Chapter Four

Organizing for Exploration

by Sylvia K. Kraemer

The Eisenhower administration's calculated policy of "open skies" and "peaceful uses of space" to enable satellite overflights of other nations virtually assured that the U.S. non-defense space program would be lodged in a civilian agency.[1] Eisenhower's uneasiness over an emerging military-industrial complex, expressed in his Farewell Address,[2] no doubt also contributed to his view that all non-defense-related space activities should be assigned to a new civilian organization. Scientists—who recognized that scientific exploration of space would fare better intertwined with a "peaceful," or nonmilitary, space program—agreed with Eisenhower. The president's own Science Advisory Committee, chaired by James R. Killian, Jr., of the Massachusetts Institute of Technology, favored creating a civilian national space agency out of the nucleus of the National Advisory Committee for Aeronautics (NACA).[3] In a March 1958 memorandum to President Eisenhower, Killian joined forces with Bureau of the Budget Director Percival Brundage and Nelson A. Rockefeller, chairman of the President's Advisory Committee on Government Organization, to make a lucid case for choosing NACA over the proposed alternatives, the most prominent of which were the Department of Defense (DOD), the Atomic Energy Commission, a private contractor, or a new Department of Science and Technology, to lead "the civil space effort." [IV-1, IV-2, IV-3, IV-4, IV-5]

A New Organization

Created by the National Aeronautics and Space Act (PL 85-568) [II-17], the National Aeronautics and Space Administration (NASA) opened for business on October 1, 1958, with a complement of nearly 8,000 employees transferred from the old NACA research laboratories: Langley Aeronautical Laboratory at Hampton, Virginia (est. 1917); Ames Aeronautical Laboratory at Moffett Field, California (est. 1939); the Flight Research Center at nearby Muroc Dry Lake (est. 1946), now known as the Dryden Flight Research Center; and the Lewis Flight Propulsion Laboratory in Cleveland, Ohio (est. 1940). By the end of 1960, NASA personnel rolls had nearly doubled to over 16,000. The principal increases were a result of the tripling of NASA Headquarters personnel and the addition of portions of the Army Ballistic Missile Agency (ABMA), renamed the George C. Marshall Space Flight Center, and the new Goddard Space Flight Center in Beltsville, Maryland. Most of Goddard's personnel had been transferred from the Naval Research Laboratory (NRL) and the Naval Ordnance Laboratory (NOL). The Jet Propulsion Laboratory of the California Institute of Technology, a contractor-owned and -operated facility involved in rocket

1. See R. Cargill Hall, "Origins of U.S. Space Policy: Eisenhower, Open Skies, and Freedom of Space," Chapter Two of this volume.

2. "Farewell Radio and Television Address to the American People," January 17, 1961, *Public Papers of the Presidents of the United States: Dwight D. Eisenhower, 1960-61* (Washington, DC: U.S. Government Printing Office, 1962), pp. 1035-40. Quote from pp. 1038-39; "military-industrial complex" phrase on p. 1038.

3. The political and legislative origins of the National Aeronautics and Space Administration are described in Walter A. McDougall, *...The Heavens and The Earth: A Political History of the Space Age* (New York: Basic Books, 1985), Chapter 7, "The Birth of NASA," and Enid Curtis Bok Schoettle, "The Establishment of NASA," in Sanford A. Lakoff, ed., *Knowledge and Power: Essays on Science and Government* (New York: Free Press, 1966).

research since 1936, was also transferred from the U.S. Army to NASA. The Manned Spacecraft Center in Houston and the Kennedy Space Center at Cape Canaveral were added within the next three years.[4]

