CHAPTER 5

End of the Honeymoon: 1965–1975

Entering the decade 1965–1975, the science establishment was an integral component of the research conducted in the United States; by the end of the decade, the establishment was under siege.

By 1965 the science establishment consisted of twenty federal funding agencies, fifty or so private and state universities with large research faculties and graduate student bodies, and several industrial laboratories also pursuing basic research. Laboratory facilities in many universities, neglected during WWII, had been remodeled by federal grants after the war. Facilities that were beyond the financial capability of a single university—laboratories with new, specialized apparatus such as particle accelerators, astronomical observatories with advanced technology telescopes, and hospitals with elaborate diagnostic equipment—were built and subsidized annually to provide U.S. and foreign scientists with modern research equipment. In some instances, the facilities were operated by associations of universities that were responsible for staffing, for equitable use of the facility by qualified scientists throughout the nation, and for the quality of the research produced. The facilities themselves remained the property of the federal government. There were also many federal laboratories, focused on limited areas of research, that were expected to produce important direct applications.

The entire enterprise, excepting only the NIH, was under the benign ministry—as opposed to supervision—of the president's special assistant for science and Technology and the president's Science Advisory Committee (PSAC), both of which had been put in place in 1957, primarily to address science issues related to national security. In practice, the enterprise was self-governing by means of a multitude of loosely connected committees and panels whose recommendations were based mainly on the peer review process.

Under this system, all the federal support of science and technology in the United States—particularly in the universities—flowed through the federal science funding agencies, and it still does today. The variety of agencies gave individual scientists a choice among funding agencies with different interests and different personnel to which they could submit proposals. Equally important, rejection of a proposal for support of a project by one agency was not the end of the world; the proposal could be and usually was resubmitted or submitted elsewhere, often with a successful outcome. In general this loose, unstructured system worked well because the members of each scientific discipline had been educated in pretty much the same way, had similar goals, and were part of the common disciplinary culture.

Within the agencies there were a number of science administrators, many with advanced degrees in their specialties, who found personal fulfillment in encouraging and facilitating research done by others. These administrators helped to set agency policy and were the point of contact with university scientists. They were organizers of the peer review committees and panels, transmitters of recommendations for action within an agency, and ultimately participants in preparing budget requests of Congress. In short, as dedicated public servants of science, they held together the diverse U.S. science establishment that had emerged twenty years after the end of WWII.

The government's commitment to the continuing support of basic science was subjected to its first serious test in the decade 1965–1975, which was not a good one for the nation. Caught up in the many crises of the cold war, the United States defeated the USSR attempt to emplace nuclear warheads in Cuba—the Cuban Missile Crisis—and reacted with increasing irritation and force to the North Vietnamese policy of political murder as a means to conquer South Vietnam. President Johnson greatly enlarged the U.S. presence in Vietnam despite serious misgivings among his own advisers and in the nation as a whole. The military draft was a festering sore on the body of the nation's youth. It divided the country between those who saw service in Vietnam as a moral obligation and those who saw refusal to serve in what they believed to be an illicit war as an equally moral obligation. During much of the decade, the United States was suffocated by the Vietnam quagmire, unwilling either to win or to lose the full-scale war that had developed for fear that exertion of greater force might lead to a larger war.

The war in Vietnam sharply divided most communities in the United States, and the science community was no exception. Members of the PSAC itself were divided on issues arising from the conflict. In response, President Johnson became angry with the divisions within his own White House science structure and was less cooperative with PSAC than Eisenhower and Kennedy had been. Nevertheless, the science adviser and PSAC continued to carry out many studies of scientific, educational, and international concern. Fewer studies relating to national security were undertaken, however.

The succeeding administration under President Nixon did not immediately move to end the war, which gave rise to further unease and impatience among the public at large. The embattled Nixon administration also found it difficult to understand or tolerate criticism, particularly public criticism, of presidential policies by some members of the PSAC. The conduct and official reporting of the war was disturbing to the PSAC, as were the administration's positions on development of an antiballistic missile system and supersonic transport. Disagreements on these issues widened the breach between the president and his advisory committee. Nixon also believed that the Department of Defense had an adequate supply of technical advisory committees and that PSAC should devote most of its attention to nondefense matters, as it had in fact been doing. Nixon's staff was less compromising; they did not understand the work of the PSAC, were especially unhappy with the members who questioned White House policies, and judged the PSAC to be an overall political liability. In January 1973, at the start of Nixon's second term, the position of science adviser to the president was abolished and with it the PSAC and the Office of Science and Technology.

The Johnson and Nixon administrations, deeply preoccupied with the deteriorating situation in Vietnam and the public reaction to it, were seriously upset by the mistrust and disapproval of their policies shown by U.S. university faculties and students. They were particularly ired by the disapproval of American scientists. After all, both administrations contended, scientists were supposed to be a conservative group more likely than most to have the patience to wait for a positive turn of events. Johnson's loss of confidence in the science adviser and the PSAC and their ousting by Nixon were attempts by those administrations to distance themselves from the science community as a whole. Moreover, the war was costing more than either president had anticipated, and fiscal prudence was in order. The budget for the federal science agencies was an expense that could be appreciably reduced, since it did not contribute directly to the prosecution of the war. From a cynical point of view, the reduction would also divert scientists' complaints about the war to complaints about the inadequacy of their funding. Accordingly, the budget of the NSF, always the bellwether agency, sustained a 20 percent decrease in 1969, after peak budgets in 1966–1968. Similarly, the number of permanent, full-time employees of the NIH's Division of Research Grants was reduced steadily by budget cuts in the period from 1969–1974, during which the number of applications submitted for review increased from eight to thirteen thousand.

