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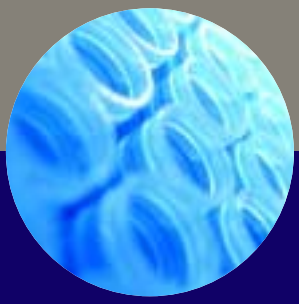



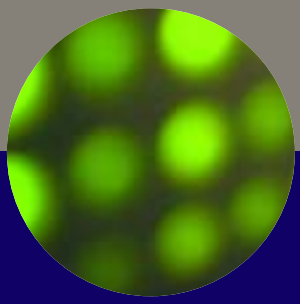

Carnegie Institution of Washington

At the Frontiers of Science

2004-2005 YEAR BOOK

CARNEGIE INSTITUTION OF WASHINGTON

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2004-2005 YEAR BOOK

The President's Report

July 1, 2004-June 30, 2005

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OF WASHINGTON

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ABOUT CARNEGIE

". . . to encourage, in the broadest and most liberal manner, investigation, research, and discovery, and the application of knowledge to the improvement of mankind . . ."

The Carnegie Institution of Washington was incorporated with these words in 1902 by its founder, Andrew Carnegie. Since then, the institution has remained true to its mission. At six research departments across the country, the scientific staff and a constantly changing roster of students, postdoctoral fellows, and visiting investigators tackle fundamental questions on the frontiers of biology, earth sciences, and astronomy.

CARNEGIE INSTITUTION

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THE PRESIDENT'S COMMENTARY

". . . we have sought to nurture basic science that holds great promise, if successful, but that may be far from the mainstream because of the high risk of failure, the difficulty of the problem, or the need for extended effort before results can be obtained. It is exactly such work that is likely to lead to transformational change—to significant and startling advances." —RICHARD A. MESERVE

Carnegie president Richard Meserve.

IMAGE COURTESY JIM JOHNSON.

In many respects, the U.S. is at a crossroads. The nation faces divisive issues concerning Iraq, tax policy, budget priorities, health care, and many other matters. Some of the controversies involve science, including issues relating to intelligent design, stem cell research, and climate change. All of these matters deserve careful and thoughtful response. But in my view, there is one issue that is of singular importance because it affects the nation's ability, either directly or indirectly, to respond to all of these matters. That issue is the capacity of the U.S. to harness science and technology to nurture continuing American success in the 21st century. I shall focus here on this issue and its relation to the Carnegie Institution.

It can reasonably be argued that the human condition advanced more significantly over the 20th century than over the entire remainder of history. This change was due in large measure to significant scientific and technical accomplishments. The harnessing of electricity has allowed illumination during the night and provided clean energy for use in the home and at work. In fact, nearly 16% of the world's electrical supply (20% in the U.S.) comes from nuclear fission, a form of energy that we did not even know existed at the turn of the 20th century. Automobile and aeronautical technology and highway development facilitated rapid transportation and have changed lifestyles around the globe. Water distribution and sanitization have provided safe and abundant drinking-water supplies that were unknown to our forebears. Medical advances have eradicated various diseases and substantially lengthened the average American's life span. Agricultural mechanization and biotechnology have enhanced the food supply.

The revolution in electronics has fundamentally altered communications and changed the way we amuse and educate ourselves. The Internet has provided ready access to an enormous range of information from anywhere in the world with a few mouse clicks. In short, our lives are vastly different from those who lived only a century ago.[1] The typical American has access to opportunities and capabilities that were beyond the reach, or even the imagination, of the wealthiest individuals in previous centuries. However, the treasure that science can yield is far from fully exploited; there is the promise of more startling change to come.

Progress notwithstanding, science and technology have also presented us with challenges. Technological advances, for instance, have created environmental problems—most notably, air and water pollution, as well as climate change. But science has simultaneously given us the capacity, if we have the will, to understand and limit adverse impacts. Any fair accounting of the balance sheet would show that science and technology have advanced the human condition far more than they have threatened it.

