Order Code RL31031

CRS Report for Congress
Received through the CRS Web

The Changing Composition of the Federal Research and Development Portfolio

June 27, 2001

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The Changing Composition of the Federal Research and Development Portfolio

Summary

Each year since FY1997, Congress has appropriated more funds for research and development (R&D) than requested by the Administration. For FY2001,Congress appropriated $90.0 billion for R&D, 9.2% above the FY2000 level. In addition, legislation passed the Senate in the 106th Congress calling for doubling of federal funding for nondefense R&D over the next 11 years. Despite this seemingly favorable climate for federal R&D funding, however, concerns have been raised about the composition of the federal R&D portfolio. In particular there are questions about whether the funding growth is distributed most effectively among the various fields of science and engineering.

Most of the recent growth in federal nondefense R&D funding has been in the life sciences. From FY1995 to FY2001, constant dollar funding for health-related R&D increased by 62% while that for the remaining nondefense R&D agencies increased by 9.5%. Health-related R&D now constitutes 45% of all nondefense R&D funding up from 35% in FY1990 and 25% in FY1980. For basic and applied research alone, the share allocated to the National Institutes of Health (NIH) — which supports nearly all of the federally-funded health science research — rose from 18% in FY1971 to 48% in FY2001. This situation, however, is not unique. During the 1960s, funding for space R&D absorbed 63% of the growth in federal nondefense R&D funding from FY1962 to FY 1968. During the 1970s, funding for energy R&D accounted for 45% of the growth in federal nondefense R&D funding from FY1973 to FY1979. The ratio of the growth of NIH funding to that of the rest of the nondefense R&D for the FY1995 to FY2002 period, however, is unprecedented.

In recent months, many observers, including supporters of increased funding for health care R&D, have expressed concern about the fact that the growth in federal funding for physical science and engineering research, critical to the nation's economic future, has not kept pace with that for the life sciences. They point out that many important advances in health care and health science in recent years — such as magnetic resonance imaging — have depended on research findings from the physical sciences and engineering. Also, some observers note that this difference in R&D funding growth rates may be contributing to a decline in graduate school enrollment in the physical sciences and engineering, which could intensify possible shortfalls in the number of engineers and scientists needed by the nation.

These concerns are likely to appear in at least three formats this Congress. First, legislation to double federal nondefense R&D funding over the next 10 to 11 years, a version of which passed the Senate in the last Congress, is likely to be reintroduced. Second, the Administration's FY2002 budget request includes a 13.5% increase for NIH while reducing the remaining nondefense R&D funding by 3%. Many in Congress have already expressed concern about the latter, and attempts may be made to increase funding for several of those other agencies. Third, debate over the allocation of federal R&D funding among the various agencies may rekindle efforts to develop a more comprehensive means of setting federal R&D funding priorities.

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Background

Over the past several years, congressional support for federal funding of research and development has grown substantially. For each year from FY1997 through FY2001, Congress has increased federal research and development (R&D) funding above the Administration request. Over that period, federal funding for R&D grew by nearly 22%. In the last session of the 106th Congress the Senate passed legislation (S. 296) calling for a doubling of federal funding for nondefense R&D for 16 agencies over the next 11 years. Similar legislation was considered in the House. Because a significant proportion of the growth in R&D funding over the last five years has been in the health sciences, however, questions have arisen about whether the federal R&D funding is allocated most effectively among all fields of science. The questions do not so much focus on whether health R&D is getting too much funding, but whether the non-health fields are getting adequate support. This report addresses that allocation issue.

A recent report from the National Science Foundation (NSF) noted that while "research and development expenditures have never exceeded 3% of the United States' economy, R&D has been widely recognized as a key ingredients for economic growth..."[1] Neal Lane, former director of the Office of Science and Technology Policy, under the Clinton Administration, noted that both public and private investments in R&D have generated new knowledge and new industries, created new jobs, reduced pollution, improved medical treatment, helped to educate future scientist and engineers, and increased living standards for all Americans. A number of economists, including those in the current Administration, attribute much of the nation's prosperity in the 1990s to increased productivity stemming, in large part, from technological development arising from scientific research.[2]

Support for R&D in the United States from both public and private sector sources is estimated to have reached a record $264.2 billion in 2000, according to the NSF. Of that total, NSF estimated that private industry contributed 68% of all funding, with the federal government contributing 27%, and universities and non-profits the remaining 5%.

The end of the Cold War, growing budget surpluses, and the dramatic surge in private sector support for R&D have raised questions about the appropriate role the federal government should play in the nation's R&D enterprise. Given the private sector's recognition of the important role R&D plays in helping to fuel the new high tech economy, it is unlikely that the federal government will ever again be the predominant supporter of R&D funding as it was in the past. Nevertheless, in a recent *New York Times* article, Allan Bromley, Science Advisor, to former President George H. W. Bush wrote that,

> "Technological innovation depends upon the steady flow of discoveries and trained workers generated by federal science investments in universities and national laboratories. These discoveries feed directly into industries that drive the economy. It's a straightforward relationship, industry is attentive to immediate market pressures, and the federal government makes the investments that ensures long term competitiveness."[3]

Of the three components of R&D[4] — basic research, applied research, and development — the federal government supports 60% of the nation's basic research

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[1]National Science Foundation, Division of Science Resources Studies, *Sixth Year of Unprecedented R&D Growth Expected in 2000,* NSF 01-310, November 29, 2000. NSF also noted that other factors such as education, training, production engineering, design, and quality control also contributed to economic growth.

[2]Budget of the United States Government, Office of Management and Budget, *Budget: Fiscal Year 2002*, Washington, DC, 2001, 29.

[3]*Science and the Surplus,* D Allan Bromley. New York Times, Section A, Page 19. March 9, 2001.