In the view of the Johnson and Nixon administrations, when scientists took government money to support their research, they became in effect adjuncts of the government, not exactly members but no longer private citizens either. If the Oppenheimer case had not already done so, the hostility of the White House toward its scientific advisers reinforced the idea that elected government officials expected cooperation not criticism from them. And they extended this expectation to the science community as a whole.

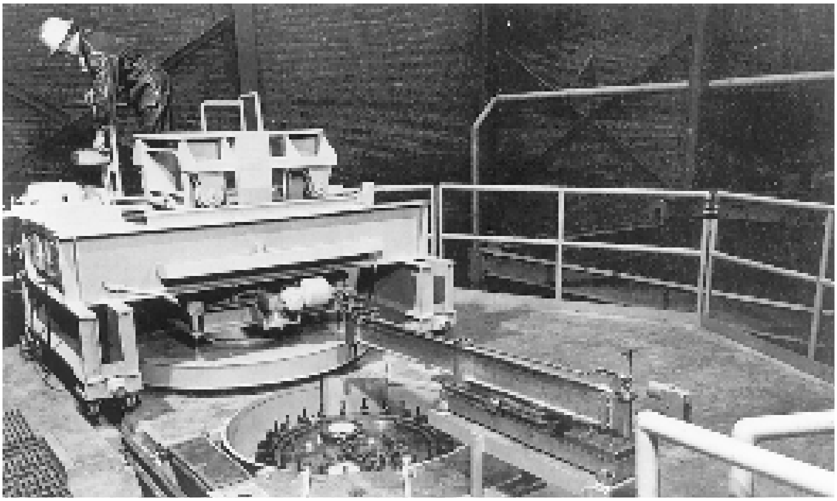
Scientists did not immediately react. They would, however, be more wary of affiliations with the government, particularly with the DOD. This wariness coincided with vociferous and unruly demonstrations by students and faculty against classified research on their campuses. In turn, Congress would forbid the DOD from supporting university research unrelated to its military mission. Whether intended or not, the stage was set for the development of an R&D establishment within the DOD essentially independent of and remote from the science establishment outside the government.

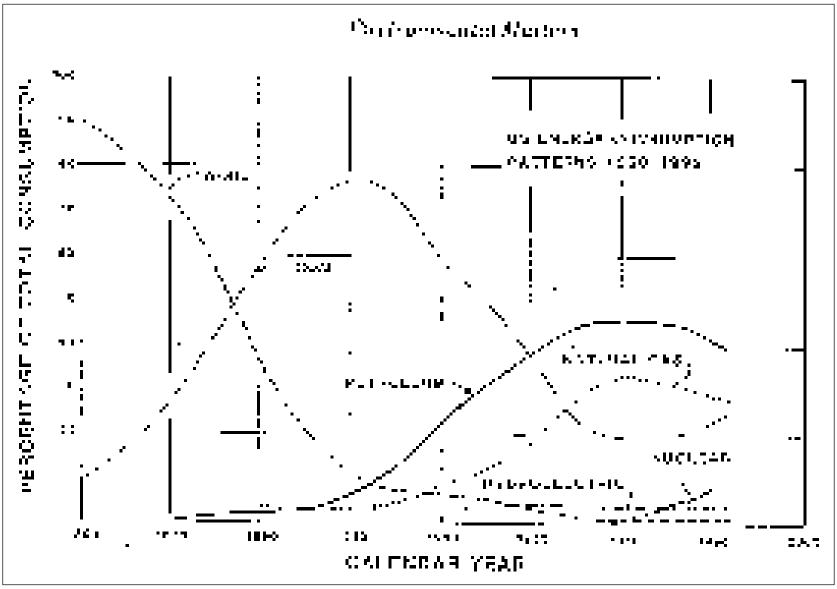
The Atoms for Peace program continued to be thwarted by public fear of the atom in any form and by cost competition from conventional energy sources, yet the energy crisis in the early 1970s demanded a unified federal energy policy.

By 1965 atomic energy and atomic weapons had fully emerged from government and military councils into the mainstream of American life. Atomic energy for peaceful purposes and atomic weapons as deterrents of war or as agents for waging war were unrelated applications of the atom. But the public intuitively associated both with the radioactivity they had come to dread after seeing the survivors of Hiroshima and Nagasaki. While most people would pay lip service to the difference between a nuclear reactor and a nuclear bomb, the collective consciousness inextricably connected them to radioactive danger. Neither the AEC nor private industry, both working toward the promotion of nuclear power, recognized the intensity of that aversion to the atom in any form or any application.

