performance Computing and Communications (HPCC). The program focuses on the underlying research and the human talent needed to develop the next generation of supercomputer systems (including hardware, software, and networks).

The goal of the proposed initiative is to meet, by 1996, the needs of Federal research agencies to investigate and understand a wide range of fundamental scientific and engineering computational problems and, at the same time, allow the private sector to "leap frog" over the expected incremental improvements in conventional supercomputers.

Investments in research and technology development are planned in four HPCC program components:

- *High Performance Computing Systems (Hardware)*: Undertaking research in scalable computer processors, memory, input/output devices and operating systems needed for scalable teraflop (trillion oper-

ations per second) supercomputers. The budget proposes \$157 million.

- *Advanced Software Technology and Algorithms (Software)*: In the long-run, the return to both the Government and the economy generally of software investments may be even greater than that of hardware investments. The computational model used to simulate the solid rocket booster failure blamed for the Space Shuttle Challenger disaster takes roughly 14 hours to run on a typical research lab minicomputer. Using a parallel processor significantly reduced this time, but optimized software brought it to under five seconds. This component has a large share of the initiative because there is a great need for adequate and affordable software to address unique fundamental scientific and engineering problems. The software usually represents five times the hardware costs. The budget proposes \$265 million.
- *National Research and Education Network (Networks and Communications)*: The goal of the National Research and Education Network (NREN) is to enable rapid access by the Nation's educational and research institutions to a broad range of Federal resources, including libraries, databases, and scientific facilities (e.g., computers, telescopes, accelerators). The focus of this element would be on integrating and up-

Table C-6. THE BUDGET PROPOSES A 31 PERCENT INCREASE FOR HIGH PERFORMANCE COMPUTING

(Dollar amounts in millions)

Agency	Budget Authority			
	1991 Enacted	1992 Proposed	Dollar change	Percent change
Defense (DARPA)	183	232	+49	+27
National Science Foundation	169	213	+44	+26
Energy	65	93	+28	+43
National Aeronautics and Space Administration	54	72	+18	+33
Health and Human Services (National Library of Medicine)	14	17	+3	+21
Environmental Protection Agency	1	5	+4	+400
National Institute of Standards and Technology	2	3	+1	+50
National Oceanic and Atmospheric Administration	1	3	+2	+200
Total, All agencies	489	638	+149	+30

grading existing federally supported research networks and on research in gigabit (billion bit per second) network switches, protocols, software, and security mechanisms. These improvements would be used to enable the transition of the existing Federal research network into a national gigabit research and education network. The budget proposes \$92 million.

- *Basic Research and Human Resources (Research/Training)*: This component would focus on fundamental "leapfrog" advances in HPC technology and the training of students in the computational sciences. The budget proposes \$124 million.

Advancing New Energy Technologies.—

A major element of the Administration's National Energy Strategy (NES) will be increased investment in energy technology R&D. The budget includes \$903 million, an increase of \$227 million or 34 percent, for increased investments in R&D in support of NES R&D initiatives Governmentwide. The budget proposes \$653 million for Department of Energy NES-related R&D, an increase of \$134 million or 26 percent. Over the five year period 1992 through 1996, DOE would invest \$3.5 billion in NES R&D initiatives discussed in this section.

The NES R&D strategy is based on several key elements:

- an emphasis on R&D areas that, if successful, could lead to significant displacement of petroleum;
- selection of R&D areas based on high R&D payoff potential—i.e., the potential to achieve significant cost and performance improvements;
- a comprehensive, interagency R&D program that includes both technology enhancements (e.g., more efficient engines) and more fundamental system changes (e.g., the potential for high speed rail and Maglev systems to displace automobile and air travel);
- a collaborative, cost-shared, Government-university-industry effort. This implementation approach would rely upon industry-led, joint Government-industry R&D planning and management and 50:50 cost

sharing, with the research performed by industry or universities (except in situations where Government labs have unique research and testing capabilities). The formation of industry R&D consortia would be encouraged where feasible (e.g., in the pre-competitive R&D stage). This implementation approach would maximize the involvement of the ultimate technology users, enhancing the technology transfer process, and would minimize Government overhead costs.

The Department of Energy (DOE) estimates that the NES R&D Initiative could lead to a reduction in oil consumption of 5–8 million barrels per day by the year 2030, depending on the success of the proposed R&D programs.

The NES R&D strategy is intended to foster a new, results-oriented approach, and not merely more-of-the-same traditional Government-funded energy R&D programs. The Federal Government has had a substantial, broad-based energy R&D program since the 1973 oil embargo. From 1980 through 1990, the Government has invested about \$21 billion in energy technology R&D. This investment has had relatively little payoff, for a combination of reasons: (1) the inherently high risks of some R&D, (2) poor R&D choices (e.g., synfuels, breeder reactors), and (3) lack of significant private sector financial and management involvement linking R&D to successful commercial deployment. The NES energy R&D initiative will take better advantage of the Nation's tremendous university and private sector technical talent, while avoiding the mistakes of past Government managed, crisis-born energy R&D programs.

The specific components of the NES R&D initiative are shown in Table C-7. These include:

- *Improved Vehicle Propulsion Technology* through research on high temperature diesel and gas turbine engines. Conventional spark-ignited and diesel engines have efficiencies of up to 31 percent. More efficient engines, including gas turbines, could achieve efficiencies approaching 40 percent.
- *Electric Vehicles*, including a new joint auto industry-government consortium to

Table C-7. THE BUDGET PROPOSES A 34 PERCENT INCREASE FOR NATIONAL ENERGY STRATEGY R&D INITIATIVES

(Dollar amounts in millions)

Initiative	Budget Authority			
	1991 Enacted	1992 Proposed	Dollar change	Percent change
Displacing Oil in the Transportation Sector	302	432	+130	+43
Surface Transportation Efficiency	162	260	+98	+60
Improved Vehicle Propulsion Technology	39	42	+3	+8
Electric/Hybrid Vehicles	30	42	+12	+40
Intelligent Vehicle/Highway Systems	23	60	+37	+161
High Speed Rail/Magnetic Levitation	12	24	+12	+100
Telecommuting	58	92	+34	+59
Air Transportation Efficiency	51	59	+8	+16
Energy-Efficient Aeronautics R&D	16	17	+1	+6
Efficient Air Traffic Control R&D	35	42	+7	+20
New Transportation Fuels	89	113	+24	+27
Fuels from Biomass	33	44	+11	+33
Alternative Fuel Utilization	14	17	+3	+21
Advanced Oil Recovery	42	52	+10	+24
Increased Energy Efficiency in Buildings and Industry	129	157	+28	+22
Targeted Industrial Energy Efficiency R&D	84	102	+18	+21
Targeted Buildings Energy Efficiency R&D	45	55	+10	+22
Advanced Electricity Technology	245	314	+69	+28
Photovoltaics	47	51	+4	+9
Superconductivity	19	22	+3	+16
Advanced Light Water Reactor R&D	29	63	+34	+117
Advanced Reactor Concepts	150	178	+28	+19
Total, All activities	676	903	+227	+34
Total, Department of Energy	519	653	+134	+26

develop battery technology for electric vehicles. Improved batteries that could extend vehicle range to 120–200 miles could enable electric vehicles to capture as much as 20 percent of the market by 2030. Fuel-cell-powered electric vehicles offer the potential to achieve up to 50 percent efficiencies.

- *Intelligent Vehicle/Highway Systems (IVHS)*, is intended to increase highway safety, reduce congestion and decrease highway fuel consumption. IVHS uses state-of-the-art electronics, communications, and computer technology to improve traffic control systems, warn drivers of dangerous situations, and generally make more efficient use of the existing road system. IVHS can reduce congestion, improve traffic flow, reduce idling at traffic signals,

and allow drivers to choose more efficient routes to their destination. DOE projections show a potential 30 percent *decrease* in average on-the-road fuel efficiency due to increasing congestion under current trends. Unless corrected, this could substantially offset any gains from more fuel-efficient vehicles. A study by Mobility 2000, a expert group of Federal and State highway officials and corporate and academic technical experts, estimated that IVHS has the potential to save up to 20 million gallons per day of gasoline.

- *High Speed Rail and Maglev* (magnetically-levitated trains), which may offer transportation and energy efficiency improvements. Current efforts include investigations into the economic and technical feasibility of high-speed rail and maglev

as well as research on potential applications that would enhance the capacity of the existing transportation network. This work is being performed by the Departments of Transportation and Energy and the Army Corps of Engineers. High speed rail and Maglev transportation may have potential for trips of 200–600 miles in length, competing with both long distance automobile travel and short-haul air travel.

- *The National Research and Education Network*, part of the High Performance Computing and Communications Initiative, also will help advance technology to facilitate increased telecommuting, reducing both business travel and daily commuting. The flex-place workforce has grown over the past decade from 300,000 to 3.6 million. It is estimated that there are about 46 million potential telecommuters. Additional R&D can aid the emergence and spread of telecommuting networks, by linking cable and fiberoptic networks and enhancing the capability from digital data. In the absence of major system change, the Department of Energy projections show that total vehicle miles traveled (VMT) could increase by 50 percent by the year 2030. About 50 percent of VMT is work-related.
- *Energy-efficient Aeronautics R&D*, including technologies such as hybrid laminar flow and large structure composite materials will reduce aircraft friction and lower aircraft weight. The Department of Energy projects that U.S. air travel will double in the next 20–30 years. New technologies could save millions of gallons of aviation fuel per year.
- *Energy-efficient Air Traffic Control R&D*, a part of the national effort to modernize the air traffic control system, will permit more direct routing of flights.
- *Advanced Transportation Fuels from Biomass* will demonstrate use of lignocellulosic feedstocks to provide alcohol fuels on a scale which can verify technology and commercial costs. The production of ethanol from food crops currently costs \$1.20 per gallon or more, requiring large Federal tax subsidies. The goal of this R&D ini-

tiative is the production of ethanol from non-food crops at \$0.60 per gallon.

- *Alternative fuels utilization* will continue vehicle testing activities that will provide the database to facilitate greater use of alternative fuels.
- *Advanced Oil and Gas Recovery Technologies* will improve reservoir understanding for targeted drilling and develop better instrumentation, chemical injectants and reservoir interpretation techniques. Currently, up to two-thirds of oil resources remain in the ground after conventional production is completed. It is estimated that up to 25 billion additional barrels could be recovered through advanced recovery techniques by the year 2030.
- *Improved Energy Efficiency in Buildings and Industry* includes targeted R&D to provide cost-effective efficiency improvements and reduce oil consumption.
- *Advanced Light Water Nuclear Reactors* will incorporate passive safety features in a standardized design. This will reduce the time needed to license new plants, while assuring that safety issues are adequately addressed. The Department of Energy is currently supporting first-of-a-kind engineering work that will assist companies in their efforts to have the Nuclear Regulatory Commission certify the safety of new standardized designs.
- *Advanced Reactor Concepts* will have safety features that go beyond even the standardized designs currently before the Nuclear Regulatory Commission. High Temperature Gas Cooled Reactors use specially-coated fuel elements that will not fail even under the high temperatures that could occur during an accident. Liquid metal reactors use liquid sodium as the heat exchange medium. Researchers have demonstrated that both reactor types can shut themselves down safely under conditions that would be extremely serious for present-day reactors. The Department of Energy continues R&D support for both of these advanced concepts.

The NES R&D Initiatives are supported by increased investments in related areas of basic

research. Basic research in areas such as advanced materials, superconductors, geo- and biosciences, and catalysis research may help accelerate development of petroleum substitutes and energy conservation technologies.

Enabling New Products and Processes—Advanced Manufacturing and Materials R&D.—The budget proposes \$1,310 million for both advanced manufacturing and materials R&D, two key enabling technologies.

- **Advanced Manufacturing.**—The budget proposes over \$1 billion for research and development on advanced manufacturing technologies. This includes an increase of over 15 percent for nondefense-related manufacturing R&D. Advanced manufacturing R&D includes activities within two broad areas: (1) efforts designed to use technology to improve the efficiency or quality by which a product is brought from design to completion; and (2) activities directed at expanding the technical capability to bring a product (which is new and fundamentally different in character from existing products) from design to completion. An example of the latter is the effort to fabricate high-temperature superconducting wires.

Improvements in U.S. manufacturing technology can increase productivity and quality, leading to competitive products which increase market share while supporting a high standard of living. While industry has the central role in R&D to improve manufacturing technology, an appropriate role in such R&D exists for the government as well. The Federal role in advanced manufacturing R&D lies in supporting (1) generic manufacturing technologies and (2) those technologies which are directly applicable to the procurement needs of government programs. About half of advanced manufacturing R&D proposed in the 1992 budget falls into each of these categories.

- **Materials R&D.**—Materials R&D forms the foundation for many advances in other technological areas such as aeronautics, computers, biotechnology, and manufacturing. The Federal Government funds a substantial amount of materials R&D, mainly in the area of materials science. However,

additional work is needed in fundamental research on the synthesis and processing of novel materials. The budget proposes \$84 million for a new initiative in the National Science Foundation intended to strengthen the competitive position of the U.S. in developing and using next-generation materials and processing methods. The 1992 program will focus on two areas recognized as having a high potential payoff: electronic and photonic materials, and biomolecular materials.

A class of materials that has received much attention is *superconductors*. The Federal Government has traditionally supported the basic science that characterizes both high temperature (HTS) and low temperature (LTS) superconducting phenomena. The researchers in the U.S. credited with bringing the HTS materials to worldwide attention were all supported for many years by Federal agencies. At the time of the discovery of the phenomenon of HTS, the government was spending about \$55 million annually on all aspects of superconductivity. The budget provides \$93 million in 5 agencies (Defense, NASA, Energy, National Science Foundation and the National Institute of Standards and Technology in Commerce) for superconductivity R&D.

Protecting the Public Health Through Biomedical and Behavioral Research

"Progress in the war against disease depends upon a flow of new scientific knowledge. New products, new industries, and more jobs require continuous additions to knowledge of the laws of nature, and the application of that knowledge to practical purposes. This essential, new knowledge can be obtained only through basic scientific research."¹

Since Vannevar Bush made this statement in 1945, federally supported research has helped Americans live longer, healthier lives by improving the quality of medical practice and by developing new preventive measures. The U.S. leads the world in biomedical research—both the pace of new discoveries and America's continued dominance of scientific Nobel prizes attest to that pre-eminence.

¹Vannevar Bush. *Science, the Endless Frontier: A Report to the President*. U.S. GPO, July 1945, p. 1.

The budget assures that the next generation will reap similar benefits by seeking substantial increases in the country's investment in biomedical and behavioral research and development. In the Department of Health and Human Services alone, this increase amounts to \$564 million, or 6 percent, over 1991 funding levels.

Advances in biomedical and behavioral research can improve the quality of health care while helping to control health care costs. One example includes the research-induced changes in medical practice which reduced coronary heart disease death rates and the duration of heart diseases-related hospital stays—saving hundreds of thousands of lives and billions of dollars. Current path-breaking research, such as the first human gene therapy experiments conducted at the National Institutes of Health (NIH), proffers the hope of similar advances in human health and cost efficiency in the future. Research at the Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA) into the causes of human addiction to drugs and alcohol offers hope of finding ways to reduce the human and societal toll caused by substance abuse.

The Federal investment in biomedical and behavioral research is large. In total, the budget proposes \$9.8 billion for the Department of Health and Human Services, an increase of 6 percent over 1991. While most of this research is basic, considerable sums are invested in applied research and development as shown in Table C-8. This research helps ensure that basic research discoveries are translated into marketable therapies. Indeed, NIH funding of

clinical trials, through which promising new therapies, preventive interventions and cures are examined for safety and efficacy, will total over \$725 million in 1992. For example, since pharmaceutical companies traditionally have been slow to develop anti-drug abuse medications, the 1992 budget contains a \$55 million initiative for medications development in ADAMHA, a 39 percent increase over 1991.

This Federal investment in biomedical and behavioral research has increased as a proportion of GNP from 0.12 percent in 1970 to 0.16 percent in 1992.

Although most of HHS funds are utilized for basic research which advances knowledge for combatting many diseases, some research can be loosely classified as related to one specific disease or another, as shown on table C-9. By comparing these data with the data in Table B-2 in Chapter IV.B., it can be seen that this investment by disease roughly corresponds to the toll these afflictions take in terms of death, illness, and human suffering.

Relating Research Investments to Selected Diseases.—Some have argued that a disproportionate share of health-related research dollars are being devoted to HIV/AIDS. It is true that spending per death from HIV/AIDS is high compared to that for heart disease, cancer, and stroke, the three leading causes of death in the country. HIV, however, often strikes early in life. More than 45 percent of AIDS victims are younger than 35, and a growing number are children. As a result, some suggest that research spending per year of potential life lost before age 65 for HIV and

Table C-8. HEALTH R&D IN THE DEPARTMENT OF HEALTH AND HUMAN SERVICES

(Dollar amounts in millions)

	Budget Authority			
	1991 Enacted	1992 Proposed	Dollar change	Percent change
Basic Research	5,101	5,477	+376	+7
Applied research	3,161	3,283	+123	+4
Development	1,012	1,076	+65	+6
Total Conduct, HHS R&D	9,273	9,836	+564	+6

the three killer diseases is more comparable than that for spending per death, as shown in the following chart. In addition, a comprehensive assessment of relative funding levels must consider other factors, such as morbidity and quality of life. The charts also show substantial investments in diabetes, a disease that is a major contributor to disability as well as the Nation's seventh leading cause of death.

Deaths and years of potential life lost attributable to the three major killers and diabetes are projected to grow, individually and collectively, by less than 7 percent over the 4 years between 1990 and 1993. In contrast, deaths and years of potential life lost due to HIV will increase much more quickly, rising by 40 to 80 percent. These projections further support the priority given to HIV research in the 1992 budget.

The Budget Includes a Major Investment to Confront Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome (HIV/AIDS).—Since the greatest hope for devising better treatments, or even a cure or vaccines, for HIV/AIDS will come from advances in knowledge, the budget continues to place a priority on biomedical and behavioral research related to HIV/AIDS. As shown in table C-10, governmentwide HIV/AIDS funding will increase by \$558 million or 15 percent. This includes a 5 percent increase for research and a 24 percent increase for treatment.

The budget would enable the Nation to continue making progress in the battle against HIV/AIDS. Additional candidate therapies will be screened and tested, education programs

will continue to discourage behaviors that lead to transmission of the virus, and treatment and income support funds will continue to be made available to those already afflicted. Indeed, the largest increase related to HIV/AIDS will come from Federal spending for Medicaid and Medicare, which are projected to increase by a total of 29 percent over 1991. Additional research and education are the best methods for ensuring that future generations will not bear so heavy a burden, and the 1992 budget therefore makes substantial efforts in these areas.

Moving Fusion Energy From Science to Engineering.—Fusion energy offers the potential to be a clean plentiful fuel for the production of electricity for the longer term. Compared with the burning of fossil fuels, fusion would produce no sulphur or carbon dioxide. The Fusion Program Advisory Committee (FPAC) of the Department of Energy has recommended a long-range goal-oriented plan for an operating Demonstration Power Plant by 2025 and an operating Commercial Power Plant by 2040.