The U.S. has led the world in creating and implementing many of the past century's technical developments, yielding an economic and strategic strength that is vastly disproportionate to our population. But there are problems on the horizon. Globalization is presenting a challenge to our position as a world leader. Jobs are flowing overseas to lower-wage skilled workers even, through modern communications, for service work.[2] In technical fields in which the U.S. has long enjoyed an edge, we now face competition from countries such as China and India, which are growing quickly and whose workers' skills are expanding rapidly.

Of course, we should welcome the improvement of standards of living around the globe that has accompanied these changes. Such advances serve humanitarian purposes in that they enable more people to escape poverty, hunger, and disease. Moreover, these advances also nurture a web of economic, political, and personal connections that can minimize distrust, enhance cumulative prosperity, and further the prospects for understanding and peace. Nonetheless, there is reason to worry about the future position of the U.S. in a world in which the technological advantage that we have long enjoyed is diminished. It is not inconsistent to hope for advances in the rest of the world while simultaneously seeking to maintain our role as a scientific and technological pathfinder and thereby to maintain our leadership position.

With the encouragement of several members of Congress, the National Academies established a committee to examine the challenge of ensuring a prosperous future for the U.S. The committee was chaired by Norman Augustine, the retired chairman and CEO of Lockheed Martin, and included numerous prominent members from the academic and business communities.[3] Its report, *Rising Above The Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, includes a careful analysis of the role of science and technology in maintaining the vitality of the U.S., and sets out a number of actions that the U.S. should take to preserve its position as a global power.

In the face of growing scientific and technical capacities around the globe, the Augustine committee urged action to enhance K-12 science and mathematics education, to sustain science and engineering

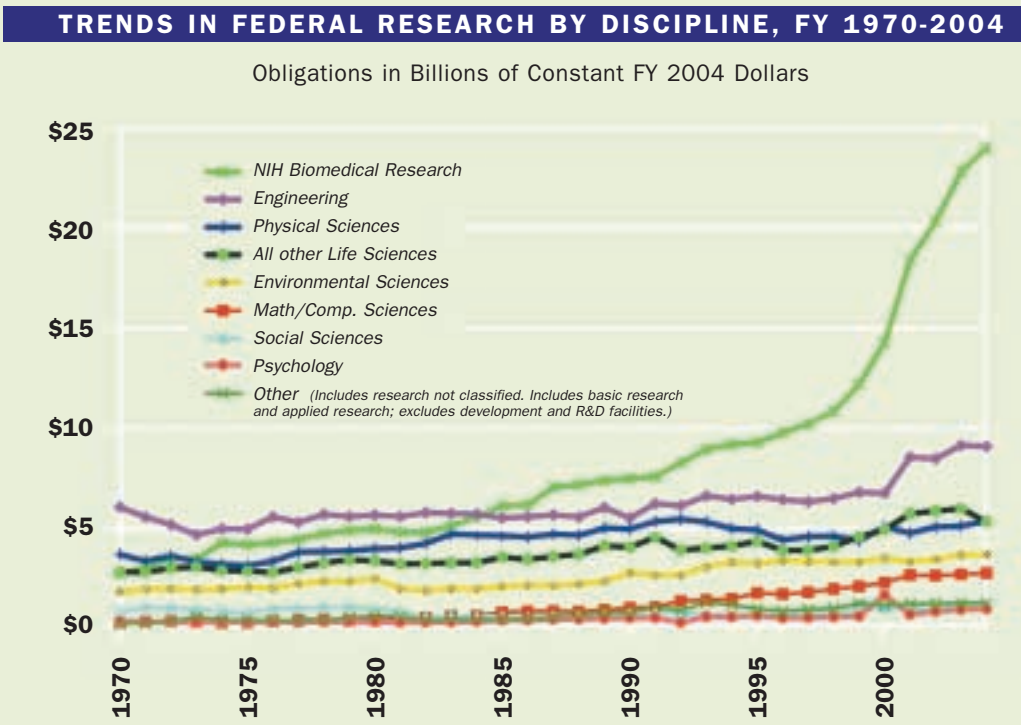

FIGURE 1
Trends in federal spending since 1970 show that most of the growth in scientific support has been in the life sciences.