It might have been possible to relieve the worst of those fears through strenuous, nationwide educational programs that clarified the difference between bombs and reactors and emphasized the concerns for safety incorporated in reactor designs. The commission was too preoccupied, however, with the technical problems involved in development of power reactors to initiate such a program. And private industry did not then see the problem, much less the solution. The situation actually could have been open to remedy, because the public accepted previously the navy's construction of nuclear submarines in U.S. shipyards, close to population centers, without strong reaction. There was implicit faith—warranted or not—that the navy and the civilian shipbuilders would exercise due care to prevent accidents. That faith might have been carried over to include private nuclear power reactors, but the effort to promote this goal never materialized.

What might have been a redeeming feature of nuclear power—modest capital costs and low operating costs—was not forthcoming at the time of the rush to exploit it. The first power reactor in the nation, at Shippingport, Pennsylvania, in 1957, was described as an economic failure, but it did cause the commission to initiate the Power Demonstration Reactor Program that encouraged industry to design, construct, and invest in other power reactors. By the late 1960s seventy-five nuclear power plants were on order with

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a total capacity of forty-five thousand megawatts of output electricity, compared with the fledgling sixty megawatts at Shippingport.

Soon thereafter, the aversion of the public to nuclear power began to be manifested in legal activity. The commission was forced by the courts to consider environmental hazards and other safety concerns in addition to radiation effects and to make substantive changes in its review and licensing procedures. All of this significantly increased the cost of nuclear power plants and decreased utilities' interest in building them.

By then, however, the commission was also worried about a potential shortage of uranium and began intensive study of breeder reactors that would produce more fuel than they would consume. But breeder reactors were also a source of bomb material, plutonium, the material used in the second atomic bomb of WWII. The coupling between the peacetime and wartime uses of atomic energy, which might well have been kept loose without concentration on the breeder reactor, became an intimate connection in the mind of the public and reinforced its fear of any peacetime use of the atom. Moreover, the commission and the utility industry were beset by the growing problem of what to do with the high-level radioactive wastes from nuclear power plants. The only commercial waste-reprocessing plant in the nation had closed down in 1972, and the long, unsuccessful quest for geologic storage sites began about that time. The absence of a waste disposal program in the early 1970s, combined with rising concerns about reactor and environmental safety, dimmed the future of nuclear power in the United States. In other Western countries, however, with fewer fossil fuel reserves, the movement to nuclear power was much stronger and nuclear

FIGURE 5.1. *Top*: Mechanism for removing fuel elements from an experimental breeder reactor, probably the one at Shippingport. This photograph, taken just before full power operation in December 1951, shows the small diameter of the reactor tank in comparison with the large amount of concrete shielding required. During removal a rod had to be shielded and kept in an inert atmosphere at all times.

Source: R. G. Hewlett and Francis Duncan, *Atomic Shield: A History of the U.S. Atomic Energy Commission*, vol. 2, *1947/1952* (Washington, D.C.: U.S. Atomic Energy Commission, 1972), p. 462.

Bottom: U.S. energy consumption patterns, 1850–1992. Note that it has taken roughly sixty years to shift from one dominant fuel to the next.

Source: D. Allan Bromley, *The President's Scientists* (New Haven: Yale University Press, 1994), p. 144. Courtesy of D. Allan Bromley.

power was soon on its way to dominate electric power production in England, France, and Japan.

The nation's ambivalence toward nuclear power and the intense emotions aroused by debate on the subject effectively prevented serious consideration of a broad national energy policy, which was lacking in the United States as late as the 1960s. Historically, Americans relied on private industry to establish production and distribution of the sources of energy, except on occasions when the federal government undertook major energy development projects such as dam building and rural electrification. Even then, federal intervention was regional in nature and restricted to specific technologies. The multiplicity of fuels and resources and their exploitation had caused the government—a large-scale user of energy in many forms—to establish agencies to protect its interests and the interests of individual citizens. The agencies proceeded independently, however, and energy and fuel technologies were not treated in any unified way. For example, the Office of Oil and Gas and the Office of Coal Research, both within the Department of the Interior, acted independently, enforcing conservative practices and fair pricing in the absence of a broader directive. Any such directive would have required some form of explicit national policy and opened the government to the accusation of undue interference in the business of the private sector.

This state of affairs was called into question in 1971 by President Nixon, who observed in a message to Congress that the United States could no longer take its energy supplies for granted. Since 1967, he noted, the United States' rate of energy consumption had outpaced the nation's production of goods and services. Conflicts between energy producers and environmentalists forecast difficult choices that would worsen the energy situation. To address the problem, Nixon asked Congress to establish a department of natural resources to unify energy resource development. That proposal made little headway in Congress or with the public, since both were convinced that the prospect of an energy shortage could not be taken seriously, not at a time when fuel for their cars and homes and industries was ample and seemingly inexhaustible.

The situation changed drastically in October 1973, when war broke out again in the Middle East. The Organization of Petroleum Exporting Countries (OPEC) placed an embargo on crude oil shipped to the United States. A month later, oil supplies were critically low, creating acute shortages of fuel for cars and electric power plants. Nixon's warning had been validated, but a public opinion poll in January 1974 did not confirm that the U.S. public believed the shortages to be real. The responsible parties, they thought, were the oil companies and the federal government, not necessarily the Arab nations.