Because of the way NASA was initially assembled, a little over 80 percent of NASA's technical core during the 1960s and 1970s—its engineers and scientists—held within its corporate memory the experience of working with NACA, ABMA, and the Navy organizations from which the Goddard Space Flight Center had drawn much of its personnel. Each group would bring its own institutional culture. Predominating among NASA's initial cadre, the scientists and research engineers of NACA (est. 1915) had based their careers in an institution that had conducted research in aerodynamics and aircraft structures and propulsion systems for both industrial and military clients. Informally structured, NACA had been overseen by its Main Committee and various technical subcommittees, and its work in aeronautical engineering was done largely by civil servants. Aside from its work in aeronautics, what distinguished NACA as an institution was the ethos that permeated its laboratories. With its emphasis on technical competence, evaluation of one's work by technical peers, and a collegial in-house research environment conducive to engineering innovation, the NACA centers were not well equipped for the sweeping institutional growth and change that would complicate their life after 1958.[5]

To the technical core of NACA were added, during NASA's first two years, the complementary Naval Research Laboratory habits of in-house engineering research and science and, by the ABMA group, the emphasis on in-house technical development characteristic of the Army's arsenal system. The presence at ABMA of a contingent of German rocket engineers reinforced its emphasis on in-house technical mastery and control. What these various components shared was a common culture that placed technical judgment above political competence. They undoubtedly also shared the conviction that they were embarked upon an exploratory venture unrivaled in the annals of mankind.[6]

The new agency's charter, the "Space Act of 1958," had given it broad latitude to contribute "to the general welfare and security of the United States" by expanding "human knowledge of phenomena in the atmosphere and space" and preserving "the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere." Within three years—not much time given the pace of policy evolution in most popularly elected governments—John F. Kennedy provided NASA a specific mission so compelling that debate over just how NASA's broad charter was to be carried out was effectively quieted.

The Cold War, most notably in the "Sputnik Crisis," and then the flight of Yuri Gagarin in 1961 stimulated not only the creation of NASA in 1958 but its tremendous expansion in the early 1960s to carry out the Apollo program.[7] After President John F. Kennedy issued

4. By the end of 1960, the old NACA laboratories and Marshall Space Flight Center accounted for 49 percent and 33 percent, respectively, of NASA's employees. (The Manned Spacecraft Center in Houston, Texas, was added in 1961. The U.S. Army's Missile Firing Laboratory at Cape Canaveral, Florida, was added to Marshall Space Flight Center's organization in 1960 and was renamed the John F. Kennedy Space Center in 1963.) The 157 personnel who had been working on the Navy's Project Vanguard, which became the nucleus of the Goddard Space Flight Center (est. 1959), were transferred to NASA in 1958 from one of the Navy's own in-house research laboratories, the Naval Research Laboratory. They were soon joined by 63 more who had been working for the Naval Research Laboratory's Space Sciences and Theoretical Divisions. The next large group to transfer to NASA was the 5,367 civil servants from the Army Ballistic Missile Agency (ABMA) at Redstone Arsenal, in Huntsville, Alabama. ABMA had been essentially an in-house operation. The youngest NASA installations, the Manned Spacecraft Center (renamed Johnson Space Center in 1973) and the Kennedy Space Center, were initially staffed by personnel from Langley Research Center and the ABMA.

5. Alex Roland, *Model Research: The National Advisory Committee for Aeronautics, 1915-1958* (Washington, DC: NASA SP-4103, 1985); Nancy Jane Petrovic, "Design for Decline: Executive Management and the Eclipse of NASA," Ph.D. Dissertation, University of Maryland, 1982 (Ann Arbor, MI: University Microfilms International, 1982).

6. On NASA's culture, see Howard E. McCurdy, *Inside NASA: High Technology and Organizational Culture in the U.S. Space Program* (Baltimore, MD: Johns Hopkins University Press, 1993).

7. Thanks to the GI Bill and its Korean War counterpart, the military services' reserve officers' training programs, cooperative work-education programs, and draft exemptions for those in engineering school or working for the government in engineering fields, NASA and its contractors were able to mobilize unprecedented numbers of engineers and scientists.

his challenge to the nation in May 1961 to send a man to the Moon and return him safely within the decade—a challenge framed within the Cold War contest between the Communist Bloc nations and the "free world"—NASA undertook a mobilization comparable, in relative scale, to that undertaken by the United States to fight World War II. The agency's civil service personnel rolls increased by a factor of three, while the men and women employed on NASA contracts increased by a factor of ten. Likewise, NASA's annual budget increased an order of magnitude between 1960 and 1965, from roughly $500 million to $5.2 billion.