[4]According to NSF the object of agency sponsored **basic research** is to gain more complete knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products in mind. The object of **applied research** is to gain knowledge or understanding necessary for determining the means by which a recognized need may be met. **Development,** the remaining 53% of federal R&D, is the systematic use of the knowledge or understanding gained from **research,** directed towards the production of useful materials, devices, systems or methods.

and about the same percentage of all R&D performed at the nations' universities and colleges. Over the past fifty years, basic research has contributed to an array of impressive scientific breakthroughs in such diverse areas as computers, information technology, genetic engineering, lasers, environmental sciences, agricultures, and the development of new drugs. Besides supporting high-risk long-term basic research, the federal government also plays a pivotal role in educating future scientists and engineers. Further, many analysts assert that federally-funded applied research and development related to the missions of the funding agencies has contributed to advancements in medicine and health care, superior defense technology, energy efficient technologies, and cleaner air and water.

The Changing Federal R&D Portfolio

While it is very likely that the federal government will continue to play a crucial role in supporting the Nation's R&D enterprise, a number of critics in the scientific community as well as some Members of Congress have raised concerns about the current trends in the federal R&D budget portfolio. Specifically their concerns center around the relative rate of the growth of government research support for the life sciences, through the National Institutes of Health (NIH), as compared to other fields of research, primarily in the physical sciences and engineering. These critics argue that because the latter have not kept pace with the former, the nation runs the risk of a having inadequate scientific and technical resources in the physical sciences and engineering. While Congress appears to be in the process of doubling the funding for NIH between FY1998 and FY2003, those agencies that primarily support other fields of science, such as the physical sciences, engineering, and mathematics, have seen their funding remain flat or increase less than 5%, in constant dollars, between FY1998 and FY2001. According to most recent data from the Office of Management and Budget (OMB), NIH accounts for 45% of all federal nondefense R&D funding in FY2001, up from 35% in 1990.[5]

Charles Wessner, a member of the National Research Council's Board on Science Technology and Economic Policy noted, that a number of prominent scientists and engineers, including Harold Varmus (former NIH Director), have argued for more federal research funding for other scientific disciplines to more closely match the gains in federal health-related R&D funding. Dr. Wessner stated that "scientific progress, and importantly commercial development, often require investments in physics and chemistry and new materials. Past progress on magnetic resonance imaging diagnostics involved many disciplines and technologies."[6] Others have noted that scientific discoveries in other fields of science, such as physical sciences and math, have led to important advances in the life sciences.

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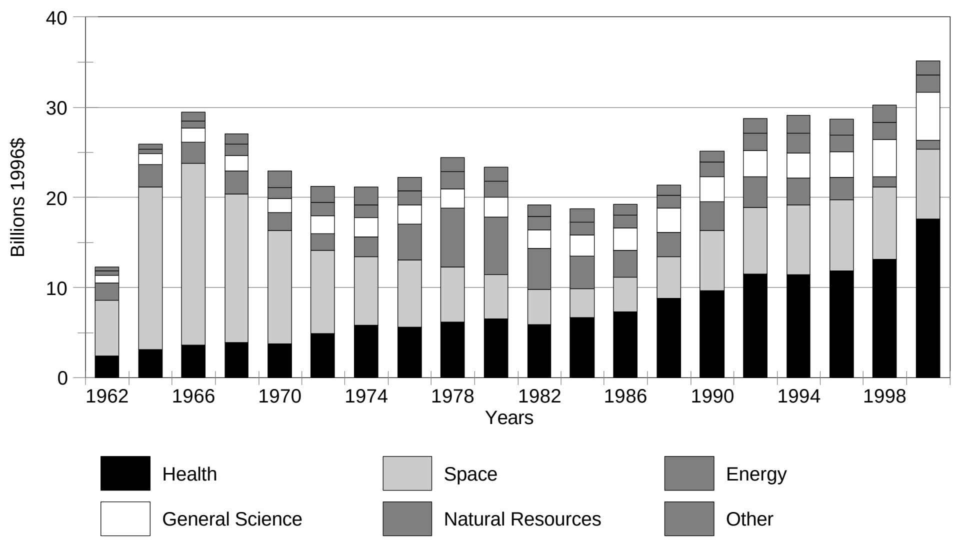
[5]It should be noted that NIH also funds research in fields classified as physical science and mathematics, although nearly all of its funding supports research in the life sciences.

[6]*ATP, NSF Among the Losers in Bush's First Budget Plan,* Scott Nance, New Technology Week, March 5, 2001. P. 10.

While health-related R&D has enjoyed strong Presidential and congressional support over the last few years, the data displayed in Figure 1 indicate that emphasizing one R&D area is not a unique situation. The chart highlights changing Presidential and congressional priorities for federal nondefense R&D funding by budget function since 1962. M.R.C. Greenwood, a former member of the National Science Board, also noted that a historical review of federal R&D spending reveals that setting the Nation's R&D priorities was often "crisis" driven.[7]

Despite the establishment of the National Science Foundation in 1950 and calls for greater federal support for non-defense R&D, it was not until the launch of Sputnik in 1957 and the creation of the National Aeronautics and Space Administration (NASA) in 1958 that funding for federal nondefense R&D begin to expand rapidly. In 1955, total federal nondefense R&D was $2 billion, in FY1996

Figure 1. Federal Nondefense R&D Funding by Budget Function



dollars. By 1962, however, total federal nondefense R&D spending was $13 billion and reached $31.5 billion by 1966, all in constant FY1996 dollars.[8] As indicated in Figure 1, space science and technology dominated federal nondefense R&D funding through the 1960s, absorbing 66% of all federal nondefense R&D dollars in 1966. After 1970, funding for space R&D, in constant dollars, continued to decline until the Challenger accident in 1986.

As funding for space R&D declined in the 1970s, the oil embargo of 1973 -1974 led to calls by the Congress and Administration for more energy-related R&D

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[7]*The future Role of the Federal Government,* Science and Engineering and Education in the 21st Century, the National Science Board Policy Symposium, March 28-29, 1996 Arlington, Virginia, p.23-30.