Nevertheless, the Nixon administration moved rapidly to establish the Federal Energy Administration, a temporary agency intended to meet the energy crisis. The Watergate scandal forced President Nixon to resign in August 1974, but soon after, amid the national turmoil provoked by his resignation, Vice President Gerald R. Ford assumed the presidency and signed the Energy Reorganization Act. It established the Energy Research and Development Administration (ERDA) and the Nuclear Regulatory Commission (NRC) and abolished the Atomic Energy Commission. The NRC was given the authority to license and regulate nuclear power plants, originally functions of the AEC, while the development and production of nuclear power and weapons went to ERDA, which, under the reorganization, also acquired the task of unifying all energy concerns and technologies within the federal government. The energy research and development functions of the Office of Coal Research and the Bureau of Mines also went to ERDA, as did the NSF offices of solar and geothermal development and the Environmental Protection Agency's work on innovative automotive systems.

The Energy Research and Development Administration was activated on January 19, 1975, with Robert C. Seamans Jr. as administrator. Seamans was president of the National Academy of Engineering and a former secretary of the air force. He divided the new agency into traditional units—fossil energy; nuclear energy; and solar, geothermal, and advanced energy systems—and further established units for environment and safety, conservation, and national security (including weapons research and production).

Seamans was required by the Energy Reorganization Act to consult with the secretary of defense to decide whether the nuclear weapons programs should be transferred to the Department of Defense or retained under civilian control in ERDA. One year later, their report to the president recommended that civilian control be continued under ERDA because civilian weapons research laboratories were already uniquely capable to handle such research and development.

The AEC was the first exclusive science and technology agency handling projects of such magnitude that it affected national security directly. Deeply involved in the production, testing, and control of entirely new weapons, all with enormous destructive power, the AEC was fortunately shielded from the outside world and its reactions. Recall that committees were formally prescribed in its enabling legislation: the Joint House and Senate Committee on Atomic Energy, the Military Liaison Committee, and the General Advisory Committee. Taken together, the AEC and its committees were a well-balanced, carefully crafted instrument, fully able to carry out the duties originally assigned by Congress. In the turbulent thirty-year period of unrelenting heavy pressure that followed its creation, it served the nation well.

On the other hand, the circumstances that produced ERDA—the energy crisis and the administrative desire to unify responsibility for national energy resources and operations—ensured that it would be simply another government agency left with the burden of continuously justifying its policies to Congress. There, a wide spectrum of contending opinions on energy policy were represented, often loudly and contentiously. Protection from those contending forces might have come from the inclusion of a standing House/Senate committee on energy to oversee ERDA, but that was never provided. Nor was provision made in the ERDA legislation for scientific and technological support of the new agency by nongovernment committees. The new agency was left to carry its burden alone. The absence of outside support and constructive criticism for the Department of Energy (DOE), which, as planned, would replace ERDA in two years' time, would be an ongoing, serious detriment.

The Daddario-Kennedy amendment brought the National Science Foundation more closely under the wing of Congress.

In 1965, during Leland Haworth's tenure as director of the NSF, a subcommittee of the House Committee on Science and Aeronautics, which had been created in the aftermath of *Sputnik*, began to review the NSF charter. Three years later, at the same time as approval of a $500 million NSF budget, Congress passed a major amendment—the Daddario-Kennedy Amendment—to that charter. The amendment required annual reviews of the NSF's programs by both the House and Senate subcommittees on science. It also required annual authorization for its budget appropriation, replacing the continuing authorization that had been provided in the original NSF act. The amendment also specified that the appointments of the associate director and the four assistant directors be made by the president. Previously, presidential approval had been required only for the director and the Science Board. Besides making the foundation more vulnerable to political interference, the Daddario-Kennedy Amendment sought to bring operation of the foundation more firmly under the control of Congress. Now Congress could explicitly direct the NSF to support social sciences and applied research. Those disciplines, long subjects of contention, were dealt with in the NSF by the experience gained from trial and error. The value of an explicit directive to fund them was at best debatable.

The Daddario-Kennedy amendment significantly changed the NSF, but Congress and the White House were not done yet. The first in a series of events was the selection and subsequent repudiation by the Nixon administration of Franklin Long, a distinguished chemist at Cornell University, to succeed Haworth as director of the NSF. Nixon determined that Long was unacceptable because Long had opposed the administration's antiballistic missile program. Many scientists were already alienated by and highly suspicious of the ultimate effectiveness of the program, and they deplored its wastefulness. On the occasion of the appointment of only the third director of the NSF, the original nonpolitical condition for selection was violated.