IMAGE COURTESY AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, AAAS.

Life sciences—split into NIH support for biomedical research and all other agencies' support for life sciences. Source: NSF, *Federal Funds for Research and Development FY 2002, 2003, and 2004,* 2004. FY 2003 and 2004 data are preliminary. Constant-dollar conversions based on OMB's GDP deflators. October 2004 © AAAS.

research, to recruit the best and the brightest students to higher education in science and engineering, and to provide incentives for innovation. The report provides a clear, albeit very challenging, set of recommendations to protect our country's future. As this is written, it remains to be seen if we have the political will, or the financial resources, to pursue the committee's advice.

I shall focus on one recommendation that bears directly on the Carnegie Institution.[4] The committee highlights the importance of strengthening the commitment to long-term basic research, noting that such work is "transformational," in that it can yield sweeping change. The committee observes that the private sector cannot be expected to invest adequately in such basic research for many understandable reasons: the benefits may not be captured by the private sponsor, the work is risky, and shareholder pressure for short-term results discourages such long-term investments. There is a role for government support, but

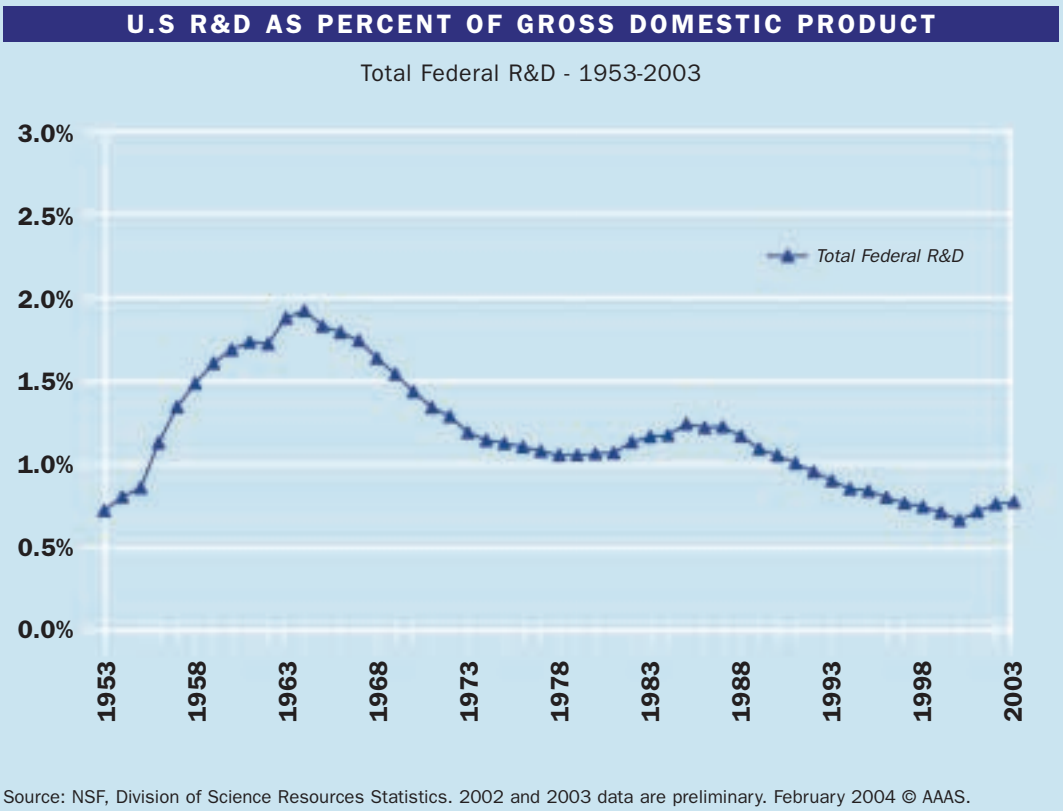

FIGURE 2
The total federal research and development spending has declined in recent years as a percentage of U.S. gross domestic product.