[8]Data from *Federal R&D Funding by Budget Function, Fiscal Years 1999-2001, October 2000,* p. 40-46. Data for FY2000 and FY2001 from OMB. Beginning in FY1998 DOE's basic research funding was transferred from Energy to General Science where NSF's basic research program and NASA's space programs are included.

spending. The second oil price shock in the late 1970s led to the establishment of the Department of Energy (DOE) and helped to further accelerate energy R&D spending. Between FY1972 and FY1980, energy R&D increased 255% in constant dollars. However, 1980 marked the highwater point for energy R&D as it reached 24% of total nondefense R&D funding, the same percentage as health research that year.

The election of President Ronald Reagan in 1980 changed federal R&D funding priorities again. The Reagan Administration did not support many of DOE's alternative energy R&D activities believing that such efforts should be funded primarily by the private sector. Thus, as indicated in Figure 1, funding for energy R&D declined to nearly 1974 levels, in constant dollars, by 1988. Concomitantly the Reagan Administration's creation of the Strategic Defense Initiative (SDI), along with greater investments in a variety of defense-related technologies, led to a resurgence of funding in DOD's and DOE's defense-related R&D programs.

Figure 2 (next page) compares federal nondefense and defense R&D spending since the early 1960s in constant 1996 dollars. Prior to the 1960s, defense R&D[9] dominated the federal R&D portfolio, and accounted for over 70% of all federal R&D funding. However, as indicated in Figure 2, by FY1966 the disparity between defense and nondefense R&D funding had closed significantly. Federal R&D funding remained evenly divided between nondefense and defense activities through the 1960s and most of the 1970s. By about 1986, however, defense related R&D amounted to 68% of all federal R&D spending. Nondefense R&D funding (even though basic research funding increased in constant dollars during the Reagan years) declined to pre-1964 levels, in constant 1996 dollars.

The end of the Cold War in 1991 and the election of President Clinton in 1992 marked the beginning of a different focus for federal R&D.[10] The Clinton Administration tied much of its R&D strategy to economic growth and technological innovation. One of the objectives of the new Administration was to increase nondefense R&D funding while concomitantly slowing the growth of defense-related R&D. As indicated in Figure 2, parity between nondefense and defense R&D spending was restored in the FY2001 budget.

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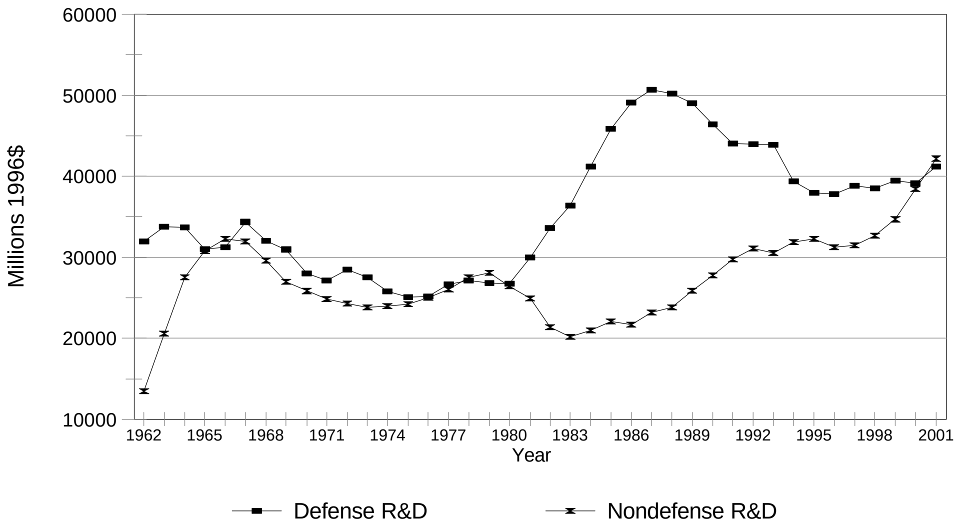
[9]Defense R&D consists of DOD and DOE defense related R&D programs.

[10]For a detailed discussion of that period, see Congressional Research Service, *Federal Research and Development: Budgeting and Priority-Settion, 1993-2000,* by Genevieve Knezo, RL30905, March 14, 2001.

Most of the resurgence of nondefense R&D spending, however, occurred since FY1996 during a period of growing budget surpluses. The major recipient of the growth in nondefense R&D funding was the health sciences, primarily the National

Figure 2. Nondefense and Defense R&D Funding



Institutes of Health (NIH). Figure 1 (page 3) illustrates how health-related R&D has come to dominate nondefense R&D funding. Since 1986, federal health R&D funding has increased from 33% of total nondefense R&D to an estimated 45% in FY2001.

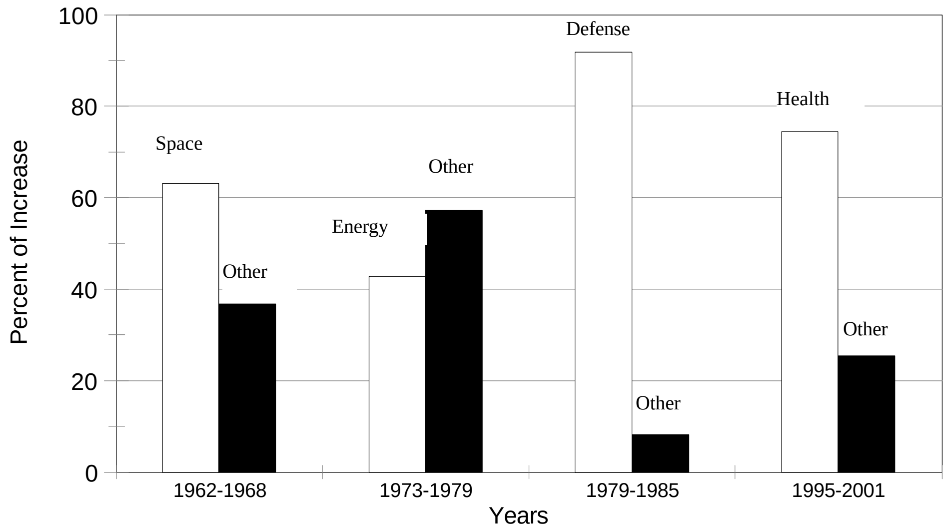
Figure 3 (next page) gives another perspective of theses changes in federal R&D funding priorities using comparative federal R&D funding data over selected six-year intervals. Of the total growth in federal nondefense R&D funding between FY1962 and FY1968, 63% went to space related R&D and 37% to all other nondefense R&D. Of the total growth in federal nondefense R&D funding between FY1973 and FY1979, 43% went to energy R&D, while 57% went to all other areas.