The directorship was assumed by William D. McElroy, a Johns Hopkins University professor of biochemistry, who set out to move the NSF toward a larger budget and a higher public profile. In 1969, when McElroy took office, the NSF was spending $400 million annually, compared with its $40 million pre-*Sputnik* budget. In that year, however, it experienced the first decrease—of almost 20 percent—in its history, allocated by Congress and the administration. The reasons given for the retrenchment were an oversupply of Ph.D.s and the lack of relevance of the NSF's programs to national problems, particularly the war in Vietnam. To address the budget cut and accomplish his goal of a $1 billion agency, McElroy felt it necessary to work closely with the Office of Management and Budget (OMB), formerly the Bureau of the Budget, in shaping the NSF's programs as well as its expenditures. The National Science Board, the NSF's and McElroy's statutory advisory board, strongly opposed OMB influence in policy making of the NSF, and, as they feared, it temporarily weakened the agency.

Concern with relevance led McElroy to initiate a program known as Research Applied to National Needs (RANN), which was also a response to the Daddario-Kennedy Amendment. The establishment of RANN was anticipated in 1970 by a modest $6 million program with the grandiose name Interdisciplinary Research Relevant to Problems of Our Society (IRRPOS).

Following NSF practice in the basic sciences and engineering, the foundation requested proposals from the scientific community in the areas of environmental quality and urban growth and management. After two years, and without significant accomplishment, IRRPOS expanded into RANN.

The NSF and OMB jointly attempted to design a comprehensive program of technical innovation for a presidential message on science but did not succeed in producing anything persuasive enough for presentation to Congress and the public. However, the attempt did stimulate OMB to promise a $100 million budget increase to NSF in return for its support of a major applied research program focused on national problems. The program was intended primarily as a stimulant to the national economy. A pump-priming program was recommended to most federal agencies by the OMB in the 1972 budget year. The foundation agreed to phase out a major portion of its educational programs in return for the $100 million, part of which would go for applied research. Yet RANN had another budgetary effect on the NSF. The rise of expenditures for RANN coincided with the phaseout and termination of the Institutional Support Program (ISP) of the NSF. From 1960 to 1974 Institutional Support furnished block grants to institutions, primarily universities; funds could be applied to research support, instrumentation, and graduate research facilities. The ISP attempted to improve the science infrastructure of those universities that had suffered in WWII and again in the financially tight years during and after the Korean War. It was a major part of the NSF's growth, accounting for 20 to 25 percent of the research budget during the period from 1960 to 1968. But beginning in 1969, with the NSF's $30 million budget cut, the program decreased rapidly and was essentially supplanted by RANN, even though the content and clients of the two programs were entirely different. By the time RANN was downgraded in 1977 to a small applied research directorate, it had spent almost $500 million. Most of the program was transferred to ERDA and later to the DOE.

These forays by Congress and the OMB into NSF policy and operations were too hit-or-miss in nature to have lasting value or to do lasting damage. Moreover, the steps taken to make the NSF leadership subject to political direction did not accomplish what their proponents intended because committees of Congress were not equipped to exercise detailed day-by-day direction of a science foundation. The NSF was damaged, however, by the increased extent to which appointments of its directors were politicized. An ominous indicator was the resignation of McElroy in 1972, after a tenure of only three years (Waterman had served two full terms, a total of twelve years, and Haworth, six). H. Guyford Stever, who succeeded McElroy, also served a mere three years but that was during the time when the Nixon White House was feuding actively with the science establishment. Stever had been in the OSRD throughout WWII and was chief scientist of the U.S. Air Force afterward, in 1955–1956. He was professor of aeronautics and astronautics at MIT and president of Carnegie-Mellon University from 1965 to 1972. President Nixon assigned him the task of making the science-advising system work while he served simultaneously as science adviser and director of the NSF.

Nevertheless, the core values of the NSF remained intact, and it prospered financially throughout the incursion by RANN, despite the demise of the institutional support program. The growth of RANN coincided with significant increase in individual investigator support. In 1970, when RANN started, individual investigator awards accounted for 50 percent of the NSF budget. By 1978 individual awards reached 66 percent of the total budget, more than twice the dollar amount expended in 1970, and RANN ceased to be supported. The other categories of major expense were group research and facilities, the latter signifying the NSF's support of major experimental facilities, which substituted for institutional awards. The dedication of the NSF to its primary mission—the support of basic science in a variety of fields and mathematics and engineering—gave rise to advances in many of those fields, leading more individuals to compete for grants from the larger NSF budget. The quality of the proposals that were submitted was raised by the competition, and the awards were more widely distributed geographically, a result that Congress originally sought.

Internal and external politics roiled the National Institutes.

The NIH was undergoing its own difficulties, similar to those plaguing the NSF. Two issues vital to the well-being of the NIH arose once more, this time with increased intensity. The first was the issue of peer review, with its implication of elitism. The second concerned the relative value of research initiated by individual investigators as opposed to centrally managed programs with consensus goals. These issues provoked serious discussion within the medical community, but differences therein were exacerbated by congressional interference and especially by the climate of hostility toward science emanating from the executive office. Much of the real internal problem came from the NIH's enormous growth during its short existence. The

DRG organization, which once operated with a personal touch, had become necessarily an impersonal bureaucracy. It still intended to maintain prompt review procedures but was forced to develop cumbersome requirements that alienated many of its applicants, even successful ones. But once funding leveled off, followed by Vietnam War–driven budget cuts, the NIH realized that it had overexpanded to the point that it could not meet its obligations as long as the budgetary crisis remained.

