CHAPTER 1

Introduction

When Franklin Delano Roosevelt and a Democratic congress won control of the federal government of the United States in 1932, a controversial new view of how federal influence and money might be used to change American society was also inaugurated. The active role of the federal government in pursuit of that view led to the creation of many federal agencies in the quarter century between 1932 and 1957 and brought about a very different nation than had existed previously. With the approval of the American public, that view is still firmly in place sixty-five years later, but controversy continues over how widely it should be extended and precisely how it should be implemented.

One far-reaching change that came about during World War II was an increase in government involvement in scientific research. This area was largely left to the private sector of the United States before the war, apart from certain special developments that were the result of patient, determined pressure from forward-looking private citizens. For example, soon after the first powered airplane flight at Kitty Hawk, the enormous potential of aviation required an agency to coordinate research and development and advise the government on progress in aviation. After years of prodding—remember that the Wright brothers successfully flew their airplane in 1903 and made trial flights for the War Department in 1908—the National Advisory Committee for Aeronautics was created in 1915, one year after the beginning of the First World War. It is worth noting that NACA, as it came to be called, received an annual budget of $5,000 for its first five years. By the early 1920s those funds were supplemented by private money from the Daniel Guggenheim Fund for the Promotion of Aeronautics, which supported programs in the new science at several universities and helped to stimulate wide interest in it. By 1929 fourteen hundred aeroengineering students were enrolled in more than a dozen universities in the United States; and in 1930 the Guggenheim Fund helped bring the brilliant Theodore von Karman from Germany to the California Institute of Technology (Caltech), thereby enriching aerodynamic theory and planting the seed from which the famous Jet Propulsion Laboratory of Caltech grew. The influence of NACA will reappear in these pages, evident not only in the development of aeronautics but also as an early training ground for U.S. science policy makers. Apart from NACA, however, and the National Bureau of Standards (NBS), whose name defined its function, virtually all other science laboratories in the nation were in the private sector, mostly in universities.

With the onset of WWII in Europe in 1939, the government and a number of eminent advisers on science recognized that coordination of research and development in areas other than flight and physical and chemical standards—particularly in weapons development and medicine—was a matter of extreme urgency and required government action. How this coordination was carried out and—because it was so successful—its outgrowth after the war are matters of more than historical interest. The idea that emerged from the wartime experience and the decade thereafter was that federal funding for peacetime research in government agencies and institutions outside the government, especially universities, would be vitally important to the well-being of the nation. This idea is no longer subject to serious dissent, but questions of how funding should be provided, how it should be controlled and to what extent, what fraction of the available resources should be devoted to research, and how to set the emphasis between science and technology are still far from being completely resolved after fifty years of government sponsorship of research.

The first step toward the present system occurred near the end of World War II, when on November 17, 1944, President Roosevelt wrote to Vannevar

Bush, then director of the Office of Scientific Research and Development, asking for recommendations of ways in which the federal government might help to promote science and science education after the war. The Office of Scientific Research and Development (OSRD) was a World War II agency that had coordinated development of radar and the proximity fuze, among other important weaponry innovations, and of startling advances in military medicine, all at the same time and in parallel with the development of the atomic bomb by the Manhattan Project. These national efforts are acknowledged to have been eminently successful in coordinating scientific research and applying existing knowledge to the solution of the technical problems that arose in the war.

President Roosevelt's letter was a model of its kind, brief but specific in its request, optimistic and uplifting, as one of its paragraphs conveys: "New frontiers of the mind are before us, and if they are pioneered with the same vision, boldness, and drive with which we have waged this war we can create a fuller and more fruitful employment and a fuller and more fruitful life." By the time Vannevar Bush was able to reply in July 1945, however, President Roosevelt was dead, and it was to the new president, Harry S. Truman, that Bush transmitted his report, titled *Science: The Endless Frontier*. The report laid out a detailed plan for the federal support of science and science education in peacetime, much of which was implemented in the Truman and Eisenhower administrations. It was effectively responsible for the creation of two government science agencies: directly for the National Science Foundation and indirectly for the growth of the National Institutes of Health. Of equal importance, it emphasized the code of behavior to be followed by those agencies and other federal science agencies in carrying out the goals outlined in President Roosevelt's letter.