Table 1: Dimensions of the Apollo Mobilization[8]

Overall Budget (billions)

	Amount	Percentage Increase
FY 61	$0.964	——
FY 62	$1.825	89%
FY 63	$3.674	101%
FY 64	$5.100	38%
FY 65	$5.250	2%

Construction of Facilities Budget (millions)

FY 61	$98.2	——
FY 62	$217.1	121%
FY 63	$569.8	162%
FY 64	$546.6	-4%
FY 65	$522.2	-4%

Personnel

In-House NASA	Contractor	Ratio	
1958 (9/30)	8,040	——	——
1960	10,200	36,500	1:3.5
1961	17,500	57,000	1:3.3
1962	23,700	115,500	1:4.9
1963	29,900	218,400	1:7.3
1964	32,500	347,100	1:10.7
1965	34,300	376,700	1:11

Contracting Out

The private sector provided even more scientists, engineers, technicians, and supporting personnel for Apollo than did NASA. Throughout its history, between roughly 80 percent and 90 percent of NASA's budget has gone into goods, services, and development procured from the private sector through contracts. The notion of relying on private industry and universities did not originate with NASA's Apollo-era Administrator James E. Webb (1961-1968)—though both necessity and good politics made him a natural

8. Jane Van Nimmen and Leonard C. Bruno with Robert L. Rosholt, *NASA Historical Data Book, Vol. I, NASA Resources, 1958-1968*, (Washington, DC: NASA SP-4012, 1988), pp. 137-141, 134, 63-119.

champion of contracting out as the best way of getting the agency's work done. NACA had supplemented its in-house research with contracts to Stanford, the Massachusetts Institute of Technology, and other universities. To NASA's first administrator, T. Keith Glennan, and his ideologically sympathetic boss, President Eisenhower, reliance on the private sector came naturally.[9] [IV-7] Indeed, the practice had its roots deep in U.S. history. [IV-8]

Since the beginning of the republic, U.S. citizens have shared a widespread mistrust of large government establishments. Coupled with this mistrust has been a public faith in private enterprise that, through the mechanism of a free market, was thought the best guarantor of economic growth and a free society. On this usually bi-partisan ideological foundation, and partly in reaction to the alleged excesses of the New Deal, federal policy encouraged government agencies to acquire their goods and services from the private sector.

The military services had been acquiring equipment and logistics support from the private sector since the early nineteenth century; they were well schooled in government procurement. More recently, it was the U.S. Army and U.S. Air Force, created out of the U.S. Army Air Forces under the Defense Reorganization Act of 1947 that established the Department of Defense, that had the most experience with contracting to the private sector. As a result of the Army's Manhattan Project and the ballistic missile programs managed by the Air Force's Research and Development Command, both services came to rely on private contractors for advanced engineering and development work and, in some cases, to assist in the technical direction of other development contractors—the Air Force going so far as to create the Rand and Aerospace Corporations.

Contracting out by NASA also had great practical merit. Because most of the experience in the country to date in related missile and high-performance aircraft development centered in industry, which had worked as contractors to the military, the resources of industry could be marshalled more effectively *by* the government than reproduced *within* the government. NASA would be able to harness talent and institutional resources already in existence in the emerging aerospace industry and the country's leading research universities.[10] In 1959 the General Services Administration authorized NASA's use of the Armed Service Procurement Regulations of 1947, which contained important exemptions, suited to research and development work, from the principle of making awards to the "lowest responsible bidder." Contracting out promised the additional political advantage of dispersing Federal funds around the country and, as a consequence, creating within Congress a political constituency with a material interest in the health—and management—of the space program. The attempt to meld different institutional cultures into a single organization was not without its problems. For example, when the California Institute of Technology's Jet Propulsion Laboratory (JPL) became affiliated with NASA on January 1, 1959, its managers believed the lab would be called upon to play the dominant role in determining America's space exploration agenda. NASA had a much more limited role in mind for JPL, however, and the resulting conflict between these divergent expectations laid a foundation for lingering animosity between the two institutions.[11] [IV-6]