At the same time, the Nixon administration, in what was perhaps a legitimate effort to reduce the federal commitment to biomedical research, waged an unnecessarily vindictive war against the grant system, summarily firing a director of the DRG, suspending training grants, and reducing the number of review committees. Of even greater concern, it attempted to abolish, or at least radically change, the peer review system itself. The OMB in fact called for abolition of the study section function. Only Nixon's resignation in August 1974 thwarted this wrong-headed plan, but by then it had unleashed contending forces within the NIH and DRG and further encouraged discord between the academic science community and the NIH. For example, an NIH planning committee studying administrative reform expressed a preference for review by a new office of extramural services of all submitted proposals, based on what it called "program relevance," prior to the consideration of technical merit. This idea went against the basic tenets of the NIH, and the incoming NIH director, Robert S. Stone, ruled against establishing such an office. On the government side, an assistant secretary in the Department of Health, Education, and Welfare, remarked that the extramural review system was "governed by the public will" and cautioned the NIH against any change in its organization that would reduce the government's involvement in NIH operations.[1]

Nevertheless, the NIH began yet another examination of the DRG to consider limiting its independence in favor of a larger review role for the individual institutes or perhaps to do away with it completely. After expansion in the early 1960s, the DRG was downsized by one-third, and this staff reduction, coupled with a new, artificial ceiling on the allowable number of study sections, worsened the situation. Committees and study teams were formed to debate administrative change and modernization. A complicating factor in these deliberations was the Sunshine Law of 1974, a mandate intended to change the merit review procedures of all government science agencies by opening all meetings to public attendance. The Grants Peer Review Study Team, consisting entirely of NIH officials, was organized early in 1975 to consider the Sunshine Law, its constraints, and the operating regulations newly issued by the Department of Health, Education, and Welfare. The study team chairperson, Ruth L. Kirschstein, director of one of the NIH institutes, presented one current of thought of the time by asking the broader questions: "How can a system, devised in an era of elitism, of secrecy, and of economic growth . . . be adapted to an era in which stress is on equal opportunity, openness, and limited availability of funds? . . . If such a system proves unworkable, what system should be substituted?"[2]

After thirty years of nonstop growth and extraordinary accomplishments, such overstated questions and the self-examination they involved were unlikely to lead to an improved peer review and award system. Indeed, the study team brought forth a number of recommendations following

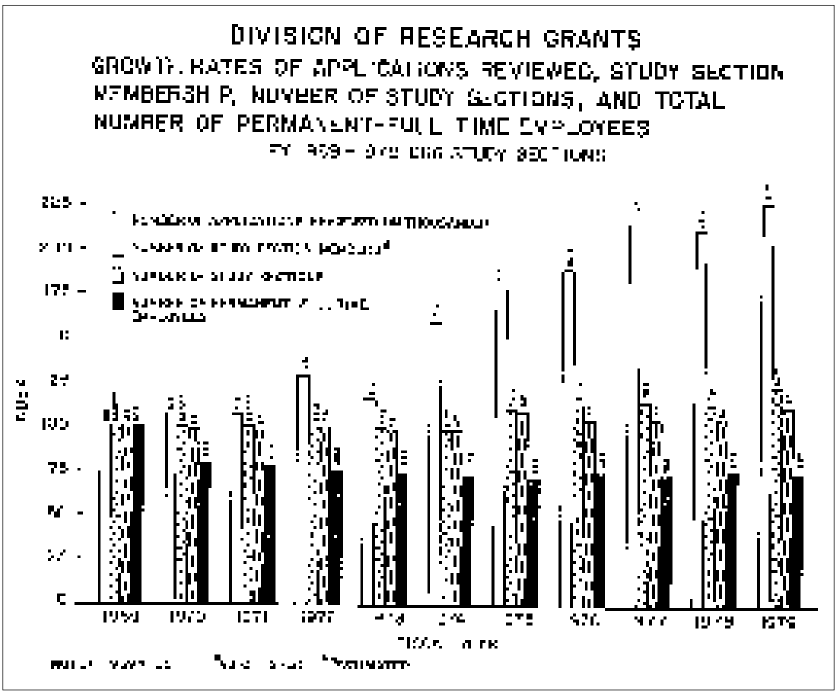

FIGURE 5.2. Ten-year survey of growth rates of the Division of Research Grants in several areas.

Source: Richard Mandel, *A Half Century of Peer Review (1946–1996)* (Alexandria, Va.: Division of Research Grants, National Institutes of Health, Logistic Applications, 1996), p. 123.

extensive opinion surveys of academic review group members and respondents at public hearings. In the end, the DRG was held up as a model organization, one that expertly carried out the review function. More than 95 percent of those surveyed had rated the DRG review process as "good" or "excellent." Large majorities spoke strongly against congressional demands for public access to review procedures and against charges that the study sections were afflicted with bias, mediocrity, and cronyism. The DRG retained its influence in extramural policy making and review.