The budget proposes \$337 million for fusion, an increase of \$62 million (23 percent) over the 1991 level. Funding is included for R&D and design work at the Plasma Physics Laboratory at Princeton University leading to a Burning Plasma Experiment to improve the scientific base for magnetic fusion. Over the next year, the Department will be seeking international participation in this endeavor prior to committing to a specific construction project. Inertial confinement fusion alter-

Table C-9. HHS RESEARCH FUNDING ATTRIBUTED TO SELECTED CAUSES OF ILLNESS

(In millions of dollars)

	Budget Authority	
	1991 Enacted	1992 Proposed
Cancer	1,566	1,653
Heart Disease	663	711
Stroke	76	84
Diabetes	262	277
Injuries	45	46
HIV/AIDS	1,122	1,185

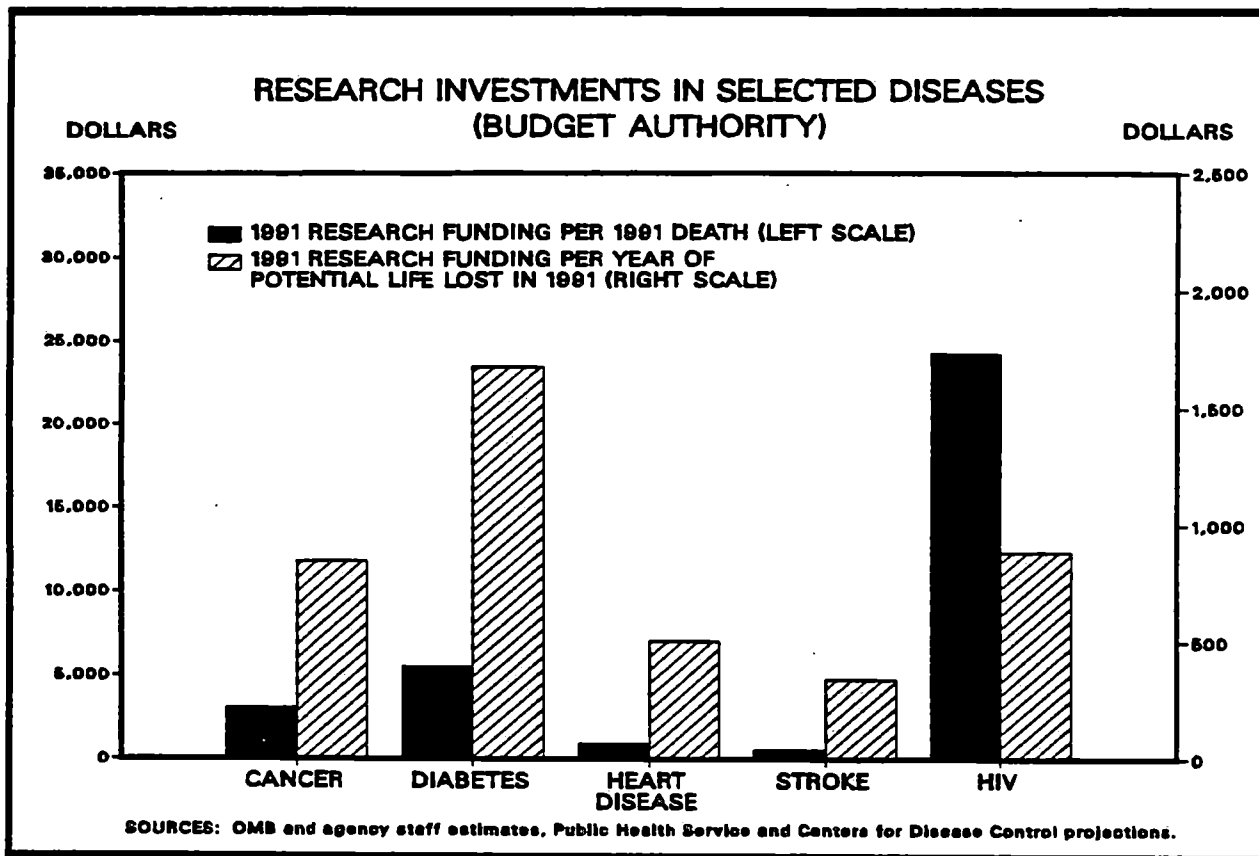


**Table C-10. THE BUDGET PROPOSES A 15 PERCENT INCREASE IN
FEDERAL FUNDING FOR HIV/AIDS¹**

(Dollar amounts in millions)

	1991 Enacted	1992 Proposed	Dollar change	Percent change
HIV/AIDS:				
Research	1,152	1,210	+58	+5
Treatment	1,614	1,999	+385	+24
Prevention	630	637	+7	+1
Income Support	305	414	+109	+36
Total²	3,701	4,259	+558	+15

¹Funds are for programs in the Departments of Health and Human Services, Defense, Veterans Affairs, Education, Justice, State, Labor, and independent agencies. Total also includes obligations for the Social Security Administration.

²In addition to the spending identified above, the budget includes other initiatives, most notably those related to drugs and infant mortality, that contribute to the fight against HIV and AIDS.

natives will also be pursued in the research program.

The budget proposes that the United States continue international participation in the engineering design phase of the International

Thermonuclear Engineering Reactor. This 6-year collaboration among four equal partners (U.S., European Community, Japan, and the Soviet Union) is a model for international cooperation in science and technology. Such a

joint project has the advantages of sharing knowledge and personnel, reducing the financial burden for each party, and optimizing the use of special facilities and capabilities for the common goal of achieving energy from fusion.

Improving the Air Transport System—Aeronautics R&D.—The goal of NASA's aeronautics research and technology program is based on a strategy that calls for developing a broad technology base in support of the commercial aviation industry; enhancing the safety and capacity of the national airspace system; and helping assure U.S. aeronautical superiority for national security. Aeronautics R&D has traditionally been a highly successful close cooperative effort between the Federal Government and the private sector.

Technologies are being pursued which offer major advances in vehicle performance and capabilities. Research efforts have been expanded in high-payoff areas associated with a broad range of future vehicle applications including subsonic and high-speed transport aircraft.

The budget proposes \$543 million for aeronautics R&D (excluding High Performance Computing), an increase of 13 percent over the 1991 enacted level. The budget proposal reflects the need to continue to address critical technology barriers to and strengthen technology development necessary for future aviation advances. Work in focused high-speed research has been expanded to include a focus on enabling propulsion materials necessary to develop future aircraft. In addition, the budget includes funding for a new program focused on advanced subsonic aircraft. This program will develop nondestructive evaluation technology to help ensure the safe operation of aging transport aircraft now in the National Airspace System and will also provide the technology base for application and certification of fly-by-light and power-by-wire control systems.

In addition to the work proposed above, the budget includes \$72 million as NASA's share of the joint NASA/Defense National Aerospace Plane Program (NASP). Defense will provide \$233 million in 1992. This program is focused on development of hypersonic technology leading to a future decision on a flight research vehicle.

Expanding Civilian Applied R&D at the National Institute of Standards and Technology (NIST).—The budget proposes \$248 million, a 15 percent increase over 1991, for NIST. NIST carries out R&D which supports standards development and advances measurement techniques, both of which are critical to improving product quality, allowing for effective use of new technologies, and improving public safety. In addition, NIST performs generic applied research and technology development, often in collaboration with industry, which has potential benefit to broad segments of the economy. The budget proposal continues an effort begun in the 1991 budget to expand NIST's ability to perform generic applied research and technology development and to address a rapidly growing number of important standards and measurement issues.

NIST in-house research covers a broad spectrum of technologies such as electronics, manufacturing, materials science, chemical science and information systems. The 1992 increase will support new projects in many areas including: expedited development of measurement standards for intelligent machines; development of standards for fiber-optic systems and high-temperature superconductors; expanded research into intelligent processing of materials; analysis of the thermophysical properties of refrigerants that are alternatives to chlorofluorocarbons; methods to measure the performance of high density recording on magnetic films; and development of seismic design and construction standards to reduce vulnerability to earthquakes.

The budget also includes \$36 million for the Advanced Technology Program (ATP). This program provides a minority share of funding for industry-led high risk R&D on pre-competitive, generic technologies. In a broad sense, the goal of the program is to help bridge the gap between more fundamental R&D and commercial R&D. ATP is an important, but experimental, program whose results cannot be predicted with certainty. Another experimental program is the Manufacturing Technology Centers. The budget proposes \$10 million for this program to support the continuation of the five existing Manufacturing Technology Centers and the start of a sixth center. These centers are intended to enhance U.S. manufacturing by transferring Federal advanced manu-

facturing technologies and practices to the private sector. Three of the centers will undergo a review in 1992.

MAINTAINING NATIONAL SECURITY: DEFENSE R&D IN THE 1992 BUDGET

For all defense-related R&D, including R&D supported by the Departments of Defense and Energy, the budget proposes \$43 billion, an increase of over \$5 billion, or 14 percent, above 1991. Defense-related R&D will comprise 60 percent of overall Federal R&D funding in 1992.

Department of Defense.—A strong defense R&D program is a key element of United States national security strategy. This is underscored by the fact that R&D funding will grow from \$35 billion in 1991 to over \$40 billion in 1992 while the defense budget overall will decline in real terms. Not only does the Defense R&D program provide for the development of major weapon systems but it also provides important general benefits to U.S. technological capabilities.

Technology Base.—The budget proposes \$3.9 billion for the technology base—programs for basic and applied research that provide future defense options and that advance technologies with broad applications. It also helps guard against technological surprise by potential adversaries. Investment in the technology base provides a broad range of options for future military capabilities that may be necessary. It is essential for the U.S. to maintain the technological superiority in fielded weapon systems

and the commitment to development and exploitation of advanced technologies. Examples are anti-submarine technologies for detecting increasingly quiet submarines, improving torpedo warheads and delivery mechanisms, and developing nonconventional methods of acoustic detection. As discussed in the section of this chapter on high performance computing and communications, Defense will play a lead role in developing the technology to increase computer performance by several orders of magnitude. This continues the pathfinding efforts of the Department of Defense that have led to today's advanced parallel processors. In addition, DOD technology-base R&D programs have led to civilian applications. These include CATSCAN imaging technology for improved medical diagnosis, advanced structural materials for commercial aircraft (aluminum alloys and composites) and such common devices as microwave ovens. The basic research portion of the DOD technology base supports a wide range of scientific disciplines, including oceanography, materials, mathematics and biochemistry.

Development.—The budget proposes nearly \$37 billion for development programs, an increase of over \$5 billion, or 16 percent. Within this total, the budget proposes \$2.2 billion to fabricate prototype systems and subsystems that support defense missions. Some of these also have potential commercial applications. Defense will provide major support to SEMATECH, the semiconductor industry consortium, to advance the manufacturing of integrated circuits. In space, defense is providing significant support for the National Aerospace

Table C-11. MAINTAINING NATIONAL SECURITY

(Dollar amounts in millions)

Department	Budget Authority			
	1991 Enacted	1992 Proposed	Dollar change	Percent change
Defense-military functions	35,176	40,479	+5,303	+15
Basic research	992	1,010	+17	+2
Applied research	2,754	2,861	+106	+4
Development	31,429	36,609	+5,180	+16
Energy-atomic energy defense programs	2,608	2,768	+161	+6
Total, Conduct of R&D	37,783	43,247	+5,464	+14

Plane Program and for development of a new space launch system.

The budget proposes nearly \$5 billion for preliminary work on subsystems and supporting technology for defense against ballistic missiles under the Strategic Defense Initiative. These efforts are directed toward a defense against limited attacks from anywhere in the world against U.S. territory, deployed U.S. forces or our allies.

The largest portion of Defense R&D funding is allocated to the development of a new generation of advanced weapons systems and improvements to currently-deployed systems. The budget proposes over \$29 billion for these activities. New weapons systems under development include the B-2 bomber, the Advanced Cruise Missile, the Advanced Tactical Fighter, the SSN-21 attack submarine and advanced armored vehicles. In addition, current systems, such as the M-1 tank, the F/A-18 fighter and the F-16 multi-role aircraft will be upgraded.

Department of Energy.—The budget proposes \$2.8 billion for Department of Energy (DOE) Atomic Energy Defense programs, an increase of \$161 million, or 6 percent over 1991. The largest component of these R&D activities is the research, development and testing of nuclear weapons. The budget proposes \$1.8 billion for that activity, including associated R&D facilities, an increase of \$27 million over 1991. The DOE nuclear weapons R&D program will increase efforts to improve the safety of nuclear weapons and to develop new technology to verify arms control treaties. In addition, the DOE weapons laboratories are increasing efforts to promote the transfer of non-sensitive defense-funded technology to the private sector. The budget proposes \$32 million to support for such technology transfer activities.

The environmental cleanup of atomic energy defense facilities is one of the fastest growing programs in DOE. Technology development activities play a major role in the clean-up effort, resolving major technical issues related to effective waste management and cleanup and advancing technologies to attain and maintain compliance with current laws and regulations. The budget proposes to increase this investment in technology development by 60 percent, from \$206 million in 1991 to \$330 million in

1992. The complete DOE environmental restoration and waste management program is discussed in detail in Chapter IV.E.

In addition, DOE develops nuclear reactor systems to power Naval vessels. The budget proposes \$678 million for Naval reactors R&D, an increase of \$26 million over 1991.

ENCOURAGING INCREASED PRIVATE SECTOR R&D INVESTMENTS

The budget proposes permanent extension of the research and experimentation tax credit and a one-year extension of the tax rules governing the allocation of foreign and domestic R&D expenditures.

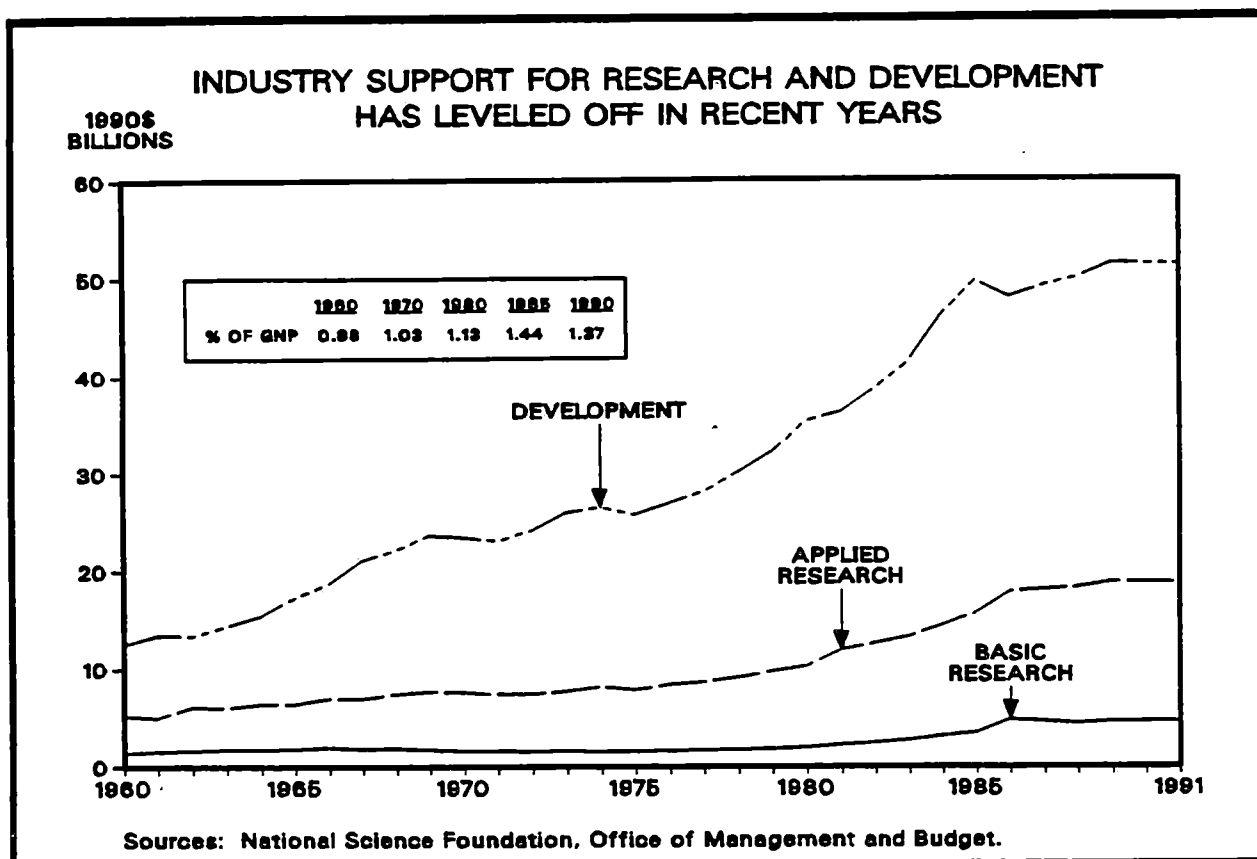
Industry is the largest supporter of R&D in the Nation, providing about 50 percent of the total national R&D investment. It also performs much of the R&D funded by the Federal Government. In total, over 70 percent of all R&D is performed by industry.

From the early 1960s through the mid-1980s, total real industrial R&D expenditures increased significantly, mostly in development. Since the mid-1980s, however, the rate of growth in industrial R&D spending has leveled off, dropping from a rate of 7 percent average annual percent real growth between 1980-1985 to 2 percent between 1985-1990. For 1990 and 1991, both the National Science Foundation and the Battelle Memorial Institute project that industrial R&D will, at best, keep pace with inflation. The tax incentives can help boost private R&D investment.

R&E Tax Credit

The Research and Experimentation (R&E) tax credit was originally adopted in 1981 to encourage increased private R&D spending. The credit was never made permanent, but was renewed in 1986, 1988, 1989 and 1990 at a lower rate than originally granted. Reducing the rate of the credit, combined with reductions in corporate income tax rates and the actual calculation of the credit, have the effect of reducing the incentive effect of the original credit by more than 50 percent.

R&E tax credits prior to 1989 reduced the cost of increments to R&D for most qualifying firms by about 6 to 9 percent. In 1989 the incentives provided by the credit were im-



proved. The version of the R&E credit enacted in 1989, and extended in the 1990 Omnibus Budget Reconciliation Act, reduces, for most qualifying firms, the cost of increments to R&D by 20 percent. Bailey and Lawrence have estimated that this version of the R&E tax credit should increase corporate R&D spending in the 1990s by about 4 percent. Making the credit permanent would help reverse the recent trend toward leveling off of corporate R&D spending.

The budget proposes two changes in the tax code designed to provide additional incentives for industry to increase its R&D expenditures. The budget proposes to make the 20 percent R&E tax credit permanent by allowing 100 percent of total research expenses to be used for the computation of the credit for all years after December 31, 1990. In addition, the budget proposes to extend for one year the rules, as modified in 1989 and extended in the Omnibus Budget Reconciliation Act of 1990, for the allocation of foreign and domestic R&D expenditures for companies with foreign operations. The proposal would allow 100 per-

cent of U.S. expenditures to be covered rather than the current 75 percent. This proposal would apply to all tax years beginning after August 1, 1990, when the current rules expired.

ENHANCING THE R&D INFRASTRUCTURE

Adequate research facilities and equipment are essential to the effectiveness of national research efforts—collectively an enterprise that supports the search for a basic understanding of nature, the missions of government agencies, the improvement of industrial products and processes, and the training of future generations of scientists and engineers. To sustain a strong national research capability and to enable expansion of research capacity, R&D infrastructure must be maintained and replenished.

Overview of Trends and Status of National R&D Infrastructure

The Federal Government directly funds the cost of facilities and equipment necessary for

the conduct of R&D at Federal facilities. Private industry and universities have primary responsibility for the R&D infrastructure under their respective jurisdictions. However, since the Federal Government does support basic research at universities, it provides substantial funding for university R&D facilities and equipment:

- For *new facilities and equipment*, Federal agencies provide direct funding where they are directly related to federally funded research.
- For *repair and renovation*, the Federal Government provides indirect funding, through the payments to universities of use and depreciation allowances for research facilities as part of the indirect costs associated with research grants.

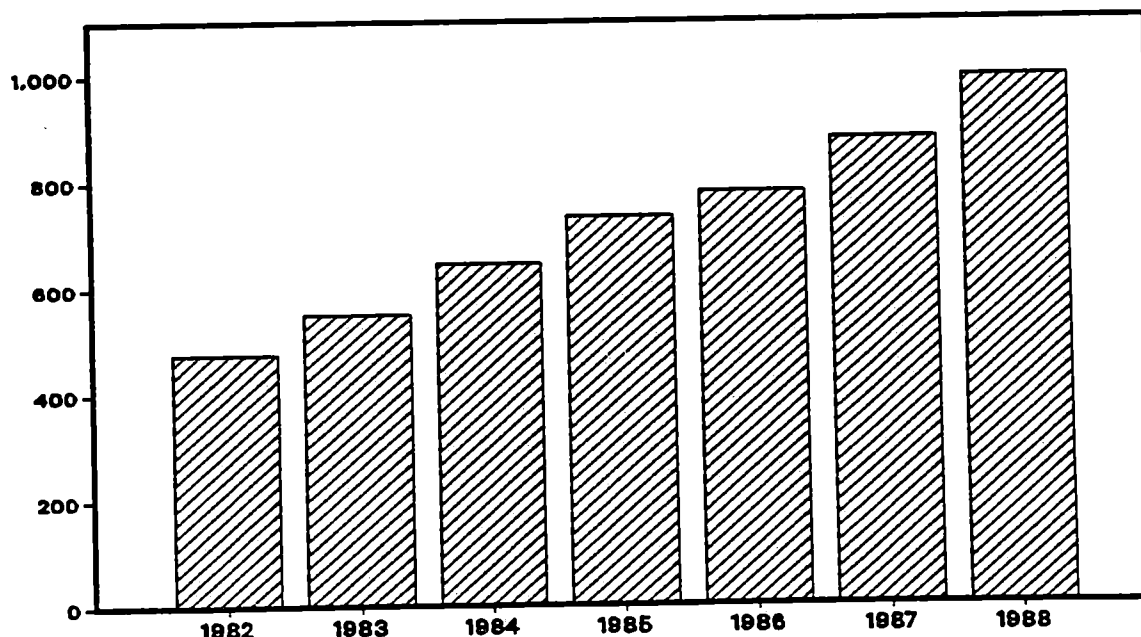
University Research Facilities.—The National Science Foundation reported in its 1990 facilities survey that there were an estimated 116 million net assignable square feet (NASF) of science/engineering (S/E) research space at the Nation's 525 research-performing institu-

tions in 1990, representing 42 percent of the total 276 million NASF of S/E space at these institutions. (This figure excludes academically-administered Federally Funded Research and Development Centers (FFRDCs).) There were no significant changes from 1988 to 1990 either in the overall amount of academic research space or in its distribution among institution types or research disciplines.