By 1961 the federal government had been contracting to the private sector for much of its research and development work for two decades, since World War II. Enough questions had been raised about the wisdom of that policy to prompt President John F. Kennedy to ask the director of the Bureau of the Budget to review it. Budget Director David E. Bell was joined in this task by the secretary of defense (Robert S. McNamara), the administrator of NASA (James E. Webb), the chairman of the Civil Service Commission (John W. Macy, Jr.), the chairman of the Atomic Energy Commission (Glenn T. Seaborg), the director of

9. On Glennan, see J.D. Hunley, ed., *The Birth of NASA: The Diary of T. Keith Glennan* (Washington, DC: NASA SP-4105, 1993).

10. One NASA installation, the Jet Propulsion Laboratory of the California Institute of Technology in Pasadena, California, would remain wholly a contractor operation. For an excellent and brief discussion of the NASA acquisition process, see Arnold S. Levine, *Managing NASA in the Apollo Era* (Washington, DC: NASA SP-4102, 1982), Chapter 4.

11. Clayton L. Koppes, *JPL and the American Space Program* (New Haven: Yale University Press, 1982.)

the National Science Foundation (Alan T. Waterman), and the special assistant to the president for science and technology (Jerome B. Wiesner). The report—which came to be known as the "Bell Report"—constituted a detailed and comprehensive review of federal contracting for research and development. [IV-9]

The Bell Report affirmed the federal government's policy of relying "heavily on contracts with non-federal institutions to accomplish scientific and technical work needed for public purposes." At the same time, it cautioned that "the management and control of such programs must be firmly in the hands of full-time Government officials clearly responsible to the President and the Congress. With programs of the size and complexity now common," it continued,

. . . the Government [must] have on its staff exceptionally strong and able executives, scientists, and engineers, fully qualified to weigh the views and advice of technical specialists, to make policy decisions concerning the types of work to be undertaken, when, by whom, and at what cost, to supervise the execution of work undertaken, and to evaluate the results.

This requirement, according to the Bell group, was not being met: "In recent years there has been a serious trend toward eroding the competence of the Government's research and development establishments—in part owing to the keen competition for scarce talent which has come from Government contractors." The solution, advised the budget director and heads of federal research and development agencies, was not "setting artificial or arbitrary limits on Government contractors" but creating a working environment and offering salaries that would better enable the government to compete with the private sector for top scientific and engineering talent. However wise and well-intentioned the Bell Report's recommendations may have been, they do not seem to have had great effect. "Contracting out" continues to this day to be a primary issue among NASA managers, scientists, and engineers.

Program Management

Not only were NASA's procurement procedures based on those of the military establishment, but NASA made extensive use of the military's experience in program management as well. The ratio of military detailees to civilians working in NASA increased steadily between 1960 and 1968.[12] Many of the detailees were Air Force or Navy career officers assigned to program or operations management positions. For example, 103 of the roughly 180 military detailees in NASA at the beginning of 1963 were career Navy or Air Force officers.[13] [IV-10] Though fewer in number, program managers who had honed their skills in private industry also helped to manage the NASA enterprise. For example, NASA's Office of Manned Space Flight was led during much of the 1960s and 1970s by men who had come from industry, such as George E. Mueller (Space Technology Laboratories), Dale D. Myers (North American Rockwell), and John F. Yardley (McDonnell Douglas Astronautics).