Figure 3 also illustrates the extent to which the growth in defense-related R&D dominated total federal R&D spending during the early 1980s. Between FY1979 and FY1985, defense R&D received 92% of the growth in all federal R&D funding that took place over that period. Consequently, over those six years, in constant dollars defense R&D funding increased 70% while nondefense R&D declined 22%.

During the most recent six-year interval, FY1995 to FY2001, health-related R&D, in response to major advances in molecular biology and the growing health concerns of an aging American population, received 75% of the total increase in federal nondefense R&D funding. This is the largest such increase for any nondefense R&D research area over a six year time frame since 1945.

It is instructive to compare the 1962-1968 period with the 1995-2001 period from a different perspective than is presented in Figure 3. This is done by comparing the actual constant dollar increases in the space (1962-1968) and health-related (1995-2001) R&D to the actual constant dollar increases of all other nondefense R&D fields during those two periods. During the 1962-1968 period, constant dollar funding for space R&D increased 168% while for all other nondefense R&D it rose

Figure 3. Changes in Federal R&D Priorities

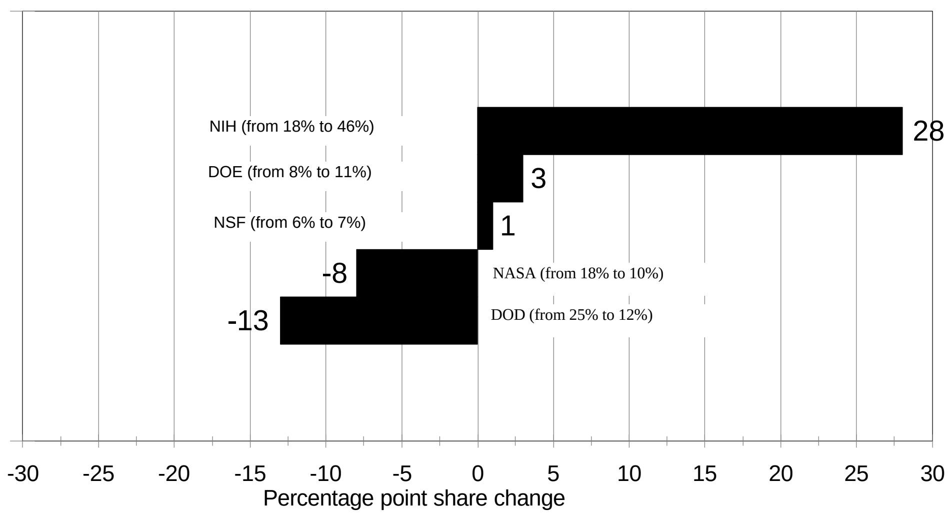


by 77%. At its peak in 1966, space R&D accounted for 64% of all federal nondefense R&D funding. By contrast, during the 1995-2001 period, constant dollar funding for health R&D increased by 62% while for all other nondefense R&D it grew by 9.5%. Health-related R&D is now estimated to constitute 45% of all federal nondefense R&D. Therefore, while the health-related R&D increase has been substantial compared to other nondefense R&D over the last six years, the former does not dominate all R&D funding the way space R&D did during the 1960s. Nevertheless, the ratio of the growth in health-related R&D funding during the last six years to all other nondefense R&D funding is considerably greater than the comparable ratio between space R&D funding and all other nondefense R&D funding during the 1960s. It is this latter fact that appears to be of most concern to critics who argue that funding for physical sciences and engineering R&D is being left behind by that for health-related R&D. It is not that health-related R&D is faring too well that is the crux of their argument, it is that the other fields do not appear to be faring well at all.

Federal Research Funding

This overview of changes in federal R&D priorities illustrates the extent and diversity of those changes and how historical events along with congressional and Presidential responses to those events have helped to shape federal R&D policy over the last 40 years. Clearly other factors such as international competition, environmental concerns, demographics, and changing political philosophies have also influenced the direction of federal R&D programs. Given that federal R&D portfolio has undergone many significant changes over the past 40 years, it is worth asking why has so much attention been given to the recent growth of health-related research, in particular NIH.

Figure 4. Change in Agency Share of Total Federal Research Funding – FY1971 and FY2001



The extent of the recent changes are shown most dramatically by concentrating on the research (both basic and applied) portion of the R&D budget.[11] Nearly all of the funds going to life science R&D and NIH in particular are classified as research. Figure 4 illustrates a the extent to which NIH's funding increases have changed the distribution of the research portion of all (both defense and nondefense) federal R&D expenditures among five major federal research agencies.[12] The chart, which is based on NSF data, shows the change that occurred in each agency's share of total federal research funding comparing FY1971 to FY2001. Total federal expenditures for research funding grew from $5.123 billion in FY1971, to an estimated $42.752 billion in FY2001. The five agencies in Figure 4 account for 80% of all federal research expenditures in FY2001, up from 75% in FY1971.

As indicated in Figure 4, NIH has enjoyed a substantially greater increase in its share of federal research funding than any of the other agencies, some of whom have seen their share drop. Looking at the absolute changes between 1971 and 2001 and between 1985 and 2001 for these five agencies in Figure 5 (next page) shows that in constant dollar terms, NIH has dominated over both intervals. Between FY1985 and FY2001, research funding increased 196% for NIH, 51% for NSF, 60% for NASA, 43% for DOE, and just under 6% for DOD. President Bush's proposed FY2002 federal R&D budget would continue these funding trends. Under the President's proposed budget, for FY2002, NIH research funding would increase 12.9%, while research funding from all other federal agencies would decline 1.5%. Essentially, the President's proposal maintains congressional efforts to double NIH funding between FY1998 and FY2003.