It would strain credulity to think that all the real internal problems of NIH had been solved by 1975 and that the organization would function seamlessly thereafter. What had been accomplished was consolidation and survival during a time of fiscal retrenchment and national upheaval. In the face of an administration whose mien was adversarial and dictatorial, the NIH had endured, as had the NSF, with values intact, and the marriage of science and government had been preserved, albeit uneasily.

NASA put a man on the moon and began consideration of its future in the post-Apollo period.

The specter of cost returned to haunt the government's view of the space program. As the decade 1965–1975 began, NASA was moving toward the goal set by President Kennedy, and few in Washington were likely to raise objections to the legacy of the assassinated president. Nevertheless, the NASA program in its entirety was not justifiable in the period of fiscal conservatism brought on by the Vietnam War. The *Gemini* program—to prepare for human experience in space—could not be relinquished if the *Apollo* program to put a man on the moon was to succeed, but a number of peripheral efforts could be delayed or even allowed to lapse in the interest of saving money.

These cutbacks were prudent, dictated by NASA itself for certain peripheral tests and experiments. Neither the White House nor Congress directed the cutbacks. A case in point, involving a reversal of roles, was the Supersonic Transport (SST), a supersonic jet plane intended for commercial airline use. The Kennedy administration endorsed studies of an SST, and NASA, in cooperation with the air force, began a test program that produced a Mach 3 airliner a few years later. That airliner required a titanium airframe instead of the customary aluminum, because titanium could withstand the greater heat generated at the increased speed. The test program produced valuable data on supersonic flight relevant to military aircraft. It also demonstrated that shock waves from SST airliners, even at the slower Mach 2, would prohibit supersonic routes over the continental United States. For reasons of economy, the test program was terminated at the time of the *Apollo* moon expedition.

Later, when the question arose of U.S. entry into the international SST airliner race, NASA had a solid base of experience to contribute to a U.S. effort. Wise counsel from Deputy Administrator Hugh Dryden, however, kept NASA in a supportive but secondary role. He reasoned that the *Apollo* program effectively prevented NASA from sponsoring another expensive program during the same budget years because they would each compete for the same funds. The fate of the SST in the United States, despite its promotion by the Nixon administration, testified to Dryden's wisdom. Furthermore, the tragedy of the three astronauts in the spacecraft originally intended for the *Apollo* mission put in motion a redesign of the spacecraft wiring system and a materials study program that alone cost $50 million. The $450 million and the manpower required by that emergency were available to NASA without competition from another high-priority in-house program.

The space administration approached its budgetary responsibilities in a sensible fashion: the White House and Congress fixed the annual budget under competing pressures from NASA and the OMB, but the emphasis and money invested in each component of the space and flight programs were determined almost exclusively by NASA itself. For example, the first discoveries about space from the earliest satellites suggested that it would be profitable to put up bigger, dedicated science satellites. These more complex spacecraft were built and launched in the mid-sixties, but their complexity caused many technical problems, and their results were generally disappointing. By the late sixties, the *Gemini* and *Apollo* programs preempted investment in the larger science satellites. At the same time, the planetary programs were also cut back, and the ambitious *Voyager* program was first curtailed and then dropped in 1968.

A year later, on July 20, 1969, Neil A. Armstrong and Edwin E. ("Buzz") Aldrin landed on the moon, took the first tenuous steps, planted the U.S. flag, and placed scientific apparatus on the lunar surface. After collecting rock samples, as geologists had been doing for centuries on the earth, they returned to the lunar module. The following day they returned to the command module for the flight home and to an ecstatic reception by a relieved and proud nation.

The *Apollo* mission had taken eleven-and-a-half years and had cost $23.5

billion. But by putting men on the moon, NASA acquired the equipment—mental, emotional, and technical—for humans to voyage in space. The world viewed NASA as the premier space agency, and its astronauts were regarded as folk heroes. There might have been cutbacks at the tail end of the *Apollo* program—the last three launches were scrapped, and the NASA budget went from $5 billion in the mid-sixties to $3.7 billion in 1970—but NASA, as seen by Americans, was now a national treasure and a source of glory.

At the same time that *Apollo* was developing, NASA embarked on a program of smaller Earth satellites dedicated to various commercial applica-