The epitome of the proven military program manager at NASA was U.S. Air Force Major General Samuel C. Phillips. Schooled in Air Force research and development

12. Nimmen and Bruno with Rosholt, *NASA Historical Data Book, Vol. I,* pp. 80-81, 98-99.

13. Albert F. Siepert, Memorandum to James E. Webb, February 8, 1963, NASA Historical Reference Collection, NASA Headquarters, Washington, DC. A list of positions "requiring USAF officers" forwarded by NASA to the Department of the Air Force in 1964 included: director, program control, Apollo; director, program control, Saturn V; deputy director for program management, Apollo spacecraft; assistant to director for program management, Saturn V; chief, configuration management, Apollo spacecraft; configuration management officer, Saturn V; chief, configuration management, Saturn I-IB; configuration management officer, Gemini; configuration management officer, Apollo launch site; assistant deputy director for program management, Apollo program office; configuration management officer; and chief, mission requirements, Apollo. Attachment to Eugene M. Zuckert, Secretary of the Air Force, Memorandum to Hugh L. Dryden, Deputy Administrator of NASA, May 27, 1964, NASA Historical Reference Collection.

program management at Wright-Patterson Air Force Base, Ohio, Phillips was assigned in 1959 to manage the development of the "Minuteman" intercontinental ballistic missile. Phillips was convinced that the development of a new technology system required that the program head have centralized authority over engineering, configuration management, procurement, testing, construction, manufacturing, logistics, and training. Phillips' success with the Minuteman program won the admiration of NASA's Associate Administrator for Manned Flight George Mueller, who brought Phillips to NASA where he served as deputy director and then program director for the Apollo program.[14]

What this conglomeration of assorted talents drawn from NASA and the military wrought was not simply the historic feat of placing Americans on the Moon and bringing them back safely. Less visible but no less important was their catalytic role in the emerging ability of U.S. industry to develop, manufacture, and operate large, complex, and sophisticated technical systems. In 1968, *Science* magazine, the publication of the American Association for the Advancement of Science, observed:

In terms of numbers of dollars or of men, NASA has not been our largest national undertaking, but in terms of complexity, rate of growth, and technological sophistication it has been unique. . . . It may turn out that [the space program's] most valuable spin-off of all will be human rather than technological: better knowledge of how to plan, coordinate, and monitor the multitudinous and varied activities of the organizations required to accomplish great social undertakings.[15]

NASA and military managers responsible for developing new aerospace technologies stimulated the government's contractors in U.S. industry to adopt program management and systems engineering strategies that would promote their survival in a market dominated by a few large federal customers.

The forces that have influenced the management strategies characteristic of U.S. industries at any given time have varied both with the nature of contemporary economic trends and with the nature of the goods being produced. For example, in the United States during the 1880s and 1890s, in an era before the triumph of mass media consumer advertising, companies sought to control markets by controlling production and/or prices. Firms producing relatively undifferentiated commodities (e.g., whiskey, salt, coal, tobacco, sugar, and kerosene) attempted to combine financial as well as management structures to achieve more effective market control within an industry. Toward the end of the century, such combinations were increasingly subject to state and federal anti-trust legislation. Successful prosecutions under the Sherman Anti-Trust Act of 1890 brought about the dissolution of such "horizontally integrated" firms as the Standard Oil Company of New Jersey and the American Tobacco Company.

Meanwhile, U.S. firms that began to produce increasingly complex manufactured items sought to achieve economies of scale in an expanding market through mass production and volume retailing (e.g., sewing machines, automobiles, and typewriters). By integrating vertically—controlling as many steps in the production of an item as possible, from raw material through manufacture and even marketing—firms (e.g., Carnegie Steel) combined to create even larger companies better able to withstand the economic oscillations of the period between the end of the Civil War and 1896.

The new large enterprises could no longer be administered informally, with control of markets the principal preoccupation of management. Creative managers of some of these enterprises (in, for example, the tobacco, meat-packing, and agricultural power machinery industries) developed the centralized, functionally departmentalized organizational structure. After 1900, a new wave of expansion occurred in industries exploiting new technologies such as electrification and the gasoline engine. Product diversification became a common strategy for expansion in firms that could exploit systematic research

14. That Phillips enjoyed continuing esteem long after Apollo was reflected in NASA's request that he head a comprehensive post-*Challenger* accident study of NASA's management practices.