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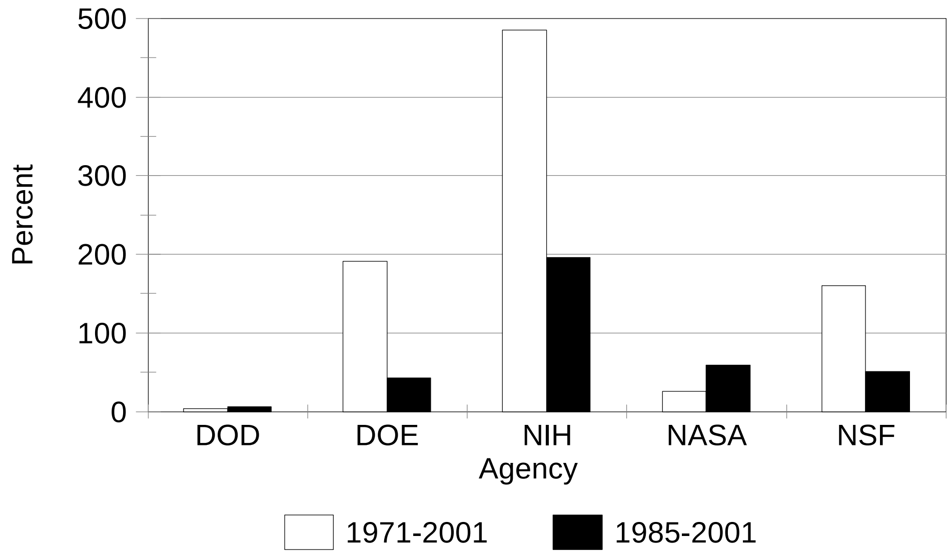
[11]See footnote 4 for definitions of research, applied research, and development.

[12]Further, over the past decade research funding has grown significantly as a percent of total federal R&D, increasing from 34% of federal R&D spending in FY1990, to an estimated 47% in FY2001.

Figure 5. Percentage Change in Research Funding – Constant Dollars



These two figures show clearly that the growth in research funding in NIH has dramatically outpaced all other agencies and has been doing so since 1971. This longer term trend has been masked to some extent by the fact that the year-to-year growth rates for NIH were generally only a few percentage points higher than the other agencies until the last few years. Those year-to-year growth rates for NIH, however, did not vary a great deal over time while, as noted above, they flucuated substantially for the other agencies, sometimes becoming negative. As a consequence, the current allocation of total research funding by agency is heavily dominated by NIH.

As noted in this report, some Members of Congress and representatives of the scientific community have voiced concerns about these changes. First, they argue that the nation needs to accelerate and maintain the growth in federal funding for all fields of science and engineering, not just health science. They note that federally funded research has played crucial role in the generation of new knowledge, technological innovation, and the education of scientists and engineers. They also point out that the federal research budget consists of a broad array of generally long term, high risk activities with potential payoffs that may not materialize for many years in the future. Because the outcomes of such research are unpredictable and have extended time frames, it is unlikely that the private sector will support such research on a consistent long term basis. According to a number of reports, federal support of basic and applied research has been crucial for numerous technological advancements that have contributed to the nation's overall economic growth and prosperity. For example, federally funded basic research in optics, coupled with advancements in lasers, led to the development of fiber optics, which helped to build the nation's modern telecommunications network.[13]

[13]Besides the direct role of funding R&D, the federal government helps to foster commercial

(continued...)

The relationship between the results of physical science and engineering research and advances in the health sciences raises a second concern. Some analysts argue that a "funding imbalance" between life sciences and all other fields of science could weaken this linkage to the detriment of continued advances in biomedicine. They note that breakthroughs in health research are often dependent on advances, or a combination of advances, in the fields of engineering, mathematics, and the physical sciences, and that growing support for the latter are also needed if the promises of health research are to be fulfilled. Magnetic Resonance Imaging is an example of how physical and engineering sciences underpin advances in medical science.[14]

A third concern relates to the increasing interdisciplinary nature of modern scientific research. In a recent *Science* magazine editorial, Donald Kennedy wrote that an increased proportion of important science and technology challenges will require an interdisciplinary approach.[15] He noted that advancements in nanotechnologies, neuroscience, information technology, climate change sciences, and bioengineering are dependent on disciplines as diverse as chemistry, physics, mathematics, and engineering. He argued that scientific gains derived from sequencing the human genome will not only be dependent on molecular biologists, but on specialists in bioinformatics trained in mathematics and computer sciences.

A fourth concern raised by the differential growth rates in federal research funding between the life sciences and the physical sciences and engineering is related to the important role played by such funding in educating future scientists and engineers. Current NSF data on graduate enrollment by field of science suggest that continued funding disparity between health and non-health related R&D may be affecting graduate enrollment in other fields of science. According to NSF data,[16] the number of graduate students in engineering, mathematics, and the physical and earth sciences grew from 1975 to 1993 and then declined by 14.4% from 1993 to 1999. The number of graduate students in the biological sciences, on the other hand, increased from 1975 to 1999, although there was essentially no change from 1993 to 1999. It is possible that the growing publicity in scientific circles given to the large increases in the NIH budget relative to other agencies over the last few years may have discouraged some students in the physical sciences and engineering from staying in graduate school because they perceived relatively poor prospects for research funding for those fields when they completed their studies. At the same time, those

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[13](...continued)
technological innovation through a variety indirect mechanisms including patent protection, and variety of tax incentives, promoting economic stability, and the promotion of international trade.

[14]National Academy of Sciences, *A Life Saving Window on the Mind and Body: The Development of Magnetic Resonance Imaging (MRI),* Beyond Discovery; The Path from Research to Human Benefit, January 31, 2001, [http://www.beyonddiscovery.org/beyond/beyonddiscovery.nsf/web/mri?OpenDocument]

[15]Donald Kennedy, *A Budget Out of Balance,* Science, Vol. 291 March 23, 2001, p. 2275.