IMAGE COURTESY AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, AAAS.

the trends in government funding are not encouraging. Although federal support for research has grown in real terms over several decades, nearly all of the growth has been in the life sciences (Fig. 1). And, in the face of an expanding economy, federal support of research and development has declined as a percentage of U.S. gross domestic product by a factor of two over the course of several decades (Fig. 2). The current budget deficits make it difficult to respond to this situation. But, to preserve the nation's future, the committee strongly recommends a very dramatic increase in investment in basic research.

The committee's recommendation highlights an emphasis that has been the Carnegie Institution's guiding purpose since our beginning over a century ago. Andrew Carnegie's deed of trust provides that the institution "shall in the broadest and most liberal manner encourage investigation, research and discovery" and thereby enable "the application of knowledge to the improvement of mankind." In defining the mission of the organization, Andrew Carnegie directed that it should "discover the exceptional man in every

department of study wherever and whenever found . . . and enable him to make the work for which he seems specially designed his life work." Consistent with this philosophy, we have sought to nurture basic science that holds great promise, if successful, but that may be far from the mainstream because of the high risk of failure, the difficulty of the problem, or the need for extended effort before results can be obtained. It is exactly such work that is likely to lead to transformational change—to significant and startling advances. In short, the type of research that the Augustine committee concludes is of singular importance to the nation has been and will continue to be a hallmark of Carnegie's scientific efforts.

Carnegie has a proud tradition in the pursuit of basic science, as a consideration of the work of Carnegie scientists reveals. Some of Carnegie's researchers are well known:

- Edwin Hubble, who revolutionized astronomy with his discovery that the universe is expanding and that there are galaxies other than our own Milky Way;
- Charles Richter, who created the earthquake measurement scale;
- Barbara McClintock, who won the Nobel Prize for her early work on patterns of genetic inheritance;
- Alfred Hershey, who won the Nobel Prize for determining that DNA, not protein, harbors the genetic recipe for life;
- Vera Rubin, who was awarded the Presidential Medal of Science for her work confirming the existence of dark matter in the universe; and
- Andrew Fire, who with colleagues elsewhere opened up the world of RNA interference, which was acclaimed by *Science* magazine as the Breakthrough of the Year in 2002.

Many other Carnegie scientists continue work at the forefront of discovery. In the following pages of this Year Book, we sample some of the startling scientific advances from each of Carnegie's departments over the past year. These examples give a flavor of the vibrancy of our institution.

As shown by the report of the Augustine committee, the research that Carnegie pursues is of a type that is central to the health of the nation. Although we can be only one participant in what must be a broad national effort, we will continue to strive to be an important contributor. Many exciting discoveries lie ahead. The best is yet to come for the Carnegie Institution, for the nation, and for the world.

Richard A. Meserve
December 21, 2005

[1] George Constable and Bob Somerville, *A Century of Innovation: Twenty Engineering Achievements That Transformed Our Lives* (Washington, D.C.: National Academy of Engineering, Joseph Henry Press, 2003).

[2] Thomas Friedman, *The World Is Flat: A Brief History of the Twenty-First Century* (New York: Farrar, Straus and Giroux, 2005).

[3] The study was chartered by the Academies' Committee on Science, Engineering, and Public Policy (COSEPUP). At the time the study was started, my predecessor as Carnegie president, Maxine Singer, served as its chair. I am a member of COSEPUP.

[4] The committee's recommendations relating to K-12 education also bear on Carnegie's efforts. Our educational activities are discussed in this Year Book.