Despite its remarkable influence on successive administrations and the way it has contributed to the progress of American science during the fifty years since it was written, many scientists and certainly the general public are largely unaware of the content of *Science: The Endless Frontier*. Yet there is still much to be learned from the report, which incidentally is an easy read without legal or scientific jargon. In the United States today, where the yearly federal investment in basic science and technology—in what we might call the science establishment—amounts to about thirty-five billion dollars, it is valuable to recognize the roots of that establishment (the OSRD, the Manhattan Project, and the Bush report) and to follow the evolution of the system by which the federal government now funds and encourages science. This enables us to ask to what extent the system has been successful and whether it now needs to be changed in part or in whole. There is special urgency to answering this question today, in the wake of the cold war, when the issue of federal government support of research confronts the need for greater protection of the environment and increased social services, as well as the demand to balance the federal budget.

The heart of the present U.S. science establishment consists of five major federal science agencies: the National Institutes of Health (NIH) in the Department of Health and Human Services (DHHS), the Department of Defense (DOD), the National Aeronautics and Space Administration (NASA), the Department of Energy (DOE), and the National Science Foundation (NSF). These agencies are responsible for 85 percent of the federal government's basic science and technology budget; the remaining 15 percent is spent by about fifteen other federal agencies for which science and technology are peripheral to their main function. It is important to recognize that all the federal funding of science in colleges and universities flows through these agencies. This book will examine the four nonmilitary (non-DOD) agencies that affect science in the colleges and universities and describe how they got to be what they are today. The level of support made available by the DOD for basic science and technology in U.S. colleges and universities is unclear, reflecting Congress's ambivalent attitude toward the DOD's involvement in educational institutions, even in circumstances that might be beneficial to both parties. As a consequence, the DOD is not recognized as a major funder of basic scientific research in colleges and universities.

In attempting to justify the federal government's continuing investment in science and technology, scientists and engineers often point to particular achievements, a tactic that at best is only partly convincing and usually succeeds in pitting members of one scientific discipline against members of another. In fact the best way to argue for extensively funding science and technology is simply to say: Look around you, and don't get hung up on the occasional mistakes, conflicting claims and false advertising, or abuse of scientific knowledge. Instead, pay attention to the interplay between modern science and technology that has given rise to deeper insights into the world around us, while at the same time improving the physical comfort and quality of our lives. Astronomy, chemistry, and physics—the so-called hard sciences—have advanced in ways that could not be foreseen at the turn of the twentieth century and continue to move forward with unabated momentum. The biological sciences have progressed from the narrow paths of descriptive disciplines preoccupied with categorization and nomenclature to the wider boulevard of molecular and cell biologies. Computer science and computers have invaded most households and businesses as well as science laboratories. In the industrially developed nations at least, human life expectancy has been substantially increased—for example, from the fifty-year average life expectancy in the United States in the early 1950s to the remarkable life expectancy of seventy-six years in 1993. At the same time, much human pain and suffering have been alleviated by advances in medicine, dentistry, and personal and public hygiene, all products of the better understanding brought about by science and technology.

Taken together, these achievements sustain each other across disciplinary boundaries through new ideas and new experimental techniques. But the sustenance common to them all has been financial support by the federal government during the past half century, which in turn stems from public approval of that use of tax money. The American science establishment is a vast enterprise, however, and its public approval depends on the degree to which the significance and vitality of the enterprise are made clear not only by media reports of new accomplishments but also by periodic overviews of the enterprise as a whole. A parallel purpose of this book is to provide one such overview.

The next chapter describes the OSRD and the Manhattan Project and their accomplishments in WWII. This is primarily to emphasize the spirit and style they established. A short account of Vannevar Bush, the unique individual who was the first presidential science adviser and the architect of the present science establishment, is included for the same reason. Chapters 3 through 7 recount the highs and lows of the fortunes of the science establishment, decade by decade, from the tumultuous beginning of each science funding agency through the changes forced on them, individually and jointly, by national and world events, up to the present. The last chapter is a summary and an attempt to look into the future of science not only as an individual pursuit but also as an organized, societal purpose in the hands of successive new generations.