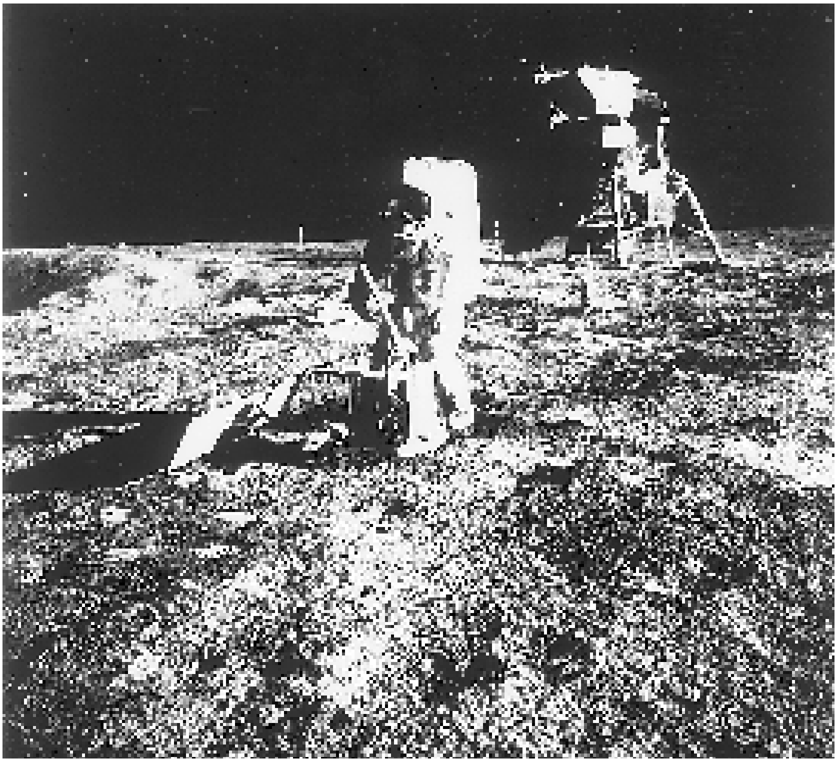

FIGURE 5.3. Astronaut Neil A. Armstrong took this photograph of Edwin E. Aldrin Jr., deploying the passive seismic experiments at Tranquility Base on the moon while the ungainly lunar module crouches in the background.

Source: R. E. Bilstein, *Orders of Magnitude: A History of the NACA and NASA, 1915–1990*, NASA SP-4406 (Washington, D.C.: NASA, 1990), p. 90.

tions. These became another major NASA achievement. The potential of communications satellites was recognized almost immediately, and NASA would not need to incur further expense in satellite communications once the research and development was completed. The Kennedy administration fostered the creation of the Communications Satellite Corporation (ComSatCorp), a government-industry collaboration with a strong international component. The corporation was given the authority to invite other nations to share in the investment as well as the service and profits, a feature that provoked a Senate filibuster before the proposal was eventually approved. The first ComSatCorp launch by NASA took place early in 1965. Later, weather and navigational satellites were launched but produced data of limited use, and large flows of cash and effort were not expended on satellite technology at the time. The experiences with these satellites led, however, to a proposal by the Department of Interior for an Earth resources satellite program that in 1972, after the peak of the *Apollo* program, developed into the very successful series of Earth Resources Technology Satellites (ERTS). A ready-made clientele, governmental and commercial, avidly sought information from ERTS—soon renamed the *Landsat* satellites—which yielded real-time data on virtually all of Earth's surface, including spectacular, extremely detailed photographs.

The successes of ComSatCorp and *Landsat* at the time when the *Apollo* mission was coming to an end heralded a new era for NASA, an era in which NASA would serve the human need for increased communication between people and nations, no matter the distance separating them. To a far greater extent than before, NASA would serve also the interests of basic science, physics, astronomy, and biomedicine. One initiative that arose during the 1972 NASA administration of Thomas O. Paine, was the space shuttle, which was proposed to the Space Task Group, a panel convened by President Nixon to advise on prospects for the post-Apollo period. The task group reported favorably on the space shuttle program, and once its cost was halved to $5.25 billion by the new NASA administrator, James C. Fletcher, development of the shuttle was approved.

A new relationship begins.

In the decade 1965–1975 the science establishment entered the real world of a protracted war, severe budget constraints, and a hostile administration in

Washington. However, the well-being of the establishment, nurtured by the federal funding of research, survived even that stressful period. Moreover, the spirit of cooperation between the federal science agencies and university scientists was in the main excellent. The funding level did not permit the growth rate of the previous two decades, but it was adequate to meet the challenges of the science of the time. U.S. science and technology achieved world eminence, despite the national turbulence in those years.

Once Gerald R. Ford acceded as president in 1974, Congress reestablished the Presidential Science Office and the position of science adviser to the president. Congressional approval and support of the science office and science adviser were thought to be necessary, and President Ford signed the bill creating this approval structure. Soon after taking office in 1977, President Carter, with a strong interest in science and engineering, made use of the structure and appointed Frank Press as the new science adviser. This appointment was well received. Under Press's leadership, the science office, newly named the Office of Science and Technology Policy (OSTP), was active once again within the White House.

Nevertheless, the relationship between the government—the White House and Congress—and the science community took on a different character after Nixon and Ford. Both sides recognized a mutual loss of trust and confidence. The easy spirit of consultation and cooperation engendered during WWII and in existence for more than a quarter century had changed. It was not a hostile relationship as it had been under Nixon, but it was stiffer and more formal than it had been before. In 1968 Congress passed the Mansfield Amendment, which forbade the DOD from supporting any research in universities not directly related to the military mission, and though later it would be weakened, this law remained influential in the policies of military and university administrators. Nixon's belief that the Department of Defense should be essentially independent of external science advisers contributed to and confirmed the major expansion of a research and development establishment within the DOD. Finally, Presidents Ford and Carter, while restoring a science advisory structure to the White House, did not reestablish the nonpartisan advisory committee, the PSAC. Those administrations would require science advisers whose loyalty was virtually guaranteed. All these events contributed to a separation—not a divorce but an estrangement—between political Washington and the science establishment.