15. Dale Wolfe, Executive Officer, American Association for the Advancement of Science, editorial for *Science*, November 15, 1968.

and development—firms in the chemical, rubber, automobile, and electrical industries. Product diversification, in turn, required a different organizational approach to management. The strategy of diversification was followed by decentralization in these firms' organizational structures.

Decentralization, however, posed its own administrative problems for these firms. How was authority to be distributed among headquarters and field activities? The most common solution was that developed by managers of the railroads nearly a half-century before: the multi-divisional line-and-staff organization, by which authority was delegated from headquarters to plant managers in the field (who could not otherwise be held accountable for the performance of their units), while managers of centrally located auxiliary or service functions set standards and procedures.[16]

In post-World War II America, several new forces began to make themselves felt on U.S. industry and, as a consequence, gave rise to new management strategies. Among these was the entrance of the public sector—primarily the federal government—into the marketplace as a significant buyer. Another was the emergence of a substantial market, and a responding productive capacity, for goods and services having highly sophisticated technological ("hardware," "software," and "services") components.

The importance of technological sophistication as a driving force in this new market cannot be overestimated. The largest public sector buyer, the military establishment, seeking out ever-improved weapons systems, funded industrial research and development both indirectly as a buyer of newer and more advanced systems and directly as the largest single investor in research and development.[17] How much the U.S. economy has been affected by these two factors—the federal government as buyer and that buyer's interest in new technologies—is reflected in the top five industries (measured by sales) in the United States in 1988. Heading the list are two U.S. industries well-established before World War II: petroleum refining ($284.3 billion) and motor vehicles and parts ($273.1 billion). Third, fourth, and fifth are industries that were initially stimulated by the federal government's post-World War II appetite for technologically sophisticated systems and its ability to find ways to pay for them: electronics ($115.3 billion), aerospace ($112.8 billion), and computers and office equipment ($112.6 billion).[18] The sales and capital represented by these figures grew on a foundation built of successfully managed government research and development programs.

To appreciate the complexity of the technical management and quality controls, not to mention coordination and accounting, that government and industrial managers faced in assuring the success of one major NASA program, consider the prime contracts awarded to industry to design, build, test, and certify the principal components of the Saturn V alone: Boeing Co., S-IC, first stage (powered by five F-1 engines); North American Aviation, S-II, second stage (powered by five J-2 engines); Douglas Aircraft Company, S-IVB, third stage (powered by a single J-2 engine); Rocketdyne Div. of North American Aviation, J-2 and F-1 engines; and International Business Machines (IBM), Saturn instrument unit.[19]

Were this the extent of industrial contractor involvement in the program, that would have been management challenge enough. In addition, a *partial* listing of the *subcontracts* these contractors awarded to other firms that "played a major role in the development and

16. Alfred D. Chandler, Jr., *Strategy and Structure: Chapters in the History of American Industrial Enterprise* (Cambridge, MA: M.I.T. Press, 1962), Chapters 1, 2, *passim.*

17. Ross M. Robertson, *History of the American Economy,* 2nd ed. (New York: Harcourt, Brace & World, Inc., 1964), p. 555. In 1946-47 the Federal government paid 24 percent, and industry paid 72 percent, of the dollars (est. $2.1 billion) spent on industrial research and development during that period. By 1969 the federal government's share of the total (est. $28 billion) had increased to 40 percent and industry's share declined to 58 percent. Which sector (private or public) actually spent the rapidly increasing number of dollars devoted to research and development during 1946-1969 underwent a comparable change: industry spent 62 percent of the nation's research and development dollars in 1946-47 and 76 percent in 1969

18. *The World Almanac and Book of Facts* (New York, 1990), p. 86. Data from *Fortune* magazine.