Federal Support for University Research Facilities.—The Federal Government has provided a significant level of support for university research facilities. This includes direct support for facilities in support of federally funded research and indirect cost recoveries. In 1988–89, the latest period for which estimates are available, private institutions initiated \$738 million of new construction and public institutions initiated \$1.73 billion of new construction. The Federal Government provided an estimated 11 percent and 16 percent of these funds, respectively.

Expenditures for the repair and renovation of research facilities totalled an estimated \$1 billion in 1988–1989, with private institutions

FEDERAL SUPPORT FOR UNIVERSITY INFRASTRUCTURE THROUGH
INDIRECT COST PAYMENTS HAS GROWN SHARPLY
\$ MILLIONS



accounting for one-third of this total (\$311 million). Direct Federal funding accounted for 9 percent of repair and renovation activity at private institutions, and 4 percent at public institutions.

Indirect Federal support for academic research facilities, through the recovery of use and depreciation charges and operations and maintenance charges on Federal grants, reached almost \$1 billion in 1988 (the latest year for which data are available). Almost 20 percent of these charges was for facility depreciation (which was then intended to be applied by the institutions to renovation or new construction). The remaining 80 percent was for recovery of operations and maintenance costs. Over the period 1982–1988, the level of indirect cost recoveries of facilities charges increased over 70 percent in real terms.

However, because indirect cost recoveries are generally credited to the general funds of the institutions, there is no way to determine if the use/depreciation recoveries were actually applied to research facility construction or repair.

The NSF survey reported an estimated \$12 billion in “needed, but unfunded capital projects” at universities. Each academic institution must provide a certification that its research facilities are adequate (to perform the research proposed) as a condition of accepting research grants. This backlog reported by NSF has not had an apparent effect on the ability of universities to accept Federal research funds. However, the perception of such a large “backlog” has led to increased calls from the institutions and many members of Congress for a major expansion of Federal support for academic research facilities. There has been Congressional action in two areas:

- “Earmarking” of Federal funds to construct new facilities at particular institutions. The Office of Science and Technology Policy, as part of its continuing evaluation of the state of university research facilities, estimates that about \$427 million was appropriated for such projects in 1991. (The issue of earmarking is discussed in more detail in a later section of this chapter.)

- Providing direct grants for academic research facilities repair and renovation through the National Science Foundation, funded at \$20 million in 1991.

The 1992 budget does not contain funding for either of these practices. Earmarking which does not involve merit review of any kind, is an inefficient use of scarce resources. Further, it has the effect of weakening the Nation’s overall R&D effort. Funds earmarked for academic research facilities by Congress in 1991 and previous appropriations bills not only were without the benefit of merit-based review, but most often came at the expense of needed increases in support for academic researchers and in other key activities at Federal laboratories. The Administration will continue to support direct Federal funding for academic research facilities where such facilities are an integral part of merit-based, competitive research projects. For example, the budget proposes \$25 million for academic research facilities associated with the National Research Initiative of the Department of Agriculture.

Special programs for facilities repair and renovation are not warranted because the Federal Government directly supports only a small proportion (less than 10 percent) of this activity. Further, the large amounts of funds recovered as indirect costs represent a considerable, and continuing, investment in academic research facilities.

1992 BUDGET PROPOSALS FOR RESEARCH FACILITIES

The budget proposes nearly \$4 billion for construction, repair and modernization of R&D facilities and for major research equipment, an increase of \$464 million or 15 percent. The major increases in 1992 are due to the initiation of construction of the Superconducting Super Collider and the new instrumentation initiative in NSF. This initiative, funded at \$50 million in 1992, will provide state-of-the-art instrumentation to university researchers through a merit-based competitive process. The Federal funding will be matched 50:50 from non-Federal sources. In addition, although total funding for R&D facilities in the Department of Agriculture (USDA) is proposed to decline, there is a total of \$25 million for

Table C-12. IMPROVING R&D FACILITIES
(Dollar amounts in millions)

Department or Agency	Budget Authority				Outlays			
	1991 Enacted	1992 Proposed	Dollar change	Percent change	1991 Enacted	1992 Proposed	Dollar change	Percent change
Energy	1,199	1,623	+424	+35	1,161	1,442	+281	+24
National Aeronautics and Space Administration	857	885	+28	+3	722	850	+128	+18
Defense-military	461	538	+76	+17	463	482	+19	+4
National Science Foundation	111	153	+42	+38	155	124	-32	-20
Agriculture	156	128	-27	-18	148	122	-26	-18
Health and Human Services	186	130	-56	-30	111	153	+42	+38
Other Agencies ¹	113	88	-24	-22	86	93	+7	+8
Total	3,082	3,545	+464	+15	2,845	3,264	+419	+15

¹Includes the Departments of Transportation, Interior, Commerce, Veterans Affairs, Education, the Treasury, the Environmental Protection Agency, Smithsonian Institution, Tennessee Valley Authority, the Corps of Engineers and the Agency for International Development.

a facilities program associated with the USDA National Research Initiative.

EARMARKING OF R&D FUNDING

The hallmark of the Federal Government's support for R&D has been the awarding of R&D grants and contracts through a competitive process. This merit-based approach is intended to maximize the potential return on these investments by selecting only the highest quality research for support.

This merit-based approach, however, has been increasingly eroded in recent years due to the Congressional practice of "earmarking", i.e., requiring that R&D funds be awarded to particular institutions or even to particular researchers. This practice is most visible in the area of new university buildings. However, the practice of earmarking is actually much more pervasive, reaching down to individual research projects.

As part of an ongoing study of the state of American science, the Office of Science and Technology Policy recently completed a detailed analysis of earmarking in the 1991 appropriation bills. The major findings of the study follow.

- The study identified 492 such earmarks, totaling \$810 million. Of these 325 (totaling \$182 million) were in Agriculture,

where specific earmarking by Congress has historically been customary.

- In other areas, R&D earmarking may be on the rise, with 48 separate actions in Energy and 20 to 30 each in Defense, Interior, General Services Administration (GSA), and the Environmental Protection Agency. In Defense, \$253 million was applied to R&D earmarks, which were exempted from a previously enacted legal requirement for competition. Also noteworthy is the \$61 million in a GSA appropriation for R&D facilities construction at 21 universities and other private institutions. Neither GSA nor the Treasury-Postal Appropriations subcommittee, where these items originated, normally have responsibility for such facilities.
- The R&D earmarks have put an extra burden of at least \$332 million on the R&D programs proposed in the President's 1991 budget, because the earmarks were made in programs where the overall funding level was the same or less than the President's 1991 request. The most serious impacts appear to be in Energy and Agriculture. The other \$475 million of R&D earmarks were covered, at least in part, by increases in the R&D accounts, which presumably means that a corresponding burden was applied elsewhere in the budget.

- At least 25 of the earmarks appear to call for the establishment of new centers, institutions, or other organizations. In most of these cases, continued Federal support in future years seems clearly implied. Thus, the 1991 earmarks have put a built-in burden on the 1992 and future budgets, an effect that will be compounded if additional earmarks are made in future years.

As the Office of Science and Technology Policy has noted, the study was based only on a review of the often meager information in

the Congressional reports and bills. Therefore, it did not identify the sponsorship of the earmarks and does not provide a basis for judgments on the merits of the earmarked items or on the motivations of the earmarking. A more in-depth case-by-case review, with agency or Congressional staff directly involved, would be needed to determine to what degree each earmark was (1) a response to advocacy by a particular institution; (2) a parochial initiative in Congress or by a Federal agency; or (3) a recognition by Congress of a significant national or programmatic need.

Table C-13. CONGRESSIONAL EARMARKING OF R&D FACILITIES AND RESEARCH IN 1991 APPROPRIATIONS BILLS

(Dollar amounts in millions)

Agency	Facilities		Research Projects		Total		Number	
	Number	Amount	Number	Amount	Number	Amount	In Law	Reports
Defense	8	107	20	147	28	253	16	12
Energy	15	104	33	81	48	186	16	32
Agriculture	54	97	271	85	325	182	—	325
Commerce	2	3	12	11	14	14	4	10
Interior	2	1	23	17	25	18	—	25
Health and Human Services	1	*	1	3	2	3	1	1
Education	—	—	5	8	5	8	5	—
General Services Administration	21	61	—	—	21	61	21	—
Environmental Protection Agency ..	4	37	16	30	20	67	1	19
National Aeronautics and Space Administration	4	18	—	—	4	18	1	3
Total, All Agencies	111	428	381	382	492	810	65	427

¹Source: Office of Science and Technology Policy.

* Less than \$500,000.

EXPANDING THE GEOGRAPHIC FRONTIER: SPACE EXPLORATION IN THE 1992 BUDGET

The exploration of space provides tangible benefits to the Nation in the form of new materials, scientific and technological discoveries that will stimulate economic growth and improve life on Earth. Space also provides large intangible benefits to the Nation with activities that lift the spirit of people everywhere. Our will to explore the unknown frontier of space, both with robotic probes and manned

missions, is one measure of the vision and maturity of the Nation.

The key to the successful exploration of space is stable and sustainable funding of a balanced program of science, applications and manned space activities. The budget provides clear evidence of the President's continued commitment to his long-term space goals, and

**Table C-14. THE BUDGET CALLS FOR A 15 PERCENT INCREASE
FOR MAJOR SPACE ACTIVITIES**

(Dollar amounts in millions)

Objective	Budget Authority			
	1991 Enacted	1992 Proposed	Dollar change	Percent change
Space Transportation Infrastructure	4,801	5,517	+716	+15
Space Shuttle	4,737	5,167	+430	+9
New Launch System	64	350	+286	+447
NASA	24	175	+151	+629
Defense	40	175	+135	+337
Space Science	1,774	2,141	+367	+21
Mission to Planet Earth	954	1,186	+232	+24
NASA	652	773	+121	+18
Other Agencies	302	413	+111	+37
Mission From Planet Earth	2,199	2,470	+271	+12
Space Station Freedom	2,044	2,214	+170	+8
Space Exploration Initiative	155	256	+101	+65
NASA	37	94	+57	+154
Energy	109	142	+33	+30
Defense	9	20	+11	+122
Other NASA Programs ¹	4,600	5,157	+557	+12
Total, All Agencies	14,328	16,471	+2,143	+15
Total, NASA	13,868	15,721	+1,853	+13

¹Includes funding for all other NASA activities including space research and technology, aeronautics, commercial programs, personnel, construction, and tracking.

to active American leadership in space science and exploration.

The budget proposes to allocate a total of \$15.7 billion for the National Aeronautics and Space Administration (NASA). This represents an increase of 13 percent over the 1991 enacted level. The strategy behind the 1992 budget has been guided in large part by the findings and recommendations of the Advisory Committee on the Future of the U.S. Space Program (the Advisory Committee). This Committee was asked to examine the goals, strategies and programs of the current civil space program and recommend changes where necessary. The budget provides increases for space activities, including research, development, and operations, to support critical elements of space transportation (that provides the enabling infrastructure for all other space activities), a robust program of space science, to meet two major "missions"—a Mission to Planet Earth and a "Mission from Planet Earth".

SPACE TRANSPORTATION INFRASTRUCTURE

The foundation of U.S. all space activities is space transportation. Without adequate transportation, no scientific or exploration activities would be possible. Over the last several years, it has become increasingly evident that the robustness and the flexibility of the U.S. space launch capability would not be sufficient to carry the Nation into the next century. At the present time, the U.S. has one manned space transportation vehicle, the Space Shuttle, and a fleet of expendable launch vehicles with a broad range of payload capability. Several classes of these expendable vehicles are provided on a commercial basis to the Federal Government to meet its needs. In addition, DOD owns a very large expendable launch vehicle, the Titan IV.

The strategy reflected in the budget is founded on two underlying principles: (1) enhance the reliability, operability and schedule

predictability of the Space Shuttle; and (2) begin now to develop new launch capability that will relieve the burden now being carried by the Shuttle;

Space Shuttle.—The budget recognizes the importance of the Shuttle to the entire civil space program. The Shuttle is the world's most versatile space transportation vehicle, with the capability to launch and retrieve satellites and to serve as an orbiting laboratory for microgravity and life sciences. However, the Shuttle is also complex and expensive to operate. Thus, its use should be limited to payloads that require manned presence or other unique Shuttle capabilities. This strategy recognizes the Shuttle for what it is—a precious resource that should be conserved—and should result in a planned level of activity that is both realistic and prudent.

As a consequence, the planned Shuttle flight rate has been established at 9 missions per year in 1992 and 1993, and 10 missions per year thereafter. This will allow Shuttle activity to increase from the current level, but will result in a more stable and attainable flight schedule, limit operational pressures on the system, reduce long-term risk exposure, and facilitate implementation of cost containment measures. These objectives are consistent with the recommendations of the Advisory Committee.

Even so, it is clear that the Shuttle will be essential to the civil space program for at least the next decade. Therefore, investments in R&D to maintain and improve the safety, reliability and performance of the Shuttle are of a high priority. These investments include:

- **The Advanced Solid Rocket Motor (ASRM).**—This program is intended to develop a newer, more capable, more reliable and safer generation of solid rockets. A new state-of-the-art ASRM production facility is under construction at Iuka, Mississippi. Advances in production learned from the ASRM are expected to be useful for solid rockets in other applications (e.g., new unmanned launch vehicles). The budget proposes \$350 million to continue the facility construction and motor development.

- **Assured Shuttle Availability (ASA).**—With many operational systems, there is a need to establish a well-planned program that is structured to make continued improvements and to incorporate new technology where it is cost-effective to do so. Both the military services and commercial transport operators routinely provide for such programs for their fleets of aircraft and ships. Up to now, however, no such structured program has existed for the Shuttle. Improvements and upgrades were approved and funded on an ad hoc basis. The budget proposes \$122 million to initiate a new program, Assured Shuttle Availability (ASA), that will provide a formal funding mechanism and process for identifying and incorporating high-priority improvements into the Shuttle. Included in this activity will be the ongoing work to develop an Alternate Turbopump for the Shuttle main engine.

New Launch System.—The continued investment in the Shuttle is coupled with the recognition that a new launch system will be needed by the early part of the next century—for a range of payloads including Shuttle-sized and larger payloads up to and including a “heavy-lift” capability. More capable and more cost-effective space transportation systems will benefit all space programs, including national security, space science and space exploration. Future space exploration will require a new heavy-lift launch vehicle. In addition, a new launch system will provide a strong technology base for improvements in the capabilities, technology and cost-effectiveness of the U.S. commercial space sector.

The budget proposes \$175 million for NASA and \$175 million for DOD to continue advanced engine development and to initiate a program that will culminate in the development of a new space launch system. This new capability was recommended by Advisory Committee on the Future of the U.S. Space Program. It is expected that NASA and DOD will jointly manage and fund this program on a 50:50 basis. The program will involve development of both new propulsion systems and new vehicle systems. The two agencies will work together to develop a strategic plan, including budget, program and management options, for

Table C-15. THE BUDGET INCLUDES FUNDING FOR 9 SHUTTLE FLIGHTS AND INVESTMENTS TO IMPROVE THE SHUTTLE

(Dollar amounts in millions)

	Budget Authority			
	1991 Enacted	1992 Proposed	Dollar change	Percent change
Space Shuttle	4,737	5,167	+430	+9
Space Shuttle operations	2,790	3,024	+234	+8
Advanced Solid Rocket Motor	401	350	-51	-13
Assured Shuttle Availability	—	122	+122	—
Production and Capability development	1,546	1,671	+125	+8
Expendable launch vehicle (ELV) services	229	342	+113	+49
Tracking and data acquisition	849	943	+94	+11
Total	5,815	6,452	+637	+11

proceeding with new vehicle development and will report to the National Space Council.

SPACE SCIENCE

The budget proposes \$2.1 billion, an increase of 21 percent over 1991, for NASA's space science programs, including astronomy, life sciences, planetary exploration, Earth science (other than Mission to Planet Earth), materials research, and other space-based research and flight programs.

Several exciting flight programs have been launched in the past year, including the Galileo mission to Jupiter and the Magellan radar mapping mission to Venus. There are over 30 minor and major flight programs that are planned for launch over the next five years, including Mars Observer, the Advanced Communications Technology Satellite, the Gamma Ray Observer, and the Advanced X-Ray Astrophysics Facility.

The implementation of this broad research program is based on a long-range, prioritized strategic science plan that was developed in cooperation with NASA's external science advisory group and is consistent with recent recommendations of the Advisory Committee on the Future of the U.S. Space Program. These programs represent nearly 20 percent of the NASA budget total.

MISSION TO PLANET EARTH: THE U.S. GLOBAL CHANGE RESEARCH PROGRAM

World leaders are taking an increased interest in the economics and social implications of global environmental changes, both natural and human-induced. In virtually all these issues, the salient feature is the significant scientific uncertainty associated with predicting the behavior of the coupled ocean-atmosphere-land Earth system. The potentially large costs associated with addressing environmental changes (e.g., "greenhouse effect", global climate change, and ozone depletion) require that policy decisions be based on adequate scientific knowledge.

To provide this knowledge, the U.S. Global Change Research Program (USGCRP) was initiated in the 1990 budget. The 1992 USGCRP budget again proposes a major expansion of this unprecedented interagency research effort. Funding for global change research will total \$1,186 million, a \$232 million, or 24 percent, increase over the 1991 enacted level. By 1992, funding for the USGCRP will have nearly doubled since 1990. These activities include a broad range of monitoring, modeling, and fundamental research efforts focused toward producing a predictive model of the Earth "system". The U.S. provides 50 percent of the estimated worldwide total of \$2 billion spent on global change research.

The USGCRP has been developed through the interagency Federal Coordinating Council on Science, Engineering and Technology's Committee on Earth and Environmental Sciences (CEES). The program is driven both by a prioritized science planning framework that has been endorsed by the U.S. and international scientific communities, and by key scientific questions related to global change policy issues such as the "greenhouse effect", global climate change, and ozone depletion.

To further ensure that the USGCRP continues to be relevant to policymakers, the CEES established a set of integrating themes (i.e., climate modeling, global water, carbon, and energy cycles, ecological systems, and sea level change) that were based on the recent Scientific and Impacts Assessments of the Intergovernmental Panel on Climate Change (IPCC). In order to improve the Earth system modeling capabilities and support the development and implementation of a comprehensive approach to greenhouse gas emission reductions, the IPCC assessments concluded that a significant reduction in scientific uncertainties would have to be achieved in the following areas:

- sources and sinks of greenhouse gases, which affect predictions of future concentrations;
- clouds and radiative balance, which strongly influence the magnitude of climate change at global and regional scales;
- oceans, which influence the timing and patterns of climate change;
- land-surface hydrology, which affect regional climate change and water availability;
- polar ice sheets, which affect predictions of global sea level changes; and
- ecological dynamics, which are impacted by and respond to climate change.