[16]National Science Foundation, Division of Science Resources Studies, *Graduate Students and Postdoctorates in Science and Engineering; Fall 1999*, NSF 01-315, Feb. 2001, 30.

large increases do not seem to have triggered a proportional increase in graduate enrollment in the biological sciences.

While graduate student enrollment in engineering, mathematics, and the physical and earth sciences increased in 1999 for the first time since 1993, the increase was small and was entirely attributed to growth in non-U.S. citizen enrollments. Graduate school enrollments of U.S. citizens in science and engineering has dropped 9%, since it peaked in 1993.[17] Some have expressed concern about the U. S. ability to continue to compete in the global market place if these science and engineering graduate education trends, particularly in the physical sciences and engineering, are not reversed soon.

Despite these arguments, it is not clear that these funding trends are causing serious problems for the nation's science and technology enterprise. While the premises for each of the four concerns expressed above may be valid, there at present does not appear to be any data supporting the notion that physical science and engineering research is suffering because the growth in federal funding for those areas is not keeping pace with that for life science research.[18] New diagnostic technologies are still entering the market — witness the advent of the full-body CT Scan — and the issue at present appears to be more whether the nation can afford such technologies. There has also been a fairly rapid expansion of funding for interdisciplinary research in recent years, particularly in information technologies and nanoscience and technology. In addition, it is important to note that declining graduate enrollments may be due to other factors such as a strong economy that has lured potential graduate students — particularly from the physical sciences and engineering — into the workforce, growing numbers of minority high school students who have traditionally been under represented in the science and engineering fields, and a lack of student interest in pursuing fields of study that are considered too academically challenging. Finally, with the pervasiveness and expansion of healthcare concerns in the nation and world, a significantly more rapid growth rate for health research than other fields over a given period of time may be justified.

Nevertheless, if this large growth rate differential were to continue for too long, the problems outlined above could come to fruition. The resources available for federal research funding are not unlimited and eventually these trends could result in a damaging shift of such resources away from the physical sciences and engineering research. At present, it appears that percentage funding increases for NIH will fall back to below double digits after 2003 when the current doubling phase is complete. It is possible, however, that even then, NIH funding growth, on average, may outpace the other agencies as has been the case over the last three decades (see Figure 5).

Congressional Issues

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[17]National Science Foundation, Data Brief, "Science and Engineering Enrollment in Science and Engineering Increase for the First Time Since 1993", NSF 01-312, Jan. 11,2001, 2.

[18]It should be noted, however, that some observers have expressed the view that the growth in NIH funding is excessive. They argue that the agency cannot effectively spend all of the funding increases it is receiving and, in addition, may have great difficulty adjusting when the double-digit growth rates cease.

Proposals to Double Federal R&D Funding. In both the 105th and 106th Congresses, legislation was introduced in both the House and Senate to double federal nondefense R&D funding over a 10- or 11-year period. While the House did not act on those bills, the Senate approved an R&D doubling bill in both sessions.[19] The Senate and House bills contained similar provisions. The bills call for the doubling of "basic scientific, biomedical, and precompetitive engineering research," for 16 nondefense agencies, including NIH (DOD research activities are not included in the bills) over an 11-year period. Further, language in the bills pointed out the desire of obtaining a balanced research portfolio because of the interdependence the various science and engineering disciplines.

According to the legislation, a balanced research portfolio would be achieved by allowing each agency's R&D budget to grow 5.5% per year in order to reach the overall doubling target. Under this provision if an agency receives an annual increase of more than 8%, its total budget may not be counted against the total recommended spending level of all 16 agencies for the following fiscal year. For example, because NIH received a 15% increase in FY2001, under this provision, its total would not be included as part of the recommended annual funding total for the remaining 15 agencies in FY2002. Thus, the remaining agencies could increase an average of 5.5% without exceeding the recommended FY2002 funding level of $45.160 billion. If NIH's FY2001 funding level was included, total spending could exceed the FY2002 target and potentially limit the growth of the other 14 agencies.

The Senate bill S. 2046, passed by the Senate last year, recognizes that "health research has emerged as a national priority...and that the pattern of substantial budgetary expansion begun in FY1999 should be maintained." The bill supports the position that rapid growth in NIH funding could be maintained while at the same time increasing funding for the remaining 15 agencies contained in the legislation. The bill also recommends that by 2011, nondefense R&D funding should be 10% of federal discretionary spending up from 7% in FY2001.

The House did not pass this legislation in either the 105th or the 106th Congress. Some Members expressed concern that the bills may circumvent the authorization process. In a letter to Senator Bill Frist, (one of the primary sponsors of the Senate R&D funding doubling bills and then Chairman of the Senate Subcommittee on Science, Transportation and Space), Representative James Sensenbrenner, then Chairman of the House Science Committee, wrote that he could not

> "support a long-term authorization bill that includes a single annual blanket authorization for all nondefense R&D agencies (contained in the legislation). In my opinion, such an authorization would provide little support for scientific research while undermining the Science Committee's ability to operate as an effective legislative entity."[20]

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[19] In the 105th Congress, the Senate passed S. 2217 and in the 106th S. 296, which was inserted in S. 2046 , The Next Generation Internet 2000, passed by the Senate. The House bill for the 105th was H.R. 4514 and for the 106th H. R. 3161.

[20] Letter to the Honorable Bill Frist, Chairman of the Senate Subcommittee on Science,

(continued...)

Representative Sensenbrenner further wrote

> "for example, voting for a cut to NASA in the next Veterans Administration, Housing and Urban Development and Independent Agencies Appropriations bill will not be inconsistent with the doubling bill since the bill contains no specific numbers for the National Aeronautics and Space Administration,"

unlike the Committee's FY 2000 authorization bill, H.R. 1654, that contains specific funding numbers for NASA.