Using the science priorities and the integrating themes, the CEES developed a balanced and integrated research effort for resolving the highest priority scientific uncertainties. The space-based component of the USGCRP is comprised of NASA's Mission to Planet Earth (MTPE) which includes three elements:

- *Earth Observing System (EOS)*: EOS is a series of space platforms and remote sensing instruments for monitoring a variety of Earth processes, a large data management system, and support to individual researchers to analyze the data. Data collection will continue for a period of roughly 15 years. The Japanese and Europeans will make major contributions by developing instruments and platforms which are integral elements of the MTPE concept.
- *Precursors*: A variety of satellite and research programs that will be flown or undertaken in the next several years designed to improve our understanding of a broad variety of terrestrial, atmospheric, and oceans processes. These are important precursors to EOS but will not provide the critical simultaneity of data collection provided by EOS.
- *Earth Probes*: This series of very small, simple, and relatively inexpensive satellites will collect data on specific concerns: global ozone, ocean surfaces, and tropical rainfall. There will be five Earth Probe missions between the 1993-1997.

The Earth-based component of the USGCRP is composed of agency activities that support global or very large scale Earth-based observations (e.g., ship, aircraft, and ground-based research campaigns), and that support fundamental research on important geophysical processes. Many of these Earth-based programs are dependent on the data collected by MTPE or provide ground-based data needed to calibrate MTPE remote sensing instruments. The balance between global space-based observations, global Earth-based observations, and the process studies is essential to the ultimate development of an integrated Earth system model. Within the Earth-based component of the USGCRP:

- NSF and NOAA will provide the continental or global scale Earth-based observations by supporting international programs such as the World Ocean Circulation Experiment, the Global Energy and Water Experiment, Joint Global Ocean Flux Studies, and the Tropical Ocean-Global Atmosphere Program.

Table C-16. U.S. GLOBAL CHANGE RESEARCH PROGRAM

(Dollar amounts in millions)

Department or Agency	Budget Authority			
	1991, Enacted	1992 Proposed	Dollar change	Percent change
National Aeronautics and Space Administration	652	773	+121	+19
Earth Observing System	191	336	+145	+76
Remotely Piloted Aircraft	—	5	+5	—
Precursors/Earth Probes	461	432	-29	-6
National Science Foundation	87	119	+32	+37
Energy	66	77	+11	+17
Agriculture	39	53	+14	+36
Commerce (NOAA)	47	78	+31	+66
Interior	37	46	+9	+24
Environmental Protection Agency	22	26	+4	+18
Smithsonian	5	8	+3	+60
Defense	0	6	+6	—
Total, Budget Authority	954	1,186	+232	+24

- NSF, NOAA, NASA, DOE, DOI, EPA, USDA, Smithsonian, and DOD will all support the prioritized and important fundamental geophysical process studies and modeling efforts that are reflected in the USGCRP integrating themes.

In 1990, the National Academy of Sciences' National Research Council conducted a review of the USGCRP and endorsed it "as a sound national program to reduce the scientific uncertainties associated with global change issues." The NRC also was asked to examine many of the underlying EOS assumptions (i.e., the environmental parameters being collected, the need for data simultaneity, and the data management approach). For EOS, the NRC endorsed the science but suggested that other flight alternatives should be examined for some of the EOS remote sensing instruments. In response to this recommendation and similar recent recommendations made by the Advisory Committee on the Future of the U.S. Space Program, an external engineering review will be undertaken during 1991 to look at alternative approaches to flying EOS instruments.

One area that has received special emphasis is Arctic research, though U.S. activities in the Arctic go beyond the range of programs included in the USGCRP.

U.S. policy in the Arctic consists of four elements: protection of essential security interests; support for sound, rational development of the region; promotion of scientific research contributing to knowledge about the Arctic; and promotion of mutually beneficial international cooperation in the Arctic. Federal Arctic research is guided by a 5-year research plan developed by the Interagency Arctic Research Policy Committee (IARPC) (in consultation with the Presidentially-appointed Arctic Research Commission and other interested groups) and updated biennially.

The budget includes \$134 million for Arctic research, an increase of about \$12 million over the 1991 level. Activities included in the USGCRP account for approximately 50 percent of this increase. Within the total for 1992, \$60 million is proposed to implement the four integrated programs covering the western Arctic: oceans research, geodynamics, studies of the Bering Sea and land mass, and monitoring and data collection activities. Approximately \$6 million of this amount is for ship and aircraft support in five agencies, NSF, Transportation, NOAA, Interior, and DOD/Navy. These programs support bilateral and multilateral environmental, space, oceans, and social science agreements and cooperative activities.

Table C-17. UNDERSTANDING THE ARCTIC

(Dollar amounts in millions)

Category	Budget Authority			
	1991 Enacted	1992 Proposed	Dollar change	Percent change
Resource development ¹	49	56	+7	+14
Arctic as laboratory ²	48	50	+2	+4
National security ³	25	28	+3	+12
Total	122	134	+12	+10

¹Includes the Departments of Interior, Commerce, Agriculture, Energy, Transportation, State, and the Environmental Protection Agency.

²Includes the Department of Health and Human Services, and the National Aeronautics and Space Administration, the National Science Foundation, and the Smithsonian Institution.

³Includes the Department of Defense. The 1991 enacted level includes a one-time increase for Defense of about \$13 million specifically for upper atmosphere research and associated facilities, including the High Frequency Active Auroral Research Program (HAARP). For the purposes of comparison with 1992 levels, this funding has been excluded.

Landsat.—Acquisition of data from land remote sensing satellites is an important element in understanding global change. The Administration is committed to operating the Land Remote Sensing Satellites (Landsats 4 and 5) as long as they are the only operational Landsat satellites, and to completing the development and launch of the next satellite (Landsat 6). The budget proposes \$17 million within the Department of Commerce, sufficient to cover the operation of Landsats 4 and 5 through August of 1992 (when Landsat 6 is expected to become operational). Landsat 6 will be operated by, and at the expense of, the Earth Observing Satellite Company.

MISSION FROM PLANET EARTH: MANNED SPACE FLIGHT AND SPACE EXPLORATION

These activities include the Space Station Freedom and the space exploration initiative. Together these programs support the goal of expanding human presence and activity beyond Earth's orbit into the solar system. The strategy underlying these activities is composed of two major elements: (1) modify Space Station Freedom to focus on two principal objectives: life sciences and microgravity, and to reduce its operational complexity; and (2) support the "long pole" technology building blocks

that will be needed for future manned exploration of the solar system.

Space Station Freedom.—NASA is completing a major review of the design of Space Station Freedom (SSF). The functions of the Space Station will be focused primarily in two major areas: life sciences and microgravity research. The former will provide needed experience in studying the effects of weightlessness and radiation exposure, as a precursor to future missions to the Moon and Mars. The latter will provide the initial benefits from SSF and will lay the groundwork for a new spurt of commercial space activity.

It is expected that the reconfigured design will result in significant advantages over the current program:

- it will place the program on a more sustainable budget path;
- it will simplify the design and permit development in stages, holding closely to current schedules for early utilization;
- it will require less dependence on the Space Shuttle. The restructured program will require fewer Shuttle assembly flights in the near-term, and opportunities to use expendable launch vehicles to support operations will be investigated;

Table C-18. SPACE STATION FREEDOM
(Dollar amounts in millions)

	Budget Authority			
	1991 Enacted	1992 Proposed	Dollar change	Percent change
Space Station Freedom:				
Research and Development (excluding FTS)	1,794	2,029	+235	+13
Flight Telerobotic Servicer ¹	106	(55)	(-51)	(-48)
Total, Research and Development	1,900	2,029	+129	+7
Facilities and Program Management	144	185	+41	+28
Total, Space Station Freedom	2,044	2,214	+170	+8

¹Proposed to be moved in 1992 to Space Research and Technology.

- it will reduce the requirements for extra-vehicular activity (EVA) for assembly, operation, and maintenance, by more careful consideration of operational requirements in the design, and by emphasizing pre-launch integration and verification of flight systems.
- participation of the European Space Agency, Japan, and Canada will, of course, be continued.

The budget provides \$2,029 million for SSF development, an increase of 7 percent over the 1991 enacted level. This amount will support continued progress on development.

A major change has been made in the Flight Telerobotic Servicer (FTS) project. FTS was intended to be one of several systems that would provide early robotic assembly and servicing capability to the Space Station. However, the Space Station design review has revealed that the importance of having FTS available in the earliest stages of Space Station operations has been greatly diminished. FTS no longer represents a "critical path" item. Even so, the FTS robotic technologies, particularly the end-effector technologies, are of great importance in the long-term for the Space Station and the space program generally. Therefore, the budget proposes \$55 million to focus the FTS project on technology development, and proposes to move the FTS program to the Space Research and Technology area as part of a broader Automation and Robotics activity.

Space Exploration Initiative.—The President remains firmly committed to his long-term goal, articulated in 1989, of manned and unmanned exploration of the solar system. The budget reflects this commitment by proposing \$256 million, an increase of 65 percent, for exploration activities in NASA and the Department of Energy and for related activities in the Department of Defense. For 1992, the budget is based on a strategy of supporting activities focused on key, long-lead technologies that will be necessary for any future exploration endeavors. These technologies are: space surface nuclear power, space nuclear and conventional propulsion, and life sciences and life support technologies.

The technology strategy appears consistent with the evolving approach for space exploration under development by the Space Exploration Initiative Synthesis Group. In addition, the Synthesis Group will identify at least two fundamentally different exploration architectures. For the next few years, the Federal Government will develop these architectures in parallel with the technologies which can make exploration affordable. Only after the technology and architecture groundwork has been firmly laid, will the Administration propose specific new manned and unmanned exploration missions. This suite of exploration technologies will be expanded over time, consistent with the "go-as-you-pay" philosophy recommended by the Advisory Committee.

For space surface nuclear power, the budget proposes to continue the joint NASA/DOD/

DOE SP-100 program, and, in the Department of Energy, to conduct R&D concurrently on radioisotopic thermoelectric generators (RTGs). The focus of 1992 efforts will be on design studies and technology efforts directed at lunar operations using either SP-100 for higher power levels (10s to 100s of kilowatts) or RTGs for lower power levels. Nuclear rocket propulsion appears to offer significant advantages over conventional chemical propulsion, includ-

ing reduced trip times and reduced mass (thus lower cost). For life sciences and support technologies, the budget again proposes to initiate the Lifesat program. Lifesat will be a series of reusable satellites designed to carry living specimens into orbit, to monitor and study critical parameters such as radiation exposure, and to return the living specimens to Earth for analysis. First launch is planned for 1996.

EXPANDING THE HUMAN FRONTIER THROUGH BIOTECHNOLOGY

Biotechnology holds great promise for new life-enhancing discoveries in the fields of medicine, foods, and environmental cleanup.

The budget proposes \$4,107 million for biotechnology R&D, an increase of \$319 million, or 8 percent, over 1991. Increasing the Federal investment in biotechnology R&D will spur further advances in this rapidly growing field. In addition, the Administration recently completed a comprehensive review of all other aspects of Federal Government policy affecting biotechnology. The results of this review will be released in a forthcoming report from the President's Council on Competitiveness. Much

of the material contained in this section is drawn from the forthcoming report.

SIGNIFICANT ACHIEVEMENTS/NEW TRENDS

The biotechnology revolution began in the 1970s and 1980s when scientists learned new techniques to alter precisely the genetic constitution of living organisms. The newer, most innovative biotechnologies are tremendously diverse and include gene transfer, embryo manipulation and transfer, plant regeneration, and perhaps the most widely known, recombinant DNA technology (rDNA) or "genetic engineering."

Table C-19. THE BUDGET PROPOSES AN 8 PERCENT INCREASE IN FEDERAL INVESTMENTS IN BIOTECHNOLOGY

(Dollar amounts in millions)

Department or Agency	Budget Authority			
	1991 Enacted	1992 Proposed	Dollar change	Percent change
Health and Human Services	3,296	3,557	+261	+8
Agriculture	119	139	+20	+17
Energy	110	140	+30	+27
National Science Foundation	130	132	+2	+2
Defense	118	123	+5	+4
Other Agencies ¹	17	17	—	—
Total, All agencies	3,788	4,107	+319	+8
(Directly-related activities—non-add)	1,663	1,810	+147	+9
(Broader science-based activities—non-add)	1,998	2,144	+146	+7
(Scale-up activities—non-add)	25	32	+7	+28

¹Includes the Department of Veterans Affairs and the Environmental Protection Agency.

American researchers developed much of the basic science of biotechnology and the United States continues to lead in the commercialization of most emerging biotechnology products. The new techniques have spawned an industry that has seen rapid growth. Since 1975, more than 400 start-up firms active in biotechnology have been founded. In addition, more than 200 established firms have diversified into biotechnology and there are more than 200 supply firms that support biotechnology with materials, equipment and services in the U.S. alone. Just a decade and a half after its beginnings, the U.S. biotechnology industry produced pharmaceuticals, diagnostic tests, and agricultural products worth close to \$2 billion.

Human Health

Biotechnology enables the identification, development and manufacture of disease-fighting substances and provides new techniques for delivering medicines to diseased parts of the body. Remarkable new medicines based on biotechnology are beginning to appear daily. The Food and Drug Administration (FDA) has approved a biotechnology-based vaccine for preventing hepatitis B and eleven other drugs for treating various diseases. More than 1000 clinical trials of new drugs and biologics are underway. A majority of these are for cancer or cancer-related conditions and more than 15 percent are for AIDS or HIV-related conditions. In addition, molecular genetics and biotechnology techniques have enabled the development of a new generation of methods for identifying the genetic causes of disease and aiding medical diagnoses.

Agriculture, Foods, and Animal Husbandry

Scientific advances from biotechnology have not been limited to medicines. Biotechnology is expected to play a major role in improving U.S. agriculture and protecting the environment. Biotechnology offers modern tools for agriculture that can improve nutrition, taste, appearance, and productivity of plant, animal and other food products. Enhancements of certain characteristics in vegetables are expected to provide increased resistance to insects, thus reducing the need for chemical pesticides. Companies are field testing a variety of crops

with enhanced resistance to specific viruses, insect pests, and safer herbicides.

An important boost for agricultural biotechnology is research funded through the Department of Agriculture's National Research Initiative. Included within the plant systems category is funding for a plant genome mapping program to locate genes which control economically important traits in crop plants and forest species. Results will help scientists more rapidly and precisely transfer genes to address environmental concerns and improve food quality and safety.

A group of research experts recently convened by the National Institutes of Health (NIH) recommended approving the use of bovine somatotropin (BST), a genetically engineered version of a naturally-occurring growth hormone, in the production of milk. When administered to dairy cattle, BST can increase milk production by as much as 20 percent.

Environment

Biotechnology holds great promise for the environment including products that will clean up the ecosystem, provide alternatives to chemicals, and perform other tasks such as mineral recovery. Bioremediation is a process that involves the use of microorganisms for cleanup of the environment. Certain microorganisms will feed on and degrade hazardous or toxic chemicals and produce environmentally safe substances as by-products. Recent experiments using bioremediation have demonstrated the value of microbes for cleanup of oil spills. Bioremediation is also used for cleansing soil contaminated with gasoline. Microbial degradation of waste and waste water forms the basis of a substantial portion of the waste industry. The availability of new microbial tools for waste management will provide an opportunity for new advances in productivity in this industry.

FEDERAL INVESTMENT

The key to future growth in U.S. biotechnology industry continues to be strong support for basic research and research training. This investment continues to produce the advances in technology that allow the industry to thrive. In 1992, the total Federal investment in biotechnology-related research is proposed

at approximately \$4.1 billion. Over 80 percent of this investment is supported through NIH. One of the most significant endeavors is the human genome project—designed to map the location of all the genes in the human body—supported by the Departments of Health and Human Services and Energy.

Twelve Federal agencies support programs directly related to or in support of biotechnology, including the Departments of Health and Human Services, Energy, Commerce, Defense, Agriculture, and Veterans Affairs, as well as the National Science Foundation, the National Aeronautics and Space Administration and the Environmental Protection Agency. Most of the support for basic biomedical research essential to the advancement of biotechnology has come from the National Institutes of Health. Many of the agencies are in fields that are poised for substantial growth, such as agricultural and environmental research. The private sector also provides about \$2 billion for biotechnology research and development, most of which is committed to specific product development.

The United States biotechnology and other industries were greatly assisted by the technology transfer policies initiated in 1980 and accelerated in the Bush Administration. These policies fostered joint R&D projects between industry and federally supported universities. More recently, this process was extended to federally owned and operated laboratories by protecting private sector commercial rights to subsequent discoveries. Such joint R&D allows industry to gain access to the most advanced government facilities. Implementation of the recently enacted Technology Transfer Act fosters competitiveness in, and commercialization of, biotechnology. Commercialization of university research in cooperation with U.S. industry is an important element of federally supported university research.

The Federal Government is providing strong encouragement for cooperative precompetitive biotechnology efforts among the public sector, university sector and private sector. Over the last five years, scientists at NIH have entered into more than 400 cooperative research and development agreements (CRADAs) with private industry. The majority of these have involved the development of biotechnology, in-

cluding a gene therapy for AIDS. Other Federal agencies such as the Food and Drug Administration and the Centers for Disease Control are entering into CRADAs.

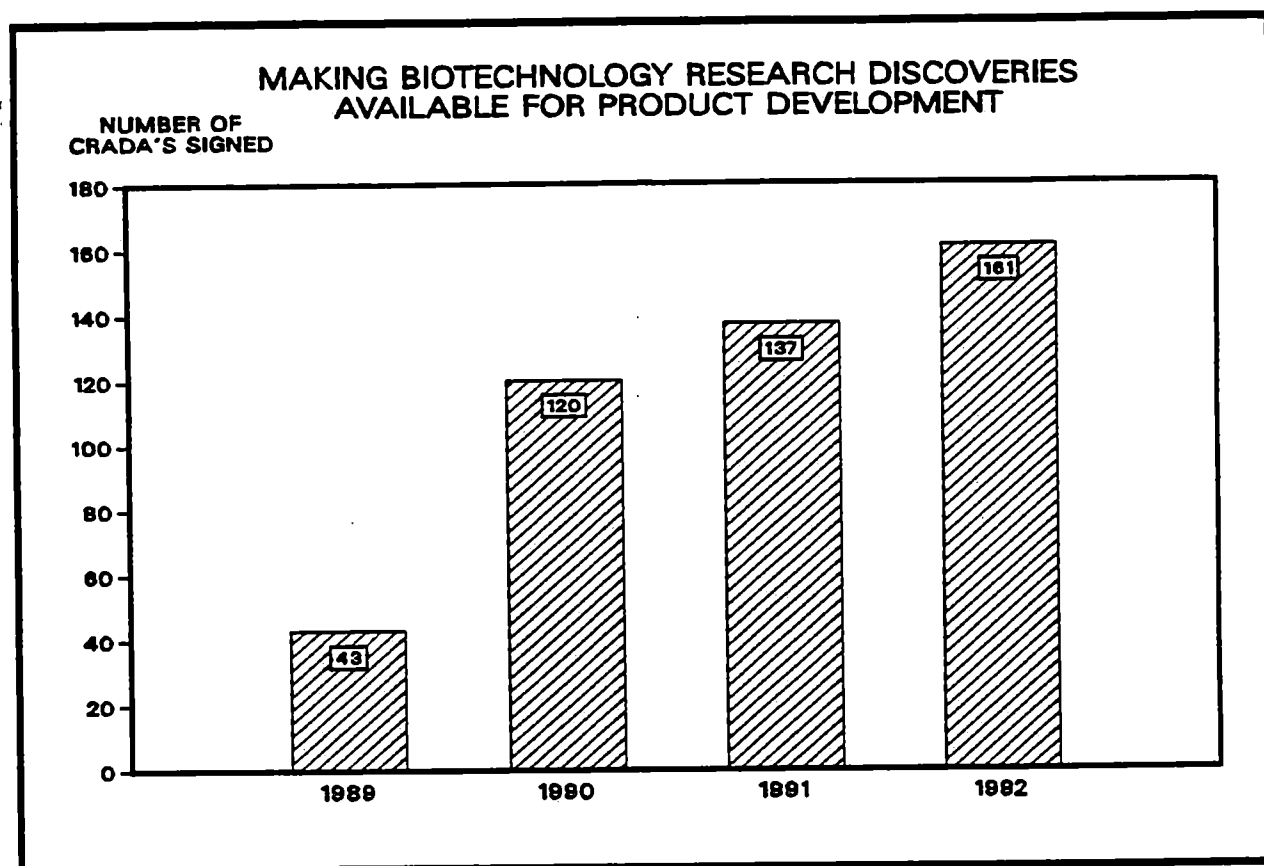
RESEARCH TRAINING

The development of biotechnology research and training centers is an additional approach that may prove effective in promoting interdisciplinary training and promoting industry/university research collaboration. The National Science Foundation now funds two biotechnology engineering research centers at the Massachusetts Institute of Technology and Montana State University. There are a number of other such centers, many established through State initiatives.