In response to the letter, Senator Frist wrote,

> "Nothing in the Federal Research Investment Act detracts from your [House Science] Committee's ability and obligation to exercise full oversight over the agencies and programs in your jurisdiction. Furthermore, the Federal Research Investment Act is an authorization bill similar to the dozens of bills that the House Science Committee has passed under your leadership."[21]

In a speech before the Universities Research Association, the current Chairman of the House Science Committee, Representative Sherwood Boehlert, indicated that the Committee would take a serious look at the current balance of the federal research portfolio.[22] Chairman Boehlert noted that at first glance, it appears that funding for biomedical research could be "a little out of whack" despite its dependence on a wide range of research disciplines. He went on to state that if the Committee is to take action "it would have to ask some tough questions, including... How would we know if NIH was over-funded in either relative or absolute terms? Given the public concern with health and the advances in biology, shouldn't NIH get a larger share of the pie?" Chairman Boehlert noted that in the past federal R&D funding priorities have been driven by other national concerns such as the Cold War and the space race.

While he indicated he was "kindly disposed" toward a 'doubling' bill, it would not preclude the committee asking pointed questions such as "Why Double? What are we going to get for the money? How will we know if we are under or over spending in any field?" The Chairman suggested that passage of such a bill would put Congress on record that science spending is a priority. Finally, he did note that passing such a bill should "not obscure the fact that doubling will never become a reality if we can't make a much more solid case to the appropriators." At this point, no comparable legislation has been introduced in the 107th Congress.

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[20](...continued)
Transportation and Space, from Chairman of the House Science Committee, F. James Sensenbrenner Jr., September 19, 2000.

[21]Letter to the Honorable F. James Sensenbrenner Jr., Chairman of the House Science Committee, September 22, 2000.

[22] Congressman Sherwood Boehlert, speech to the Universities Research Association, January 31, 2001.

FY2002 R&D Budget Request. The Administration has requested $95.2 billion for federal R&D spending in FY2002, a 5.8% increase over FY2001. Included is a requested 8.8% increase for DOD's RDT&E budget that would be the first installment of the Administration's goal of increasing DOD's annual R&D funding by $20 billion over the next five years. The Administration also proposed a 13.6% increase in NIH's budget, maintaining efforts to double the NIH budget by FY2003. These two agencies account for the total proposed increase in federal R&D spending for FY2002. Absent NIH, funding for all other nondefense R&D programs would decline by about 6% in constant dollars. The enacted tax cut and the Administration's desire to limit the growth of discretionary spending to 4% overall appear to have confined efforts to increase nondefense federal R&D funding to keeping the NIH budget on a pace to double by FY2003.

Several Members of Congress have raised concerns about the proposed FY2002 R&D budget request. At a Senate Budget Committee hearing on NIH, Senator Domenici, then Chairman of the Committee, told Health and Human Services Secretary, Tommy Thompson, that

> "to increase NIH 20 percent and not to increase NSF $100 million...those are not going to mesh. In about five years, you're going to have the medical scientists clamoring for where are the physical scientists, where are the people that work on the newest physics of machinery, and engineers and nano-engineers... ."[23]

Other Members expressed concerns that the proposed budget would end parity between defense and non-defense R&D and would further exacerbate the growing imbalance between biomedical R&D and the physical sciences. Some Members noted that the budget request could stop congressional efforts, that began in FY 2001, to double NSF's budget in five years. The budget request also maintains the Deparment of Energy's (DOE) science programs, which received a 15% increase in FY2001, at that year's level. A "Dear Colleague" letter is circulating in the House that urges an increase in funding for DOE's science programs.

In response to these concerns, the Senate adopted an amendment to the FY2002 Budget Resolution (S. Con. Res 20) that would provide an additional $674 million for NSF (continuing efforts to double NSF's budget), $469 million for DOE science, and $518 million for NASA.[24] The House-passed budget resolution mirrored the Administration's proposed FY2002 budget, maintaining a 4% increase for discretionary spending, while the Senate approved an 8% increase. The House and Senate conference report (H. Con. Res. 83, H. Rpt. 107-55) provides a 5% increase in discretionary spending overall and reduced funding for function 250 (General Science containing NSF, DOE science programs, and NASA) below the Administration's request. In another action, Representative Eddie Bernice Johnson

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[23]Senate Budget Committee Hearing on the Proposed FY2002 Budget. March 6, 2001.

[24]Two other R&D amendments were approved by the Senate. The first proposed by Senator Santorum, provides an additional $353 million for DOD research. The second amendment, sponsored by Senators Spector and Harkin, provides an additional $600 million for NIH to ensure the dollar value of its budget will double by FY2003.

introduced H.R. 1472, which proposes an annual 15% increase in the NSF budget from FY2002 to FY2005. Together with 13% increase NSF received in FY2001, this legislation would double the agency's budget by FY2005.

At a Senate OMB confirmation hearing, Senator Lieberman asked OMB Deputy Director Sean O'Keefe about the growing disparity in research funding between the life and physical sciences, while arguing that the two fields are mutually dependent. Deputy Director O'Keefe responded by noting that,

> " the President's budget continues to invest in research, both at NIH and at other agencies...The Nation needs a balanced portfolio of research, funded by the Federal government and the private sector, in both defense and nondefense areas, and across fields of science. For example, a balanced portfolio of research looked very different during the Cold War, than it does now... . We believe that the current portfolio is balanced, but we expect to further refine this balance as we assess new and ongoing research opportunities in future budgets."[25]

While the Administration's proposed budget projects a $15 billion increase for all nondefense discretionary spending in FY2003 over its FY2002 request, between FY2004 and FY2006 it projects an average annual increase for all nondefense discretionary spending of $8 billion. Over the past four years nondefense R&D funding has averaged about 14% of all nondefense discretionary spending. If this percentage were to be maintained and if the Administration's out-year spending projections were to be enacted, funding for nondefense R&D would likely increase around $2 billion in FY2003, and then drop to slightly more than half that amount over the next three years. From FY1998 to FY2001, the average annual increase for nondefense R&D was $3 billion.

In a speech to the AAAS, Chairman Boehlert discussed the challenges of the Administration's proposed out-year spending levels.[26] He argued that growth in "discretionary spending for 2003 and beyond is only enough to cover inflation." While acknowledging the actual numbers will be higher, he stated that "competition for federal dollars will be fierce." The House Science Committee Chairman told the AAAS audience that supporters of science need to be reinforcing their arguments for science investments. He then further defined "reinforcing" as "providing good, solid arguments for special levels of spending, not just throwing the word 'doubling' around as if it cast a magic spell. And it means providing good solid thinking about what it may mean to have a balanced federal research portfolio."