FEDERAL REGULATORY ENVIRONMENT

The 1986 Coordinated Framework established a roadmap for Federal regulation of biotechnology. The Framework was developed to address the concerns over the potential adverse impact of unnecessary regulation on biotechnology research and commercial applications and possible risks associated with using genetically engineered organisms in the environment. The Coordinated Framework focuses on the characteristics and risks of the biotechnology product, not the process by which it is created. This principle allows agencies to concentrate resources in areas that may pose greater risks and leaves relatively unfettered the development of biotechnology products posing little or no risk.

Based on the principles outlined in the Coordinated Framework, the Food and Drug Administration (FDA) announced that it did not need to establish new procedures for the review of new biotech-derived products. FDA's review of products based on a case-by-case assessment of risks would address any risks involved in new biotechnology products. The FDA established a system of user fees for the review of drugs and medical devices, including products that use techniques developed through biotechnology. User fees will enable the agency to speed its review of biotechnology products and, in turn, allow firms to bring their products to the marketplace sooner. The other two major regulatory agencies—the En-



vironmental Protection Agency (EPA) and the Department of Agriculture (USDA)—announced policies for developing additional rules and guidelines.

STRENGTHENING SCIENCE AND MATHEMATICS EDUCATION

There has been much debate about the health of our Nation's science and technology base and the need to improve this base so we can continue to compete in the global economy. This need is embodied in the national education goals that were established by President Bush and the Nation's Governors.

Since the spring of 1990, the interagency Federal Coordinating Council on Science, Engineering, and Technology's Committee on Education and Human Resources has been developing a strategy to achieve the national education goals related to math and science edu-

cation. The analysis began with an examination of the science and engineering pipeline.

There are few indicators of student preference for math and science prior to the last several years of high school. Yet after Grade 5, U.S. students' performance on international math and science tests begins to decline until by Grade 9 students score at the bottom. There has been a very stable thirty year pattern of only a few students (5 percent of 22 year olds) earning undergraduate math and science degrees that does not appear to be changing. It is estimated that less than 10,000, or 0.3 per-

cent, of the over 4 million 1972 5th graders will eventually obtain a science or engineering doctorate.

The conclusion from this analysis is that the national education goals can only be achieved if a balanced investment is made in attracting and retaining students throughout the science and engineering pipeline. However, in light of the performance problems mentioned above, it appears that there is a need for a special near-term emphasis on properly preparing and attracting students well in advance of college.

The budget proposes \$1,941 million for math and science education as a comprehensive step to help address the problems that limit the pool and performance of math and science learners. This represents an increase of \$225 million, or 13 percent, over the 1991 enacted level. At the precollege level, the initiative has

as its highest priority increasing the supply of, and improving the skills of precollege mathematics and science teachers. In addition, there will be increased emphasis on improving curricula, developing new educational technologies, and increasing student interest and performance in mathematics and science. Of the total increase of \$225 million, \$146 million is targeted toward the precollege level, a 28 percent increase over the 1991 enacted level. At the undergraduate level, the initiative focuses on enhancing undergraduate science, mathematics and engineering through curriculum improvements, faculty enhancement and student incentives. Graduate education programs are maintained at roughly the 1991 level. A much more detailed description of this math and science education initiative is included in Chapter IV.A., "Investing in Human Capital and Reforming American Education."

Remarks at the Presentation Ceremony for the National Medals of Science and Technology

October 18, 1989

Secretary Mosbacher and Secretary Sullivan, Dr. Bromley, and award-winning recipients and other distinguished scientists, ladies and gentlemen and friends: first, a welcome to the White House. And on behalf of every American, thank you for your magnificent efforts on behalf of this nation and, indeed, the whole world. It's an honor to address this singularly diverse and distinguished group of Americans and to present America's highest honor in the areas of science and technology: the National Medal of Science and the National Medal of Technology.

Three decades ago the National Medal of Science was created by Congress, and its purpose was to recognize individuals for their outstanding contributions to knowledge in the physical, biological, mathematical, or engineering sciences. And then 9 years ago the National Medal of Technology was established. Its purpose was to recognize scientists and engineers for projects that improve the well-being of the United States through the development or application of technology.

Over the past several decades these contributions and projects have helped make America a richer and better place. And new types of grain and fertilizers have spurred greater crop yields. Diagnostic technology has helped combat disease. And progress in biology and biotechnology has begun unmasking the secrets of heredity. And the work goes on through pioneers like you, for ours is a pioneering heritage, from Eli Whitney to Lee DeForest to the Salk vaccine for polio. And this year's 27 recipients of the Science and Technology Medals embody the best and brightest of that heritage, Americans inspired by the belief that the trailblazers of today will be the heroes of tomorrow.

Think just over our shoulder of just a handful of last year's recipients. Think of Edwin Land, who invented a plastic material that absorbed light of a specific polarization, or Maurice Hilleman, whose brilliant

discoveries in basic research and vaccine creation are combating infectious disease, or Rosalyn Yalow, whose breakthrough diagnostic technique is helping to save thousands of lives.

And think, too, of how another of last year's recipients has been a trailblazer in the aircraft industry. Since the 1940's, Kelly Johnson has designed more than 40 aircraft, including the world's largest aircraft and highest flying jet. And he not only led their development programs but on the maiden flights was the flight test engineer himself, putting his own life on the line, if you will. Like each of you, Kelly Johnson has shown that progress often comes neither quickly nor cheaply. And it demands devotion, sometimes even danger; it knows adversity and pain. And like each of you, he knows that dreams realized make possible even bigger dreams.

So, today we celebrate dreams that you are making possible—dreams that will keep America competitive, raise our standard of living, improve our quality of life. And your dreams presage a new, golden age of information, understanding, and technology and show how creativity comes from the human heart and mind. And so, in closing, let me first salute your achievements and your commitment. Many of you have been teachers, and some have served in the Government, and all have shown that America has no natural resource more precious than her intellectual resources. And next let me promise you that our administration will do its part. And if I fall down, I expect my able Science Advisor [D. Allan Bromley], friend to all in this room, to dust me off and push me back into the game so I don't forget.

We know that scientific knowledge must be renewed and expanded. And so, we will continue the American tradition of strong, broad-based support for the basic research and R&D in the areas of science and technology. The approach is going to be well-balanced and fair, and it includes both large science and technology projects as well as

Bromley reference

small science principal investigator funding. In large science and technology, look at the opportunities ahead: the superconducting supercollider and the human genome initiatives } or space station *Freedom*, which will lead us toward the stars. And then the small science potential is no less dazzling. We want to stay on the path to doubling the National Science Foundation budget—if Congress will cooperate—and give our youth a special incentive to excel in science, math, and engineering through our new program of National Science Scholars.

So, ladies and gentlemen, these priorities constitute an investment in our own future, strengthening the education which is crucial to that future. This investment in education is vital if America is to remain the leader in a very, very competitive world, both intellectually and commercially, and if science and technology are to uplift this generation, as you already have. You've done that. You've displayed your own con-

tribution in a brilliant way. You've inspired generations to come, as you must. For you are, in essence, our true pioneers, dreaming the dreams that enhance our energy and health, medicine, and productivity, national security, and education.

Again, my heartfelt congratulations on behalf of each and every citizen to you for your contributions. And now it is my great pleasure to introduce the Secretary of Commerce, Bob Mosbacher, and my Assistant for Science and Technology, Dr. Allan Bromley, who will describe your achievements. I like my end of the bargain somehow: I get to present you with America's highest technological and scientific award, and I also get to shake your hands. So, thank you very much, and thank you for your magnificent contribution not just to our country but to the people around the world.

Note: The President spoke at 2:09 p.m. in the East Room at the White House.

Nomination of Bradley Paul Holmes To Be Coordinator for International Communications and Information Policy at the Department of State *October 18, 1989*

The President today announced his intention to nominate Bradley Paul Holmes to be Coordinator for International Communications and Information Policy at the Department of State, with the rank of Ambassador. He would succeed Sonia Landau.

Since 1986 Mr. Holmes has served as chief of the policy and rules division in the mass media bureau at the Federal Communications Commission in Washington, DC. Prior to this, he served as legal adviser for Commissioner Dennis R. Patrick at the Federal Communications Commission in Wash-

ington, DC, 1984–1986; associate with the law firm of Scadden, Arps, Slate, Meagher and Flom in New York, 1981–1984; law clerk for the Honorable Mary Johnson Lowe, U.S. District Judge for the Southern District of New York, 1979–1981; and an associate with Windels, Marx, Davies and Ives in New York, 1978–1979.

Mr. Holmes graduated from Dartmouth College (B.A., 1975) and Georgetown University Law Center (J.D., 1978). He was born September 14, 1953, in Boston, MA. Mr. Holmes resides in Falls Church, VA.

mote international understanding and cooperation depends, in large part, on our ability to understand the languages, customs, and beliefs of other peoples, as well as the physical circumstances in which they live.

Despite the importance of public awareness of world geography, statistics indicate that many Americans lack basic knowledge in this field. For example, a survey sponsored by the Federal Government found that many of the Nation's 12th graders do not know that the Mississippi River flows into the Gulf of Mexico. The Department of Education reports that one-third of all adults in the United States cannot name any of the countries that belong to the North Atlantic Treaty Organization, and a National Governors' Association report approximately two years ago indicated that one in seven adults could not locate the United States on a globe. Although such findings underscore the dire need to improve general knowledge of the subject, geography as a distinct discipline has been disappearing from academic curricula around the country.

Fortunately, however, the Administration and the Nation's Governors are working to revitalize America's educational system through efforts that include renewed emphasis on the basics. By raising our expectations and reaffirming the value of learning—including the study and mastery of elementary geography—we can better equip young Americans for the challenges and opportunities of the future.

To focus attention on the importance of the study and mastery of geography, the Congress, by Senate Joint Resolution 323, has designated the week of November 11 through November 17, 1990, as "Geography Awareness Week" and has authorized and requested the President to issue a proclamation in observance of this week.

Now, Therefore, I, George Bush, President of the United States of America, do hereby proclaim the week of November 11 through November 17, 1990, as Geography Awareness Week. I urge all Americans to observe this week with appropriate programs, ceremonies, and activities.

In Witness Whereof, I have hereunto set my hand this thirteenth day of November, in the year of our Lord nineteen hundred and ninety, and of the Independence of the

United States of America the two hundred and fifteenth.

George Bush

[Filed with the Office of the Federal Register, 2:08 p.m., November 13, 1990]

Remarks at the Presentation Ceremony for the National Medals of Science and Technology

November 13, 1990

Welcome, everybody. Thank you all. Please be seated. And delighted to see you here. Pleased to see Secretary Mosbacher, our Secretary of Commerce; Secretary Watkins, Secretary of Energy; and of course, Dr. Bromley; Admiral Truly, right here in front, of NASA. Mike—Governor Castle, good to see you, sir. And we especially want to greet our honored guests, this extraordinary gathering of scientific and technological genius. Welcome to the White House, and welcome to the presentation of the 1990 National Medals of Science and the National Medals of Technology.

The timing of these awards is fortuitous. A year ago this week, Barbara and I awarded medals to some of the artistic giants of our time: Alfred Eisenstaedt and Dizzy Gillespie and John Updike, among others. And with all that assembled talent, guess what led the evening news: the Rose Garden presentation of the national turkey. [Laughter] So, you're in luck. [Laughter] This year the turkey doesn't get here until Thursday. [Laughter]

And this gathering marks a proud moment for me, just as it was when this year's Nobel Prizes were announced and it turned out that eight of the nine winners in science and economics were born in the United States of America. It is, indeed, a tribute to America's frontier spirit and to our nation's steadfast resolve and sense of the future. For when it comes to leadership in science and technology, best in America means best in the world.

America's tradition of excellence has long been nurtured by a tradition of free inquiry aimed at the simple goal of better under-

standing ourselves and the world. In the 1945 report that led to the founding of the NSF, the National Science Foundation, Vannevar Bush—no relation—wrote that “As long as scientists are free to pursue the truth wherever it may lead, there will be a flow of new scientific knowledge to those who can apply it to practical problems.”

And so it is today. More and more, nearly every product, from electronics to agriculture, incorporates the latest in technology. And more and more, our nation depends on basic scientific research to spur economic growth, longer and healthier lives, a more secure world and, indeed, a safer environment.

Today our government must help carry that research forward and contribute to the development of generic technologies that build on basic discoveries. If America is to maintain and strengthen our competitive position, we must continue not only to create new technologies but learn to more effectively translate those technologies into commercial products. In this way, we can help leverage the R&D of the private sector, helping whole industries advance in an increasingly competitive global market.

The budget highlights our administration's commitment to science and technology. We won double-digit increases for both NASA and the NSF and expanded funds to investigate global climate change. We remain committed to doing even more, doubling the NSF budget over 5 years and extending the tax credit for R&E, research and experimentation.) And we're going to keep raising America's sights. Space station *Freedom* will give us a permanent presence in Earth orbit, and the Space Exploration Initiative will take us to the Moon and Mars and beyond—back to space, back to the future, and this time back to stay.

Thirty years from now, when the Nobel Prizes are announced, I want America to be well represented. And 30 years from now, when the Medals of Science and of Technology are bestowed, I want to see America graced by a group as accomplished as that here today. Many of today's honorees serve as prime examples of how we can effectively translate basic science into commercial technology. I think of Millie Dresselhaus,^① arguably the most important and prominent woman physicist and engineer of her gen-

eration, whose hard work helped to revolutionize semiconductors, or Allan Cormack,^② whose pioneering efforts earned him a Nobel Prize and made CAT scan a household word, and scholars as diverse as Boston's Baruj Benacerraf or Seattle's Donnal Thomas,^③ another Nobel laureate, whose contributions to immunology may lead to new answers in our battle against cancer and AIDS. Scientists like you have, indeed, helped America to understand that AIDS is a disease, not a disgrace. And scientists like you who have helped America to appreciate our responsibility to those who are living with HIV and AIDS. And they deserve our compassion, they deserve our care, and they deserve more than a chance: They deserve a cure.

Another legacy of these prestigious medals and the work they honor must be the cultivation of excellence in science and math in classrooms across America. The National Science Scholars program we proposed soon after taking office has now been enacted and will encourage budding scholars of today to become the scientists of tomorrow. Guiding our efforts is an ambitious but critical goal for this decade: By the year 2000, U.S. students will be first in the world in science and math.

7 America 2000

This week is Education Week, and its theme is “Educating Everyone Takes Everyone,” a fitting motto for the challenges that lie ahead. If we are truly to remain a world leader in science and technology, then we must achieve a renaissance of quality in our schools and we must tap the talent, the energy, and the commitment of all our families, businesses, and universities.

The people we honor today are American trailblazers, real-life pioneers who pressed the very limits of their fields. You have distinguished not only yourselves but also your nation. And that's why America continues to need and want and appreciate your creativity, your genius, and your diversity.

Thank you. Congratulations to all. And God bless the United States. Thank you for coming.

Note: The President spoke at 2:01 p.m. in the East Room at the White House. In his remarks, he referred to D. Allan Bromley, Director of the Office of Science and Tech-

nology Policy; Richard H. Truly, Administrator of the National Aeronautics and Space Administration; and Gov. Michael Castle of Delaware.

Proclamation 6228—To Suspend Indefinitely the Import Quota on Cotton Comber Waste
November 13, 1990

By the President of the United States of America

A Proclamation

1. Presidential Proclamation No. 2351 of September 20, 1939, issued pursuant to section 22 of the Agricultural Adjustment Act of 1933, as amended (7 U.S.C. 624) (the Act), limited the total quantity of cotton waste that may be entered in any 12-month period beginning September 20 in any year and provided country-specific allocations of such quantity. This action was taken in order that the entry of cotton waste would not render or tend to render ineffective, or materially interfere with, the programs with respect to cotton undertaken by the Department of Agriculture.

2. In accordance with section 22 of the Act, the Secretary of Agriculture has advised me that he has reason to believe that the quantitative restrictions on imports of cotton comber waste, wherever classified in the Harmonized Tariff Schedule of the United States (HTS), should be terminated or modified because the circumstances requiring the imposition of the restrictions have changed and the quota is being underutilized.

3. Based upon this advice, I directed the United States International Trade Commission (the Commission) to initiate an investigation under section 22(d) of the Act (7 U.S.C. 624(d)) to determine whether the quota on cotton comber waste should be terminated or modified, including globalizing country quota allocations, eliminating the staple length restrictions on cotton used to make cotton comber waste, or distinguishing between bleached and unbleached cotton comber waste, or whether the quota should otherwise be adjusted to take ac-

count of circumstances that have changed since the quota was proclaimed.

4. After reviewing the facts and taking into account the report of the Commission based upon the investigation that it conducted, I have determined that the circumstances requiring the current import quotas on cotton comber waste do not exist at this time. Accordingly, I find that the quantitative restrictions imposed under section 22 of the Act on all imported cotton comber waste should be suspended indefinitely, and that the staple length restrictions on cotton comber waste should be eliminated.

5. Section 604 of the Trade Act of 1974 (19 U.S.C. 2483) authorizes the President to embody in the HTS the substance of the provisions of that Act, of other acts affecting import treatment, and actions taken thereunder.

Now, Therefore, I, George Bush, President of the United States of America, acting under authority vested in me by the Constitution and the laws of the United States of America, including but not limited to section 22 of the Act and section 604 of the Trade Act of 1974 (19 U.S.C. 2483), do hereby proclaim that:

(1) In subheading 9904.30.50 of the HTS, the title of quota quantity column (A), "Minimum Quota for certain comber wastes", is modified to read "Quota for cotton comber waste".

(2) In subheading 9904.30.50 of the HTS, the title of quota quantity column (B), "Unreserved Quota", is modified to read "Quota for other cotton wastes".

(3) In subheading 9904.30.50 of the HTS, the quota quantity column (C), with its title "Total Quota", is stricken.

(4) U.S. Note 3(b) to subchapter IV of chapter 99 of the HTS is deleted, and the words "See U.S. note 3(b) of this subchapter" in subheading 9904.30.50 of the HTS are deleted.

(5) The quantitative restrictions on imports of cotton comber waste, as provided under subheading 9904.30.50 of the HTS, as revised, are hereby suspended indefinitely.

(6) Proclamation No. 2351 is superseded to the extent inconsistent with this proclamation.

(7) This proclamation shall be effective with respect to articles entered, or with-

arou — Lear

y love,
are."

Pussycat [1871],
st. 1

1 elegant fowl!
sing!
we have tarried:
ring?"
r and a day,
g-tree grows
sy-wig stood
his nose.

Ib. st. 2

o sell for one shil-

y, "I will."
Ib. st. 3

slices of quince,
ncible spoon;
edge of the sand,
of the moon.

Ib.

Jumbles live;
nd their hands are

a sieve.
umbles [1871], st. 1

loo!"

ack to me!
ilico Pie [1871], st. 1

Ib. st. 2

, or what,

of Swat³ [1877], l. 1

npetty Tree

at,
not see,
ver Hat.

Quangle Wangle's Hat
[1877], st. 1

andel
mpkins blow,
the woods
Bonghy-Bò.

er, if tell me you can, / What's
ou folks or to me? — EUGENE
at [1884]

Lear — Bernard

Two old chairs, and half a candle,
One old jug without a handle—

These were all his worldly goods.

*The Courtship of the Yonghy-
Bongy-Bò* [1877], st. 1

1 There he heard a Lady talking,
To some milk-white Hens of Dorking—
"Tis the Lady Jingly Jones! *Ib.* st. 2

2 "I would be your wife most gladly!"
(Here she twirled her fingers madly),
"But in England I've a mate!"
Ib. st. 5

3 When awful darkness and silence reign
Over the great Gromboolian plain,
Through the long, long wintry nights.
*The Dong with the Luminous
Nose* [1877], st. 1

4 When storm-clouds brood on the towering
heights
Of the hills of the Chunkly Bore.
Ib.

5 The Pobble who has no toes
Had once as many as we;
When they said, "Some day you may lose
them all"—
He replied, "Fish fiddle de-dee!"
The Pobble Who Has No Toes
[1877], st. 1

6 It's a fact the whole world knows,
That Pobbles are happier without their toes.
Ib. 6

7 Ploffskin, Pluffskin, Pelican jee!
We think no Birds so happy as we!
Plumpskin, Ploshkin, Pelican jill!
We think so then, and we thought so still.
The Pelican Chorus [1877], chorus

Samuel Smiles

1812-1904

8 The spirit of self-help is the root of all genu-
ine growth in the individual; and, exhibited
in the lives of many, it constitutes the true
source of national vigor and strength. Help
from without is often enfeebling in its effects,
but help from within invariably invigorates.
Self-Help [1859]

William Edmondstone Aytoun

1813-1865

9 Nowhere beats the heart so kindly
As beneath the tartan plaid!
Charles Edward at Versailles
[1849], l. 219

10 The deep, unutterable woe
Which none save exiles feel.
The Island of the Scots [1849],
st. 12

Henry Ward Beecher

1813-1887

11 A thoughtful mind, when it sees a nation's
flag, sees not the flag only, but the nation
itself; and whatever may be its symbols, its
insignia, he reads chiefly in the flag the gov-
ernment, the principles, the truths, the his-
tory which belongs to the nation that sets it
forth.
The American Flag

12 Where is human nature so weak as in the
bookstore!
Star Papers [1855]. *Subtleties of
Book Buyers*

13 Now comes the mystery.
Last words [March 8, 1887]

Claude Bernard

1813-1878

14 Observation is a passive science, ex-
perimentation an active science.
*Introduction à l'Étude de la Méde-
cine Expérimentale* [1865]¹

15 The science of life is a superb and daz-
zlingly lighted hall which may be reached
only by passing through a long and ghastly
kitchen.
Ib.

16 Science repulses the indefinite. *Ib.*

17 Science admits no exceptions; otherwise
there would be no determinism in science, or
rather, there would be no science.
Leçons de Pathologie Expérimentale [1872]

18 The stability of the *internal medium* is a
primary condition for the freedom and inde-
pendence of certain living bodies in relation
to the environment surrounding them.
*Leçons sur les Phénomènes de la
Vie Communs aux Animaux et aux
Végétaux* [1878-1879]²

19 All the vital mechanisms, varied as they
are, have only one object, that of preserving
constant the conditions of life in the internal
environment. *Ib.*

¹ *An Introduction to the Study of Experimental Medi-
cine*, translated by HENRY COPLEY GREENE.

² *Lessons on Reactions Common to Animals and Plants*,
translated by J. M. D. OLMSTEAD.

- ¹ True science teaches us to doubt and to abstain from ignorance.

From Bulletin of New York Academy of Medicine, vol. IV [1928], p. 997

- ² Science increases our power in proportion as it lowers our pride. *Ib.*
³ If I had to define life in a word, it would be: Life is creation. *Ib.*

- ⁴ A modern poet has characterized the personality of art and the impersonality of science as follows: Art is I: Science is We.

Ib.

- ⁵ Man can learn nothing unless he proceeds from the known to the unknown. *Ib.*

- ⁶ We must never make experiments to confirm our ideas, but simply to control them. *Ib.*

- ⁷ The mental never influences the physical. It is always the physical that modifies the mental, and when we think that the mind is diseased, it is always an illusion.

Pensées [1937]

Georg Büchner

1813-1837

- ⁸ The Revolution is like Saturn—it eats its own children. *Danton's Death [1835]*

John William Burgon

1813-1888

- ⁹ A rose-red city half as old as time.¹
Petra [1845]

Sören Kierkegaard

1813-1855

- ¹⁰ Life can only be understood backwards; but it must be lived forwards. *Life*

- ¹¹ All essential knowledge relates to existence, or only such knowledge as has an essential relationship to existence is essential knowledge.

Concluding Unscientific Postscript

- ¹² The absurd . . . the fact that with God all things are possible. The absurd is not one of the factors which can be discriminated within the proper compass of the understanding: it is not identical with the improbable, the unexpected, the unforeseen.

Fear and Trembling [1843]. Proble-mata: Preliminary Expectoration

¹ See Samuel Rogers, 416:3.

Bernard — Faber

John Louis O'Sullivan

1813-1895

- ¹³ Our manifest destiny is to overspread the continent allotted by Providence for the free development of our yearly multiplying millions.

United States Magazine and Democratic Review [July-August 1845]

Richard Wagner

1813-1883

- ¹⁴ O thou, my gracious evening star.

Tannhäuser [1845]

- ¹⁵ To be German means to carry on a matter for its own sake.

Deutsche Kunst und Deutsche Politik² [1867]

- ¹⁶ Ride of the Valkyries.

Die Walküre [1876]

- ¹⁷ The pure fool.

Parsifal [1882]

Henry Stevenson Washburn

1813-1903

- ¹⁸ We shall meet, but we shall miss him,
 There will be one vacant chair.

The Vacant Chair, st. 1

Thomas Osborne Davis

1814-1845

- ¹⁹ Come in the evening, or come in the morning,
 Come when you're looked for, or come without warning. *The Welcome, st. 1*

- ²⁰ Sheep without a Shepherd,
 When the snow shuts out the sky—
 Oh, why did you leave us, Owen?
 Why did you die?

Lament for the Death of Eoghan Ruadh O'Neill, st. 7

Frederick William Faber

1814-1863

- ²¹ Faith of our fathers! holy faith!
 We will be true to thee till death.

A Pledge of Faithfulness [1849]

- ²² Hark! Hark! my soul, angelic songs are swelling

O'er earth's green fields, and ocean's wave-beat shore;

² German Art and German Politics.

Faber — De

How sweet the
 telling
 Of that new li

Mi

- ¹ A Hero of O
 a portrait, but
 a portrait con
 generation in
 ment.

- ² A solitary sail
 White in the b
 What is it in f
 What does it l

- ³ Beneath, the a
 Above, the gol
 Rebellious, the
 As if the storm

C

- ⁴ There's a good
 A good time co

Edwin

- ⁵ Now he [Linc

Ott

- ⁶ The great que
 cided by speech
 — that was the
 by iron and bloc

- ⁷ Politics is not

¹ Translated by C.

² Eisen und Blut.

³ Politics is not a sc
 speech [March 15, 18
 Politics is the art

- ¹ The imperatives of technology and organization, not the images of ideology, are what determine the shape of economic society.

Ib.

- ² We are becoming the servants in thought, as in action, of the machine we have created to serve us.

Ib.

- ³ The enemy of the market is not ideology but the engineer.

Ib.

- ⁴ The individual serves the industrial system not by supplying it with savings and the resulting capital; he serves it by consuming its products.

Ib.

- ⁵ It was with Malthus and Ricardo that economics became the dismal science.¹

The Age of Uncertainty [1977], ch. 1

Lyndon Baines Johnson

1908–1973

- ⁶ Come now, let us reason together.²

Saying

- ⁷ I am a free man, an American, a United States Senator, and a Democrat, in that order.

Quoted by ADLAI STEVENSON in his introduction to JOHNSON, A Time for Action [1964]

- ⁸ All I have I would have given gladly not to be standing here today.

First address to Congress as President [November 27, 1963]

- ⁹ We have talked long enough in this country about equal rights. We have talked for a hundred years or more. It is time now to write the next chapter—and to write in the books of law.

Ib.

- ¹⁰ Unfortunately many Americans live on the outskirts of hope—some because of their poverty, some because of their color, and all too many because of both. Our task is to help replace their despair with opportunity.³

First State of the Union Message [January 8, 1964]

- ¹¹ The challenge of the next half century is whether we have the wisdom to use [our] wealth to enrich and elevate our national life—and to advance the quality of American civilization.

Speech at the University of Michigan [May 22, 1964]

¹ See Carlyle, 474:11.

² See Isaiah 1:18, 28:30.

³ See Michael Harrington, 908:5.

Galbraith — Murrow

- ¹² We still seek no wider war.

Radio/television speech [August 4, 1964] on the Gulf of Tonkin resolution

- ¹³ This nation, this generation, in this hour, has man's first chance to build a Great Society,⁴ a place where the meaning of man's life matches the marvels of man's labor.

Address, accepting the presidential nomination [August 1964]

Otto Kerner, Jr.

1908–1976

- ¹⁴ Our nation is moving toward two societies—one black, one white—separate and unequal.

Report of the National Advisory Commission on Civil Disorders [1968], p. 1

Abraham Harold Maslow

1908–1970

- ¹⁵ A musician must make music, an artist must paint, a poet must write, if he is to be ultimately at peace with himself. What a man can be, he must be.

Motivation and Personality [1954]

Edward Roscoe Murrow

1908–1965

- ¹⁶ This—is London.

Opening phrase for broadcasts from London during World War II [1939–1945]

- ¹⁷ We must not confuse dissent with disloyalty.

See It Now (broadcast). Report on Senator Joseph R. McCarthy [March 7, 1954]

- ¹⁸ We will not be driven by fear into an age of unreason if we . . . remember that we are not descended from fearful men, not from men who feared to write, to speak, to associate and to defend causes which were, for the moment unpopular.

Ib.

- ¹⁹ I am entirely persuaded that the American public is more reasonable, restrained and mature than most of the broadcast industry planners believe. Their fear of controversy is not warranted by the evidence.

Speech at the Radio and Television News Directors Convention, Chicago [October 15, 1958]

⁴ See Lippmann, 814:1.

Murrow — Roethke

In order to progress, rather than backward, to the time when things were not allowed on and there was no middle compromise, when radio was raw and fast.

Theodore Roethke

1908–1962

My secrets cry aloud.
I have no need for tongue
My heart keeps open house
My doors are widely flung
Open

Thought does not crush truth
The great sledge drops in
Truth never is undone;
His shafts remain.

The Ad

For something is amiss
When mice with wings
face.

This urge, wrestle, resurrect
Cut stems struggling to
What saint strained so
Rose on such lopped limb
Cl

Nothing would sleep in

Nothing would give up
Even the dirt kept breath

Tugging all day at perversity
The indignity of it!

The

And afterwards I always
back over the loggia
As if I had broken the neck
in that swampland;
Disturbed some rhythm
portance,
By pulling off flesh from
As if I had committed
scheme of life, a de
M

The whiskey on your breath
Could make a small boy
But I hung on like death
Such waltzing was not
My Papa

I study the lives on a leaf
Sleepers, numb nudger
Beetles in caves, newts

passions, the emotions—it becomes sterile, silly, and actually without substance.

Isaac Bashevis Singer's Universe, interview with Richard Burgin in the New York Times Magazine [December 3, 1978]

- 1 Man cannot live without self-control. *Ib.*
- 2 When you betray somebody else, you also betray yourself. *Ib.*
- 3 Doubt is part of all religion. All the religious thinkers were doubters. *Ib.*
- 4 I never say the universe was an accident. The word "accident" should be erased from the dictionary. *Ib.*
- 5 Our knowledge is a little island in a great ocean of non-knowledge. *Ib.*
- 6 Originality is not seen in single words or even sentences. Originality is the sum total of a man's thinking or his writing. *Ib.*

Burrhus Frederic Skinner

1904–

7 The one fact that I would cry from every housetop is this: the Good Life is waiting for us—here and now! . . . At this very moment we have the necessary techniques, both material and psychological, to create a full and satisfying life for everyone.

Walden Two [1948], ch. 23

- 8 I remember the rage I used to feel when a prediction went awry. I could have shouted at the subjects of my experiments, "Behave, damn you, behave as you ought!" Eventually I realized that the subjects were always right. It was I who was wrong. I had made a bad prediction. *Ib.* 32
- 9 We shouldn't teach great books; we should teach a love of reading.
From R. EVANS, B. F. Skinner: The Man and His Ideas [1968]
- 10 The real problem is not whether machines think but whether men do.
Contingencies of Reinforcement [1969], ch. 9
- 11 We do not choose survival as a value; it chooses us.
Transcript of television program [October 17, 1971]
- 12 We are all controlled by the world in which we live, and part of that world has been and will be constructed by men. The question is

Singer — Fulbright

tyrants, or by ourselves in effective cultural design?

Cumulative Record [third edition, 1972], ch. 1

- 13 Physics does not change the nature of the world it studies, and no science of behavior can change the essential nature of man, even though both sciences yield technologies with a vast power to manipulate their subject matters. *Ib.* 5

Jane Ace

1905–1974

- 14 Time wounds all heels.¹
From GOODMAN ACE, The Fine Art of Hypochondria; or, How Are You? [1966]

James William Fulbright

1905–

- 15 There is an inevitable divergence, attributable to the imperfections of the human mind, between the world as it is and the world as men perceive it.
Speech in the Senate [March 27, 1964]
- 16 We are handicapped by [foreign] policies based on old myths rather than current realities. *Ib.*
- 17 A policy that can be accurately, though perhaps not prudently, defined as one of "peaceful coexistence." *Ib.*
- 18 There is much cant in American moralism and not a little inconsistency. *Ib.*
- 19 We are inclined to confuse freedom and democracy, which we regard as moral principles, with the way in which these are practiced in America—with capitalism, federalism and the two-party system, which are not moral principles, but simply the accepted practices of the American people. *Ib.*
- 20 The master myth of the cold war is that the Communist bloc is a monolith, composed of governments which are not really governments at all, but organized conspiracies . . . all equally resolute and implacable in their determination to destroy the free world. *Ib.*
- 21 We must dare to think "unthinkable" thoughts. We must learn to explore all the options and possibilities that confront us in a complex and rapidly changing world. We must learn to welcome and not to fear the

Fulbright — Kunitz

voices of dissent. We about "unthinkable things become unthr and action becomes m

The Arrogance of P

Greta Garbo [C

19

I want to be alone.

Dag Har

190

What gives life it and lose. But never above all for "the Th

The longest journey is the journey inward Of him who has cho

He who has nothi gift is God's—to Go

Lillian

There are people all the people on it locusts. And other and watch them ea

For every man w the rest of us mus Watch o

Lonely people t make each other l The Au

I am most willi about myself . . . now or in the futu people who, in 1 them, were compl or any action that Letter t Un-Am 1952]

I cannot and w fit this year's fas

Garbo maintains t always been misquot let alone!" — JOHN

Isherwood — Neruda

t, carry us all to destruc-
Ib.

Day Lewis

1904-1972

for I
lightning's hour,
pride,
power.

Tempt Me No More, st. 1

Neruda

to Reyes y Basualto]

1904-1973

addrest poem tonight.
night is starry bright
bs are shivering far

addrest poem tonight.
netimes she loved me too.
*Love Poems and a Song of
Veinte Poemas de Amor y
ción Desesperada* [1924].
*Write (Puedo Escribir)*¹

d of being a man
tailor shops and movie

able, like a felt swan
ter of sources and ashes.
*ia en la Tierra (Residence
, series II [1935]. Walking*

use,
in.
*s III [1947]. I Explain
Things (Explico Algunas*

ow of Spain

Ib.

ne are born bullets
eek out in you

es. Ib.

the same goal: to convey
are. And we must pass
id difficulty, isolation and
o reach forth to the en-
iere we can dance our
sing our sorrowful song
e or in this song there are
ancient rites of our con-

L. PHILLIPS.
D. D. WALSH.

Neruda — Singer

science in the awareness of being human and
of believing in a common destiny.

*Toward the Splendid City, upon
receiving the Nobel Prize [1971]*

What a great language I have, it's a fine
language we inherited from the fierce Con-
quistadors . . . They carried everything off
and left us everything . . . They left us the
words.

*Memoirs (Confieso Que He Vivido:
Memorias) [1974],¹ ch. 2*

Night in Valparaíso! . . . The immense
deserted night set up its formation of colossal
figures that seeded light far and wide. Al-
debaran trembled, throbbing far above, Cas-
siopeia hung her dress on heaven's doors,
while the noiseless chariot of the Southern
Cross rolled over the night sperm of the
Milky Way. Ib. 3

Poetry is an act of peace. Peace goes into
the making of a poet as flour goes into the
making of bread. Ib. 6

I continue to work with the materials I
have, the materials I am made of. With feel-
ings, beings, books, events, and battles, I am
omnivorous. I would like to swallow the
whole earth. I would like to drink the whole
sea. Ib. 11

Poetry is a deep inner calling in man; from
it came liturgy, the psalms, and also the con-
tent of religions. Ib.

J. Robert Oppenheimer²

1904-1967

In some sort of crude sense which no vul-
garity, no humor, no overstatement can quite
extinguish, the physicists have known sin;
and this is a knowledge which they cannot
lose.³

*Physics in the Contemporary
World, lecture at Massachusetts
Institute of Technology [November
25, 1947]*

The open society, the unrestricted access to
knowledge, the unplanned and uninhibited
association of men for its furtherance—these
are what may make a vast, complex, ever
growing, ever changing, ever more special-

Translated by HARDIE ST. MARTIN.

For the passage quoted by Oppenheimer at the explo-
sion of the first atom bomb [Alamogordo, New Mexico,
July 16, 1945], see *Bhagavad Gita*, 94:15. He also
quoted Vishnu from the *Gita*: I am become death, the
destroyer of worlds.

See Adlai Stevenson, 85:115.

ized and expert technological world, never-
theless a world of human community.

*Science and the Common
Understanding [1953]*

Sidney Joseph Perelman

1904-1979

8 One Touch of Venus.

*Title of play [1943] (with OGDEN
NASH)*

9 Crazy Like a Fox.

Title of book [1944]

Isaac Bashevis Singer

1904-

10 When literature becomes overly erudite, it
means that interest in the art has gone and
curiosity about the artist is what's most im-
portant. It becomes a kind of idolatry.

*Isaac Bashevis Singer Talks . . .
About Everything, interview with
Richard Burgin in the New York
Times Magazine [November 26,
1978]*

11 It seems that the analysis of character is
the highest human entertainment. And liter-
ature does it, unlike gossip, without mention-
ing real names. Ib.

12 When the writer becomes the center of his
attention, he becomes a nudnik. And a nud-
nik who believes he's profound is even worse
than just a plain nudnik. Ib.

13 We know what a person thinks not when
he tells us what he thinks, but by his actions. Ib.

14 The greatness of art is not to find what is
common but what is unique. Ib.

15 Sometimes love is stronger than a man's
convictions. Ib.

16 If you write about the things and the peo-
ple you know best, you discover your roots.
Even if they are new roots, fresh roots . . .
they are better than . . . no roots. Ib.