Establishing Federal Research and Development Priorities. Critics have argued that despite calls from Members of Congress, the White House, and the scientific community, a coherent system for establishing R&D spending and programmatic priorities across the federal government does not exist. They state that the current approach for allocating funds for federal research is an incremental process

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[25]Sean O'Keefe, Testimony before the Senate Government Affairs Committee, February 27, 2001.

[26]Congressman Sherwood Boehlert (R-NY) Speech to AAAS Colloquium, May 3, 2001. P 3&4.

that may not be a model for rational decision making, and that there appears to be little coordination within the executive and legislative branches of government in reviewing and establishing federal R&D budgets. According to a study by the National Science Board, the federal R&D "portfolio for research is treated as an accounting device that aggregates the research portfolios of the individual departments and agencies funding S&T."[27]

Many policymakers in both the executive and legislative branch generally agree that the federal R&D budget is not treated, or managed, as a single broad based portfolio of science and technology investments aimed at meeting broad based federal responsibilities. Past Administrations have used the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) to help establish and coordinate multi-agency R&D initiatives as well as to help develop policies for effective planning and administration of science, technology and engineering across the federal government. In 1993, President Clinton established the National Science and Technology Council (NSTC) as a successor to FCCSET. Among its various responsibilities the Council assisted in developing recommendations for federal agency R&D budgets aimed at accomplishing important national objectives, and advising OMB about individual agencies' R&D budget priorities. The NSTC was responsible for coordinating multi-agency research initiatives such as for information technologies and nanotechnologies. The Council played a key role in the establishment of the "21st Century Research Fund," a multi-agency research initiative including DOD, that the Clinton Administration hoped would help it promote a more balanced research portfolio.

A number of reports have suggested that the current congressional process for establishing R&D priorities is disjointed and lacks mechanisms for systematically reviewing and establishing R&D priorities across the federal government. A 1998 House Science Committee report, *Unlocking Our Future: Toward a New National Science Policy*,[28] noted that decisions about science policy and agencies' research priorities are, "made in a large number of Congressional committees and subcommittees which can impede the progress and coordination of important projects." Commonly referred to as the Ehlers' report, it suggested that

> "at a minimum Congress and the Executive Branch should improve their internal coordination process to more effectively manage, execute, and integrate oversight over these kinds of programs. While the Office of Management and Budget can fill this role in the executive Branch, no such mechanism exits in Congress."

In a 1995 report, the National Academy of Sciences recommended that

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[27]*The Scientific Allocation of Scientific Resources,* Discussion Draft ,National Science Board NBB-39, March 29, 2001, [http://www.nsf.gov/nsb/documents/2001/nsb0139/nsb0139.pdf]

[28]*Unlocking Our Future: Toward a New National Science Policy,* Committee on Science, U.S. House of Representatives, 105th Congress, September 1998, Committee Print 105-B p. 56.

> "Congress should create a process that examines the entire FS&T [federal science and technology] budget before the total budget is disaggregated into allocations to appropriations committees and subcommittees."[29]

In apparent recognition of these concerns, S. 2046, The Federal Research Investment Act, contains a provision that would require the Office of Science and Technology Policy to produce an annual report that verifies that the President's budget for nondefense R&D contains "a focused strategy that is consistent with the funding projections of this title [Title I] for each future fiscal year until 2011, including specific targets for each agency that funds nondefense research development; ... ." Further, the legislation directs that the report should examine how any differences in agencies recommended funding levels "will affect...the ability of the agencies covered by this Act to perform their missions... ."

While a number of proposals (including establishing a Department of Science and Technology[30]) and some attempts have been made, over the last several decades, to strengthen OMB's and OSTP's role in R&D priority setting, the success of such efforts has always depended on the extent to which the President believes they are needed or warranted. There has been and continues to be support to keep the process decentralized in order to ensure R&D priorities for a given agency best match that agency's mission, and to encourage the diversity inherent in the existing system. Furthermore, while many Members of Congress recognize that the current legislative process for identifying R&D spending priorities is cumbersome and disjointed, they argue that such a process reflects a general belief that power within Congress should be decentralized and not placed in the hands of a limited number of Members. Such an approach, they argue, helps to serve the diversity of constituents that Members of Congress represent and is the best way to ensure that R&D funding best serves the broader missions of the agencies.

Conclusion

The difference between the rate at which R&D funding for NIH is growing compared to the rest of federally-funded nondefense R&D is substantial. While the existence of such a difference between one research field and the others is not unique in the history of federal R&D funding since World War II, in some ways the current gap is unprecedented. Some critics have argued that if this growth rate gap does not shrink by enhancing funding growth rates for physical science and engineering research, there could be negative consequences for the nation's long-term economic well-being and even for continued advances in health care. They assert that continuation of the gap, as suggested by the FY2002 R&D budget request, could result in an excessive shift of resources away from physical science and engineering research towards the health sciences. Such a shift, however, is by no means assured

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[29] *Allocating Federal Funds for Science and Technology*, National Academy of Sciences, Committee on Criteria for Federal Support of Research and Development. National Academy Press, Washington D.C. 1995. P. 12.

[30] For additional discussion on this issue see, Congressional Research Service, *A Department of Science and Technology: A Recurring Theme,* by William C. Boesman, CRS Report, 95-235 SPR, February 3, 1995. 6p.

and it may be too soon to tell whether this growth rate gap is creating any problems for the nation. Furthermore, there appears to be substantial support for maintaining a high level of funding for health research in order to attack major health problems that are afflicting a growing number of people as the nation's population ages. In any event, Congress will have a chance to address the issue when it considers the FY2002 budget request and, possibly, legislation to double nondefense R&D funding for most agencies. Early indications in Congress suggest that some Members already consider the gap a potential problem that can be best addressed by increasing R&D funding for other nondefense agencies.