17 What nature delivers to us is never stale.
Because what nature creates has eternity in
it. Ib.

18 The very essence of literature is the war
between emotion and intellect, between life
and death. When literature becomes too
intellectual—when it begins to ignore the

9 September 1991

MEMORANDUM FOR DAN MCGROARTY

FROM: JEANNIE BUNTON

SUBJECT: NAT'L MEDAL OF SCIENCE AND TECHNOLOGY

GENERAL INFO:

- 0 284 National Medals of Science awarded since Kennedy named Dr. Theodore von Karman first recipient in 1962; 8 posthumous awards, (Kennedy remarks enclosed);
- 0 50 individuals and 2 companies have received the MOT, first medals awarded in 1985, (Reagan remarks enclosed);

THIS YEARS RECIPIENTS INCLUDE:

- 0 recipients are well-published, hold honorary degrees, are visiting professors at universities int he United States, England and Europe, have teaching experience, and continue to be involved in the classroom

- 0 ⁶ ~~five~~ Nobel Laureates -- Elion (1988 co-winner); Luria ^{deceased} (1969); Schawlow (1981), and Seaborg (1951), Weinberg (1979); *Herschbach Co-winner 1968*

- 0 seven MOS recipients were nominated for the Medal for the first time,

- 0 Four recipients are Phi Beta Kappa;

NEAT IDEAS YOU TOSSED OUT:

- 0 "not only are they inventors, but they invented their own fields, some have invented their own languages (Hopper - COBOL, and Breslow - "anti-aromaticity";
- 0 comparisons or parallels - atmosphere (ecologically) to atmosphere (outer space); computers to G-force testing to Voyager missions

MEDAL OF TECHNOLOGY:

- 0 18 recipients (2 posthumous) awarded by Commerce;
- 0 Oldest - Admiral Grace Hopper, 89 or 90 years old, (may not be attending), invented the term "bug" as relates to computer programming problems, worked with first large-scale digital computer - Mark 1, wrote its programming manual, led the development of the first English language compiler which was a major input to COBOL;
- 0 Youngest - the Pegasus Team, mid 40s, invented, developed and produced the Pegasus Rocket, the world's first privately

developed space launch vehicle. First all-new unmanned launch vehicle to be developed in the U.S. in 20 years;

OTHER NOTABLE INFO:

- 0 Dr. Carl Djerassi invented the first oral contraceptive for which won the National Medal of Science in 1973;
- 0 Robert Galvin - first to win both the Malcolm Baldrige award and the National Medal of Technology;
- 0 Stephen Bechtel - presently playing a major role in the reconstruction of Kuwait;
- 0 Col. John Stapp - G-force testing for manned space flights, was subject of his own experiments because students wouldn't do it;
- 0 Dr. Kenneth Iverson - revitalizing the domestic specialty steel industry;

MEDAL OF SCIENCE:

- 0 20 MOS recipients (1 posthumous) awarded by NSF;
- 0 Oldest - Folke Skoog, 83, C. Leonard Prof. of Botany Emeritus, Univ. of Wisconsin, awarded for pioneering work on plant hormones, discovered a major class of plant hormones;
- 0 Youngest(s) - George H. Heilmeyer, 55, former White House Fellow (70-71) served as special assistant to the Secretary of Defense, Sr. VP and Chief Technological Officer at Texas Instruments, awarded for technological competitiveness, pioneered work on liquid crystal displays at RCA, Director of the Defense Advanced Research projects, served on advisory committee to NASA, twice received the DOD Distinguished Civilian Service Medal - the highest civilian award in DOD;

and -

Edward Stone, 55, Prof. of Physics, CIT (commencement address there), for the Voyager Space mission, also active in television science program planning;

OTHER NOTABLE INFO:

- 0 Mary Eden Avery - cutting trip to Crimea short to receive award;
- 0 Ronald Breslow - bringing 84 year old dad along, introduced the concept of BIOMETIC CHEMISTRY, a term he introduced, coined the term "anti-aromaticity"

- 0 Gertrude B. Elion - 1988 NOBEL (co-winner), will be named to the Women's Hall of Fame in a November ceremony to be held in the District for her pioneering work that helped develop drugs to combat leukemia, malaria, herpes, and immune system disorders. Techniques she helped devise led to the development of the AIDS drug AZT, Presidential appointee on National Cancer Advisory Board;
- 0 G. Evelyn Hutchinson (posthumous) nephew flying in from London to accept award;
- 0 Elvin A. Kabat - former students include one Nobel Laureate;
- 0 Arthur Schawlow - invented the laser, for which won a Nobel prize in Physics 1981, 73 California Scientist of the Year, 2 awards established in his name
- 0 H. Guyford Stever - former director of NSF, former President's science advisor (76-77 Nixon and Ford) "nice to be on receiving end instead of handing them out", chair the White House Energy R&D Advisory Committee;
- 0 Glen T. Seabory - member, President's Science Advisory Committee (59-61);
- 0 Paul Marks - former member of the President's Biomedical Research Panel;

TALKING POINTS FROM OSTP:

- 0 Neato quotes by Huxley and Oppenheimer
- 0 para on administration commitment is pretty good
- 0 para on new Fellows announcement: first awards will be made in fiscal 92, up to 30 PFF planned each year, Federal Government;s most prestigious award for young U.S. science and engineering faculty, \$100,000 a year for five years to be used for research or teaching;
- 0 para on Heroes program - the foundation president (George Rathman) will be in the audience

OMB:

- 0 Budget includes a ⁶⁶¹~~\$662~~ million (28%) increase over 91 funding for precollege math and science ed. programs;
- 0 \$76 billion in 92 for research and development, including R&D facilities;
- 0 18% increase for NSF to a total of \$2.7 billion, continuing the commitment to double the NSF budget between 1987 and 1994;

0 \$638 million (increase of \$149 million or 30%) over 91 for new initiative in high performance computing and communications;

0 increase of \$225 million or 13% to \$1,941 million for math and science education. ~~28% of \$146 million targeted to precollege level;~~ *Of the total increase, \$146 million, a 28% increase is targeted toward the precollege level*

POTUS REMARKS FROM 89 and 90:

0 in each speech recognizes four recipients - that's all.

MEDAL OF SCIENCE AND TECHNOLOGY
Notes 9/9/91

Pending Acknowledgements:

Bromley, Mosbacher (both on dias with POTUS)

Dr. William Massey, dir. NSF will sit with medalist, unless he is asked to present (Mosbacher doesn't want to do it this year) extremely tentative

would be nice: (mentions that is)

George Rathman, president of the private sector foundation Heroes program (Commerce lobbied hard for a mention - brought up volunteerism and POLs)

The President's National Medal of Science



April 1991



The National Medal Of Technology

United States Department of Commerce • Washington, D.C. 20230

National Medal of Technology

RECIPIENTS

1990 Recipients

JOHN V. ATANASOFF, Iowa State University (Retired)

For his invention of the electronic digital computer, and for contributions toward the development of a technically-trained U.S. workforce.

MARVIN CAMRAS, Illinois Institute of Technology

For the development and commercialization of magnetic recording resulting in the creation of a new industry with over 125 licensees producing products such as audio and video cassettes, broadcast sound video, tapes and discs for computer memories, and magnetic sound for motion pictures.

THE DU PONT COMPANY, Edgar S. Woolard, Jr., COB and CEO

For pioneering the development and commercialization of high-performance man-made polymers such as nylon, neoprene rubber, "Teflon" fluorocarbon resin, and a wide spectrum of new fibers, films, and engineering plastics which have strengthened America's global competitiveness and benefitted mankind.

DONALD N. FREY, Northwestern University

For his management of a wide range of commercial applications of new technology while serving as a senior executive in different industries; and for subsequent teaching and research, as a Professor of Industrial Engineering and Management Science, on the principles of technology commercialization.

FRED W. GARRY, General Electric Corporation

For the design, manufacture and commercialization of high performance jet engines that lead the world in performance, efficiency, life-cycle cost, and minimal environmental impact; and for his leadership in establishing a technical information exchange and manufacturing alliances assuring the United States continuing global leadership in both commercial and military aircraft.

WILSON GREATBATCH, Wilson Greatbatch, Inc.

For invention, development and introduction into clinical usage of the implantable cardiac pacemaker resulting in saving over 2 million lives. This subsequently led to the development and commercialization of lithium batteries which greatly enhanced longevity and reliability of pacemakers and implantable devices.

JACK ST. CLAIR KILBY, Jack Kilby Company

For his invention and contributions to the commercialization of the integrated circuit and the silicon thermal print-head; for his contributions to the development of the first computer using integrated circuits; and for the invention of the hand-held calculator, and gate array.

JOHN S. MAYO, AT&T Bell Laboratories, Inc.

For providing the technological foundation for information age communications, and for overseeing the conversion of the national switched telephone network from analog to a digital-based technology for virtually all long distance call both nationwide and between continents.

GORDON E. MOORE, Intel Corporation

For his seminal leadership in bringing to American industry the two major postwar innovations in microelectronics — large-scale integrated memory and the microprocessor — that have fueled the information revolution.

DAVID B. PALL, Pall Corporation

For patenting and commercializing over 100 filtration and other fluid clarification products which have contributed significantly to society in safety of flight, upgrading of industrial products and processes and improved safety of blood transfusions; and for building Pall Corporation into a global company with 60% of sales outside the United States, primarily in Europe and Japan.

CHAUNCEY STARR, Electric Power Research Institute

For his original contributions to energy production and policy; for pioneering in nuclear power; for developing risk assessment and risk management concepts; for organizing the Electric Power Research Institute, a consortium; for leadership in engineering education and contributions to a technically-trained U.S. workforce.

1989 Recipients

**JAY W. FORRESTER, Massachusetts Institute of Technology &
ROBERT R. EVERETT, The MITRE Corporation**

For their creative work in developing technologies and applying computers to real-time applications. Their important contributions proved vital to national and free world defense and opened a new world business.

**HELEN EDWARDS, RICHARD A. LUNDY, J. RICHIE ORR, &
ALVIN TOLLESTRUP, Fermi National Accelerator Laboratory**

For their contributions to the design, construction, and initial operation of the TEVATRON particle accelerator. This scientific instrument was designed to explore the fundamental properties of matter. The innovative design and successful operation of the TEVATRON has been crucial to the design of Superconducting Super Collider, the planned next generation particle accelerator.

**HERBERT W. BOYER, University of California In San Francisco &
STANLEY N. COHEN, Stanford University Medical Center**

For their fundamental invention of gene splicing techniques allowing replication in quantity of biomedically important new products, and beneficially transformed plant materials. This discovery of recombinant DNA technology has transformed the basic science of molecular biology and the biotechnology industry.

1988 Recipients

JOHN L. ATWOOD, Rockwell International Corporation

For distinguished leadership, technical competence, and integrity in the technological advancement of aviation and space travel.

ARNOLD O. BECKMAN, Beckman Instruments and SmithKline Beckman Corporation

For exceptional creativity in designing analytical instruments that are recognized as the best in the world and for developing a successful business whose products have helped to keep the United States in the forefront of chemistry, chemical engineering, and biotechnology.

PAUL M. COOK, Raychem Corporation

For his vision and entrepreneurial efforts, his technical accomplishments, and his business and technical leadership as the key contributor in creating a worldwide chemically based industry.

ROBERT H. DENNARD, IBM T.J. Watson Research Center

For invention of the basic, one-transistor dynamic memory cell used worldwide in virtually all modern computers.

HAROLD E. EDGERTON, EG&G Corporation and Massachusetts Institute of Technology

For the invention of the electronic stroboscopic flash and for finding a multitude of applications for it within science, technology and industry.

CLARENCE L. (KELLY) JOHNSON, Lockheed Corporation

For his outstanding achievements in the design of a series of commercial, military, and reconnaissance aircraft that incorporated a wide range of technological advancements, and for his innovative management techniques which helped develop and produce these aircraft in record time and at a minimum cost.

EDWIN H. LAND, Polaroid Corporation and The Rowland Institute for Science

For the invention, development, and marketing of instant photography.

DAVID PACKARD, Hewlett-Packard Company

For extraordinary and unselfish leadership in both industry and government, particularly in widely diversified technological fields which strengthened the competitiveness and defense capabilities of the United States.

RAYMOND DAMADIAN, FONAR Corporation & PAUL C. LAUTERBUR, University of Illinois

For their independent contributions in conceiving and developing the application of magnetic resonance technology to medical uses including whole body scanning and diagnostic imaging.

1987 Recipients

JOSEPH V. CHARYK, Communications Satellite Corporation

For employment of the concept of the geosynchronous communications satellite systems as the basis for a global telecommunications system, established by international agreement, and for his guidance in the development and growth of the intelsat system, which today services over 150 nations and territories.

W. EDWARDS DEMING, Private Consultant

For his forceful promotion of statistical methodology, for his contributions to sampling theory and for his advocacy to corporations and nations of a general management philosophy that has resulted in improved product quality with consequent betterment of products available to users as well as more efficient corporate performance.

JOHN E. FRANZ, Monsanto Corporation

For his discovery of the herbicidal properties of glyphosates which have had significant consequences upon the production of agricultural food and fiber as well as upon agricultural practices throughout the world.

ROBERT N. NOYCE, Intel Corporation

For his inventions in the field of semiconductor integrated circuits for his leading role in the establishment of the microprocessor which has led to much wider use of more powerful computers and for his leadership of R&D in these areas, all of which have had profound consequences upon which aspects of living, both in the United States and throughout the world.

1986 Recipients

BERNARD GORDON, Analogic Corporation

Father of high-speed analog-to-digital conversion which has been applied to medical, analytical, computer and communications products; founder of two companies with over 2,000 employees and over \$100 million in annual sales and creator of a new masters level institute located in Massachusetts to teach engineering leadership and project engineering to engineers.

REYNOLD B. JOHNSON, IBM Corporation

Introduction and development of magnetic disk storage for computers that provided access to virtually unlimited amounts of information in fractions of a second and is the basis for time sharing systems and storage of millions of records. Over \$10 billion in annual sales and over 100,000 jobs arose from this development.

WILLIAM C. NORRIS, Control Data Corporation

Advancement of microelectronics and computer technology and creation of one of the Fortune 500 — Control Data Corporation — which has over \$5 billion in annual sales and over 50,000 employees.

FRANK N. PIASECKI, Piasecki Aircraft Corporation

Development of the tandem rotor helicopter (Flying Banana), the compound aircraft (an innovative VTOL design), and other contributions to vertical lift aircraft, as well as creation of what has become the Boeing Vertol Company with annual sales over \$500 million and over 6,000 employees.

STANLEY D. STOOKEY, Corning Glass Works

Invention of glass-ceramics (used in Corning Wear, missile nose cones, and capacitors), of photosensitive glass (used in architectural effects), of photochromic glass (used in eyeglasses which darken and fade in response to light), and of photo-etchable glass. Over \$500 million in annual sales and over 10,000 jobs have resulted from his developments.

FRANCIS VERSNYDER, United Technologies Corporation

The development and application of directionally solidified and single crystal turbine components which improve fuel efficiencies and maintenance requirements for jet aircraft engines, both commercial and military, and which contribute to United States leadership in their production. These developments have saved commercial airlines alone hundreds of millions of dollars.

1985 Recipients

**FREDERICK P. BROOKES, JR., ERICH BLOCH & BOB O. EVANS,
IBM Corporation**

For their contributions to the development of the hardware, architecture and systems engineering associated with the IBM System/360, a computer system and technologies which revolutionized the data processing industry and which helped to make the United States dominant in computer technology for many years.

STEVEN P. JOBS & STEPHEN WOZNIAK, Apple Computer, Inc.

For their development and introduction of the personal computer which has sparked the birth of a new industry extending the power of the computer to individual users.

MARVIN M. JOHNSON, Phillips Petroleum Company

For his discovery and development of metals passivating agents for catalytic cracking catalysts which have become economically effective methods permitting refineries to process crude oils with higher metal contents, particularly heavy crude oil types, and have contributed to United States competitiveness in this technological area.

RALPH LANDAU, Halcon-Scientific Design Group

For his technical, leadership and entrepreneurial roles in the development of commercially successful petrochemical processes which have been licensed or jointly developed and have helped maintain U.S. leadership in petrochemical processing.

JOHN T. PARSON & FRANK L. STULEN, John T. Parsons Company

For their development and successful demonstration of the numerically-controlled machine tool for the production of three-dimensional shapes, which has been essential for the production of commercial airliners and which is seminal for the growth of the robotics, CAD-CAM, and automated manufacturing industries.

HAROLD A. ROSEN & ALLEN E. PUCKETT, Hughes Aircraft Company

For their technological contributions and leadership in the initiation and development of geostationary communications satellites, significantly improving worldwide communications and giving the United States international preeminence in the construction of commercial satellites.

JOSEPH F. SUTTER, Boeing Commercial Airplane Company

For his technical and managerial contributions to the development and introduction of generations of jet-powered commercial aircraft which have made the United States the predominant supplier of passenger transport aircraft.

AT&T BELL TELEPHONE LABORATORIES, INC., Ian M. Ross, President

For contributions over decades to modern communication systems.

U.S. Department of Commerce
Washington, D.C. 20230

U.S. DEPARTMENT OF COMMERCE



THE UNDER SECRETARY
FOR TECHNOLOGY
TECHNOLOGY ADMINISTRATION

FACSIMILE TRANSMITTAL SHEET

Number of Pages (including cover sheet): 20

Telephone Number: 202/377-1575

Fax Number: 202/377-4498

Room: HCHB 4824-C

Date: 9/5/91To: JEANNIE BUNTONAgency/Company: WHITE HOUSE RESEARCHFAX number: 456-1651

Telephone number: _____

* * * * *

From: **John F. Sargent**Division: **Director of Public Affairs**Telephone: **202/377-1397**

SPECIAL INSTRUCTIONS/MESSAGE:

AS PROMISED.

THE NATIONAL MEDAL OF SCIENCE

Authority:

Statutory authority for the National Medal of Science is contained in Public Law 86-209 of the 86th Congress (1959), which among other things states:

"The President shall from time to time award the medal, on the basis of recommendations received from the National Academy of Sciences or on the basis of such other information and evidence as he deems appropriate, to individuals who in his judgement are deserving of special recognition by reason of their outstanding contributions to knowledge in the physical, biological, mathematical, or engineering sciences."

The law also provides that the President shall prescribe the design of the Medal on the basis of recommendations by the National Science Foundation, that not more than twenty individuals may be awarded the Medal in any one calendar year, and that the presentation of the award shall be made by the President with such ceremonies as he may deem proper, including attendance by appropriate Members of Congress. A copy of Public Law 86-209 is included in Tab A.

Procedure:

Executive Order 10910: On January 17, 1961, President Eisenhower signed Executive Order 10910 prescribing the design of the National Medal of Science on the basis of recommendations made to him by the National Science Foundation. The Executive Order also required that each individual awarded the Medal receive a Presidential citation descriptive of the award. Tab B contains a copy of Executive Order 10910.

Executive Order 10961: On August 21, 1961, President Kennedy signed Executive Order 10961 specifying procedures for the award of the Medal. To assist the President this Executive Order established a President's Committee on the National Medal of Science consisting of not less than six nor more than twelve members, designated by the President from among appropriately qualified citizens of the United States representing a cross section of major fields of science, including engineering.

The procedures provided that the Committee receive the recommendations made by the National Academy of Sciences regarding the award of the Medal, together with "such similar recommendations as may be made by any other nationally representative scientific or engineering organization." The Committee was directed on the basis of such criteria, information, and evidence as it may deem appropriate to select its candidates for the award from among these recommendations, and to transmit its own recommendations and views to the President. In addition, the National Science Foundation was called upon to provide staff and administrative services necessary for the performance of the functions of the Committee. This Executive Order was revoked and superseded by Executive Order 11287 on June 28, 1966. Tab C contains a copy of this revoked Executive Order.

Executive Order 11287: Executive Order 11287, signed by President Johnson on June 28, 1966, continued the President's Committee on the National Medal of Science, now composed of twelve appointive members and one ex-officio member, the President of the National Academy of Sciences. Each appointive member serves without compensation for a term of three years and members of the Committee may be reappointed to serve one additional three year term. Terms of membership are staggered so that four new members are appointed (or reappointed as the case may be) each year. The Chairman of the Committee continues to be designated by the President.

No changes were made in the procedures under which the Committee receives, on behalf of the President, the recommendations of various nationally representative scientific or engineering organizations as well as the recommendations of the National Academy of Sciences. Nor were any changes made in the procedures set up under which the Committee makes and transmits its recommendations to the President.

The National Science Foundation is authorized to provide such assistance as may be necessary and appropriate to carry out the award and presentation of the National Medal of Science. The Foundation continues to provide the services of the Executive Secretary of the Committee. Tab D contains a copy of Executive Order 11287.

Executive Order 11502: Executive Order 11052 enlarges the membership of the Committee by designating the President's Science Adviser as an ex-officio member. Signed by President Nixon on December 22, 1969, the order amends the structure of the Committee so that it now contains twelve appointive members and two ex-officio members - the President's Science Adviser and the President of the National Academy of Sciences. Tab E contains a copy of Executive Order 11502.

Public Law 96-516: This public law, which is the NSF Authorization Act, dated December 12, 1980, amends the original Medal of Science Act (P.L. 86-209, dated August 25, 1959) to include the behavioral and social sciences in addition to the biological, physical, mathematical and engineering sciences. No other changes were made. Tab F contains a copy of the appropriate portion of P.L. 96-516.

* * * * *

THE PRESIDENT'S COMMITTEE ON THE NATIONAL MEDAL OF SCIENCE

Membership:

In February 1962, President Kennedy appointed the first 12 members of the President's Committee on the National Medal of Science and designated Dr. Frederick Seitz, President of the National Academy of Sciences and Professor of Physics at the University of Illinois, as Chairman.

In the intervening years there have been a number of changes in the Committee membership. In 1963, Dr. Frank Brink, Jr., of the Rockefeller Institute was designated as Chairman and at that time four new committee members were appointed, replacing four of the original members. In 1965, the President designated Dr. Herbert E. Carter of the University of Illinois as Chairman. In 1966, with the signing of Executive Order 11287, terms and rotation of membership were established and new members were appointed. Since 1966 four new members generally have been appointed to the Committee each year.

A listing of the membership of the Committee by year and a listing by term of the present Committee are given in Tab G.

In recent years the Committee has met in Washington in the fall for one to two days' duration to consider the recommendations it has received. In the early years of the Medal the members of the Committee met in small groups in Washington during the summer to examine and study in detail the various nominations prior to its regular fall meeting. However, the Committee recently has found that it can accomplish its work by meeting in a one or two day session in subgroups and as a whole; therefore, it has not met individually during the summer.

Criteria:

The Committee has established the following guidelines in selecting its candidates for the National Medal of Science:

- (a) The total impact of an individual's work on the present state of physical, biological, mathematical, engineering, behavioral or social sciences is to be the principal criterion. In addition, achievements of an unusually significant nature will be considered and judged in relation to the potential effects of such achievements on the development of scientific thought.
- (b) Distinguished service in the general advancement of science and engineering, when accompanied by substantial contributions to the content of science at some time, may be recognized.

These guidelines are essentially those which were established and promulgated by the Committee during its first year of operation. These guidelines have been reviewed and discussed in detail by each Committee during each succeeding year. In addition, they have been discussed with each Presidential Science Adviser.

Sources Solicited:

The Committee has traditionally invited a large number of sources to participate in the nominating procedures for the National Medal of Science. Letters of invitation are annually sent to approximately 150 universities and colleges in the country, to approximately 150 leading scientific and engineering professional societies and organizations, to all members of the National Academy of Sciences and the National Academy of Engineering.

Each year this solicitation involves about 3500 letters of invitation. A detailed listing of the organizations solicited is given in Tab H. Tab I contains a copy of the current solicitation letter and nomination form.

The solicitation has resulted in an average response each year of about 150 nominations. More than 9,000 nominations have been received since the Committee first came into existence in 1962. In making its recommendations the Committee studies carefully the nominations received for the current review period as well as all recommendations submitted for the same period.

Recipients:

A total of 264 National Medal of Science have been awarded since President Kennedy named Dr. Theodore von Karman as the first recipient in 1962. A listing of all recipients, by year, together with their institutional affiliation at the time of the award is given in Tab I. Seven posthumous awards have been made since the Medal was established.

National Medal of Science

THE NATIONAL MEDAL OF SCIENCE depicts Man, surrounded by earth, sea, and sky, contemplating and seeking to understand Nature. The crystal in his hand symbolizes the universal order and also suggests the basic unit of living things. The formula he is sketching in the sand symbolizes scientific abstraction.

1991 NATIONAL MEDAL OF TECHNOLOGY RECIPIENTS & PHONE NUMBERS**STEPHEN D. BECHTEL, JR.** ⁽¹⁾

Citation: For outstanding leadership in applying modern technology management principles within the Bechtel Group, a world-class engineering and construction firm.

Phone Number: 415/768-7600
Address: Chairman
Bechtel Group, Incorporated
50 Beale Street
P.O. Box 3965
San Francisco, CA 94119

CHESTER GORDON BELL ⁽²⁾

Citation: For his continuing intellectual and industrial achievements in the field of computer design; and for his leading role in establishing cost-effective, powerful minicomputers which serve as a significant tool for engineering, science and industry.

Phone Number: 415/325-2037
Address: Ardent Computer Company
850 Maude Avenue
Sunnyvale, CA 94086

JOHN COCKE ⁽³⁾

Citation: For development and implementation of Reduced Instruction Set Computer (RISC) architecture that significantly increased the speed and efficiency of computers, thereby enhancing U.S. technological competitiveness.

Phone Number: 914/765-6466
Address: IBM Thomas J. Watson Research Center
P.O. Box 218
Yorktown Heights, NY 10598

CARL DJERASSI ⁽⁴⁾

Citation: For his broad technological contributions to solving environmental problems; and for his initiatives in developing novel, practical approaches to insect control products that are biodegradable and harmless.

Phone Number: 415/723-2783
Address: Department of Chemistry
Stanford University
Stanford, CA 94305-5080

1991 NATIONAL MEDAL OF TECHNOLOGY RECIPIENTS

PAGE 2 OF 4

JAMES JOHNSON DUDERSTADT ⑤

Citation: For his excellence in the development and implementation of strategies for engineering education; and for his successes in bringing women and minorities into the nation's technological workforce.

Phone Number: 313/764-6270
Address: President
University of Michigan
2068 Fleming Administration Building
Ann Arbor, MI 48109-1340

ROBERT W. GALVIN ⑥

Citation: For advancement of the American electronics industry through continuous technological innovation, establishing Motorola as a world class electronics manufacturer.

Phone Number: 708/576-5300
Address: Chairman
Motorola Incorporated
1303 East Algonquin Road
Schaumburg, IL 60196

GRACE MURRAY HOPPER ⑦

Citation: For her pioneering accomplishments in the development of computer programming languages that simplified computer technology and opened the door to a significantly larger universe of users.

Phone Number: 703/521-0029
Address: 1400 S. Joyce Street A1614
Arlington, VA 22202

F. KENNETH IVERSON ⑧

Citation: For his concept of producing steel in minimills using revolutionary slab casting technology that has revitalized the American steel industry.

Phone Number: 704/366-7000
Address: Chairman & CEO
Nucor Corporation
4425 Randolph Road
Charlotte, NC 28211

*78 yr. old wife
Lucille will accept*

1991 NATIONAL MEDAL OF TECHNOLOGY RECIPIENTS
PAGE 3 OF 4

FREDERICK M. JONES/JOSEPH A. NUMERO *wife is receiving* ⑤

(Parties deceased, call their nominator Paul Lego, Chairman & CEO of Westinghouse Electric)

Citation: For revolutionizing the preservation and distribution of food and other perishables through their development of refrigeration technology for trucks, trailers, boxcars, ships and planes; and for the development of a worldwide sales and service network.

Phone Number:

412/642-4155

Address:

Westinghouse Electric Corporation
11 Stanwix Street
Pittsburgh, PA 15222

THE PEGASUS TEAM *14* ⑥

(Call the four team leaders listed below)

Citation: For their invention, development, and production of the Pegasus rocket, the world's first privately-developed space launch vehicle that opened the door to significantly increasing payloads in space.

DAVID W. THOMPSON

Phone Number:

703/631-3600

Address:

President and CEO
Orbital Sciences Corporation
12500 Fair Lakes Circle
Fairfax, VA 22033

ANTONIO L. ELIAS

Phone Number:

703/631-3600

Address:

Orbital Sciences Corporation
12500 Fair Lakes Circle
Fairfax, VA 22033

DAVID S. HOLLINGSWORTH

Phone Number:

302/655-0373

Address:

Senior Vice President/Engineering
Orbital Sciences Corporation
12500 Fair Lakes Circle
Fairfax, VA 22033

ROBERT R. LOVELL

Phone Number:

703/631-3600

Address:

President, Space Systems Division
Orbital Sciences Corporation
12500 Fair Lakes Circle
Fairfax, VA 22033

1991 NATIONAL MEDAL OF TECHNOLOGY RECIPIENTS**PAGE 4 OF 4****CHARLES E. REED**

Citation: For his management risk-taking in continuous innovation leading the General Electric Company to world class production of advanced engineering materials.

Phone Number: 203/374-3445
Address: 3200 Park Avenue
Bridgeport, Connecticut 06604

JOHN PAUL STAPP

Citation: Research on the effects of mechanical force on living tissue leading to safety developments in crash protection technology for automobiles, aircraft, trains, manned space flight and other modes of transportation.

Phone Number: 505/437-2840
Address: Research Consultant
1413 Rockwood
P.O. Box 553
Alamogordo, New Mexico 88311

GEOFFREY BOOTHROYD & PETER DEWHURST (18)

Citation: For their concept, development, and commercialization of Design for Manufacture and Assembly (DFMA), which has dramatically reduced costs, improved product quality and enhanced the competitiveness of major U.S. manufacturers.

GEOFFREY BOOTHROYD

Phone Number: 401/792-5187
Address: Director of Graduate Studies
IME Department
University of Rhode Island
Gilbreth Hall
Kingston, Rhode Island 02881

PETER DEWHURST

Phone Number: 401/792-2186
Address: Director of the DEM Center
University of Rhode Island
Gilbreth Hall
Kingston, Rhode Island 02881

PRESIDENT'S COMMITTEE ON THE NATIONAL MEDAL OF SCIENCE
NATIONAL SCIENCE FOUNDATION
WASHINGTON, D. C. 20550

MEMORANDUM

TO: Jeannie Bunton, ~~SP. ASSISTANT~~
DATE: September 9, 1991
SUBJECT: Background information - 1991 Medal of Science
Recipients

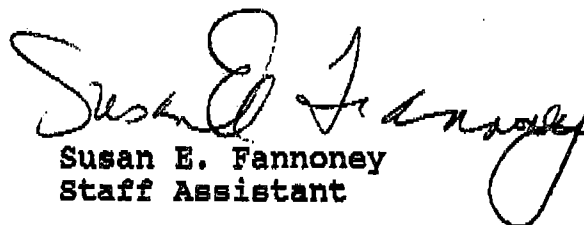
Corrections from September 6, 1991 FAX:

1. There are six (6) Nobel Laureates among the Medal of Science recipients: Elion (1988 co-winner); Herschbach (1986 co-winner); Luria (1969) (deceased); Schawlow (1981); Seaborg (1951); and Weinberg (1979).

2. Seabory should be Seaborg.

Dr. Salvador E. Luria (deceased) - Dr. Zella Luria (wife) will be accepting the award. Dr. Z. Luria is a professor of psychology at Tufts University.

Dr. G(eorge) Evelyn Hutchinson (deceased) - Mr. Arthur F(rancis) Hutchinson (from London, England), nephew, will be accepting award. Mr. Hutchinson is a chartered accountant; he has no scientific background.


Susan E. Fannoney
Staff Assistant

THE WHITE HOUSE
Office of the Press Secretary

For Immediate Release

September 16, 1991

REMARKS BY THE PRESIDENT
DURING PRESENTATION OF NATIONAL MEDAL OF SCIENCE
AND NATIONAL MEDAL OF TECHNOLOGY

The Rose Garden

10:30 A.M. EDT

THE PRESIDENT: Thank you. Please be seated, and let me welcome the dignitaries -- that's almost everybody. I don't know who is excluded, but -- (laughter) -- first, Secretary Mosbacher and Secretary Lujan here -- Bob over my shoulder -- Allan Bromley, my Science Advisor; Henson Moore, I believe is to be here, of Energy; and, of course, Rock Schnabel of Commerce; Walter Massey, the Director of the National Science Foundation. And then finally and perhaps most important today, our honorees and their friends and families. It's my pleasure to welcome all of you to this steamy Rose Garden. (Laughter.)

And with us today are five Nobel Laureates, leading engineers of the Informaton Age, authors of some of this century's world-changing discoveries and inventions. Men and women whose quantum leaps of learning compress generations of knowledge within a single lifetime of achievement. From the first moments of creation to the frontiers of the solar system and now, with Voyager, beyond: your knowledge spans the broad canvas of human endeavor.

Some of you are not only experts in your field, you invented your field. Your quests and questions produced new disciplines, new knowledge, new ways of looking at our world.

And today, your nation recognizes your monumental accomplishments, honors the differences you have made: advancing human understanding, improving the human condition, helping mankind conquer ignorance and illness, helping this nation compete and prosper.

Today's award winners range in age from the Pegasus Team -- a group of precocious 40-something scientists and one 37-year-old -- who designed and built the world's first private space rocket to Admiral Grace Hopper, born in 1906, who pioneered the revolution that put personal computers on the desks of millions of Americans -- and dragged even this President into the computer age. (Laughter.)

I was asked for a report. It's been almost six months since my first computer lesson, and I'm making progress. I make the same mistakes, but I do it five times faster. It's marvelous. (Laughter.)

The men and women we honor exemplify not simply the life of the mind, but the spirit of adventure and risk that accompanies the quest for advancement.

Take Stephen Bechtel, whose vision helped a city spring from the Saudi desert, helped turn the Arctic waters of James Bay into a source of energy for millions of North Americans, and who's now helping Kuwait rise up from the ashes of war.

Consider Colonel Stapp, John Paul Stapp, expert on the human impact of G-forces stress. When his experiments became too

MORE

dangerous to impose on others, Colonel Stapp became his own subject. And as a former Naval aviator, I can hardly believe he's withstood 40 Gs: That's the same as going from 632 miles per hour to a dead stop in 1.4 seconds. Colonel Stapp put himself on the line and made flying safer for everyone from passengers on commuter shuttles to the astronauts now orbiting the Earth on Discovery.

From the work of a single individual come benefits that can banish suffering and prolong life for many millions of people. Consider the career of Gertrude Elion, Nobel Prize-winning biochemist. Her life's work spans the quest to defeat Leukemia and Malaria to today's battle against AIDs and other immune system disorders.

Together, your efforts transformed our world. And yet, as a nation, our honor for all you've done falls short if we fail to sustain your forward march. This administration has proposed what progress demands: record funding levels for research and development, with funds channeled to the individual investigator and small research teams that so often redefine state-of-the-art. To advance technology, we've focused funds on the areas of energy and aeronautics, biotechnology and advanced materials, high performance computing and communications.

To advance science and engineering research, we've urged Congress to approve an 18-percent increase in funding for the National Science Foundation, keeping us on track with our commitment to double spending on that vital research arm by the year 1994. Our commitment to science and technology proves beyond doubt we will not shortchange the future.

In the words of Astronomer Edwin Powell Hubble: "Equipped with his five senses, man explores the universe around him, and calls the adventure science." Well, science and technology hold open the hope of infinite possibility -- of answers that eluded Einstein, of a new world free from fear and want. And that same shining future -- the new world of possibility -- exists within every child.

In the end, progress of enlightenment comes down to education, and what are we doing to cultivate the children sitting today in classrooms around the country -- the generation we'll ask to provide solutions to the challenges of a new century, answers to questions that haven't even yet been asked.

Unless we act immediately, the next generation may not be equipped to follow in your footsteps. All of you know our national education goals and the strategy that we call America 2000 -- our challenge to everyone with a stake in our schools to literally reinvent American education. Well, right now, in some studies of math and science aptitude, U.S. students rank dead last amongst the industrialized nations. And that one statistic alone should shake us out of our complacency and show us the scope of the challenge that we face.

If we're going to be first in the world in math and science by 2000, there's not a moment to waste. Because we're serious, next year's budget targets \$661 million for precollege math and science education -- a one-year increase of 28 percent.

And today, I salute every one of you who has taken the time to share your wisdom in the classroom. I mentioned earlier that we have five Nobel laureates with us today. Let me recognize another medal-winner for a singular distinction: Elvin Kabat, who's had the satisfaction of seeing one of his students go on to win a Nobel.

We must preserve the vital connection between teaching and research. That's the idea behind the Commerce Department's

Technology Heroes Program -- to turn Medal of Technology winners into role models for our kids. And that's why, today, I am pleased to announce the establishment of the Presidential Faculty Fellows Program -- to provide 5-year grants totaling \$500,000 to as many as each of 30 young faculty members each year. These grants will support young scholars in their path-breaking work in science and technology and their teaching in the classroom. Perhaps years from now, some of those Presidential Faculty Fellows will have their own day here in the Rose Garden.

In honoring each of you, this nation honors the boundless horizons of the human mind, the soaring spirit of inquiry, the special genius of the architects who fashion today's fantastic idea into tomorrow's usable tool. Your work stands as its own reward; so let me simply add your nation's thanks.

Once again, welcome to the White House. Congratulations on your well-deserved honors. Now, with the help of Dr. Massey and Secretary Mosbacher and Dr. Allan Bromley, we will present the awards.

Thank you all very much. (Applause.)

(The awards are presented.)

THE PRESIDENT: Well done to the presenter. I guess that concludes it, doesn't it?

Thank you all and, again, my congratulations. I think that concludes the ceremony. And the person that's in charge of the weather, please meet me inside. (Laughter.) Thank you all very much. (Applause.)

END

10:40 A.M. EDT

STEVE OLSON OSTP 2734 (358)

DAMAR HAWKINS OSTP 6272

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TECH. ADMIN. fax 377-4498

Hopper 12/9/06
84

Thompson, David
Pegasus 3/21/54
(37)

per John Sargent @
Commerce

Ed. shas.

401-3000

Leslie Kersch
sec. of Ed. off. Tenn. Gov.

Kirk Winter

Vance Grant of ED research
219-1659
Gary Phillips
219-1763

per Fred Jones (posthum)
John Sargent commerce
Hopper first black
first female lind to
receive medal
Dr. Stepp (crash dummy)
father of
last rocket shot
632 mph dec to 0 in 1.4 sec.

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THE WHITE HOUSE
Office of the Press Secretary

For Immediate Release

September 16, 1991

REMARKS BY THE PRESIDENT
IN SOLAR ENERGY RESEARCH INSTITUTE ANNOUNCEMENT

The Roosevelt Room

10:02 A.M. EDT

THE PRESIDENT: Good to see you all. Please be seated. Let me just welcome everybody here. And special thanks to Henson Moore, our Deputy Secretary at Energy, who, along with Jim Watkins, who's not here today, has been such a driving force for our National Energy Strategy. Dr. Sunderman, we salute you, sir, the Director of the Solar Energy Research Institute; Hank Habicht of the EPA Administration; Mike Deland and, of course, Dr. Bromley, our Science Advisor.

And may I pay my respects to the members of Congress who are with us. Senator Johnston has taken a leadership role early on, on this Senate energy bill. Senator Hank Brown -- very active in it, and Congressmen Hefley and Schaefer and Skaggs -- all of you, a warm welcome to the White House.

Before we get started, let me congratulate the Senate Energy Committee on approving a comprehensive energy bill that incorporates many of the key elements of our strategy. I urge the full Senate to act on this bill swiftly. I also hope that the House Energy and Commerce Committee will complete action on energy legislation this fall. The country needs an enacted energy strategy.

For seven months now, we've been highlighting the strengths of our National Energy Strategy -- a comprehensive -- we feel -- balanced approach to accomplish the goals of continued economic growth, increased energy efficiency, strong environmental protection, and a reduced dependence on foreign oil.

One of the most important themes in our National Energy Strategy is the more efficient use of energy resources. We must keep America on the cutting edge of new technologies, like alternative fuels, electric cars, solar and geothermal energy, high-speed rail, and advanced, even safer nuclear energy facilities. We must encourage environmentally responsible development of all U.S. energy resources, including renewable energy.

Renewable energy does reduce demand upon our other finite natural resources, it enhances our energy security and, clearly, it protects the environment.

Cost-effective renewable energy technologies can contribute in their way to a strong and growing economy -- domestically, by spurring competition and innovation in U.S. markets; and in our balance of trade by displacing more expensive imported energy and providing new services and products for export.

We saw during the past year how important this is to our national security.

We don't have to wait for scientific breakthroughs to capitalize on renewable energy technologies. We just need to translate our success in the lab into progress in the marketplace. And we must continue focused, industry-driven R&D to realize the full potential of these technologies.

In the last two years, we have increased the federal budget for renewable energy research and development by 78 percent and have started construction on a new federal lab. This funding has supported R&D in a number of important areas: photovoltaic cells that convert sunlight to electricity; advanced turbines that harness the power of the wind; and new ways of producing ethanol and methanol for our cars and trucks.

It's easy to criticize and complain that we're not doing enough in promoting renewable energy. We will leave that to others, while we quietly here do the hard work which will make renewable energy technologies a reality in the marketplace.

Much of this progress -- I call it outstanding progress -- has been accomplished in Golden, Colorado, at the Department of Energy's Solar Energy Research Institute -- SERI. SERI has excelled in R&D and in technology transfer. This year SERI scientists have won four of the prestigious R&D 100 awards.

In recognition of SERI's success and its important role in strengthening our energy future, I am pleased to announce the elevation of SERI to the status of a national laboratory. SERI, which will now be known as the National Renewable Energy Laboratory, joins an elite group of our nation's finest scientific facilities.

This designation symbolizes our commitment to finding new ways to produce and use energy that is cleaner, more efficient and more sustainable.

So once again, thank you all for joining us this morning to mark this special occasion. And let me end where I began with congratulations to Secretary Moore -- Henson Moore -- and Dr. Duane Sunderman. Thank you very, very much. (Applause.)

END

10:07 A.M. EDT

MORE