19. North American Aviation was bought by Rockwell and was known as North American Rockwell Corp. after September 1967. In 1967 Douglas Aircraft Co. and the McDonnell Corp. merged, becoming the McDonnell Douglas Corporation. The former Douglas division in California became the McDonnell Douglas Astronautics Co. (MDAC).

production of the Saturn V launch vehicle" would have to include the 50 subcontractors to Boeing, 91 subcontractors to Douglas Aircraft, 54 subcontractors to IBM, 28 subcontractors to North American Space Division, and 51 subcontractors to North American Rocketdyne.[20] These well over 250 firms provided innumerable parts and components, ranging from hydraulic hoses to analog computers, all of which had to meet exacting specifications for integrated fit and performance. "I wish to emphasize," remarked a Marshall Space Flight Center procurement officer during the bidding for the S-II stage contract, "that the important product that NASA will buy in this procurement is the efficient management of a stage system."[21]

So impressive was the management undertaking involved in developing and fabricating the Apollo/Saturn systems that even before the historic Apollo 11 mission left the launch pad on the morning of July 16, 1969, the Committee on Science and Astronautics of the U.S. House of Representatives asked key industry Apollo/Saturn contractors and NASA program managers to review their program management practices. [IV-11] Their published responses make tedious reading, littered as they are with charts and acronyms and general ineloquence, but they have an important story to tell. Unlike the industrial firms of earlier periods of U.S. history, the firms that supplied the aerospace programs of NASA and the military were engaged in the low-volume production of items that were complex, novel, and relatively unique; thousands of "end items" produced by dozens of different suppliers and manufacturers had to fit and function together, and be produced on schedule and at the levels of reliability called for by manned missions. Thus the efficiency-seeking attributes of the traditional "American system of manufacture" (use of standardized interchangeable parts and continuous process manufacture) no longer applied.

The "efficiency"-inspired organizational structure of functionally distinguished units (e.g., finance, accounting, marketing, research, facilities, engineering, testing, manufacture, logistics, etc.), adequate for the production of essentially undifferentiated products, would not suffice. "Early in the development phase of the Apollo/Saturn effort," recalled Rocketdyne's vice president of management planning and controls, "Rocketdyne management recognized that the traditional functional organizational alignment was not adequate to direct the effort of the various engine programs effectively. To ensure the necessary concentration of effort, it was decided to establish separate product organizations with responsibility for the development of specific types of engines."[22] Not all companies had been organized like Rocketdyne; Boeing's management was "basically decentralized and organized around product line responsibilities," one in which "the functional executive provides a unifying force which crosses the boundaries of the various line organizations. . . ." Nonetheless, at Boeing the "line organization managers" had the "ultimate authority and responsibility for carrying out The Boeing Co.'s contractual and related commitments to its customers."[23]

The novelty and relative uniqueness of the aerospace industry's products necessarily meant that little would be "standard"; the ability to respond intelligently and quickly to failures would become a critical management responsibility. That responsibility was felt especially acutely among government (NASA) managers responsible for the Saturn program's success:

. . . such [Apollo/Saturn program management] features as actions for early problem detection, actions and process for problem solving, and action and processes for recovery from anomalies and failures are basic features. . .[24] *. . . the system must provide visibility and flexibility. You need the visibility to identify nonproductive tasks and you need the flexibility to redirect the effort. Otherwise,*

20. Roger E. Bilstein, *Stages to Saturn: A Technological History of the Apollo/Saturn Launch Vehicles* (Washington, DC: NASA SP-4206, 1980), *passim*, and Appendix E.

21. Manned Space Flight Center, "Minutes of the Phase II Pre-Proposal Conference for Stage S-II Procurement on June 21, 1961," JSC files. Quoted in Bilstein, *Stages to Saturn*, p. 211.

22. "Apollo Program Management: Staff Study for the Subcommittee on NASA Oversight, U.S. House of Representatives, Committee on Science and Astronautics, 91st Cong., 1st sess. (Washington, DC: U.S. Government Printing Office, 1969), p. 122.

23. H.H. Gunning (Boeing Co.), *ibid.*, pp. 15-16.

24. Eberhard F.M. Rees (NASA Marshall Space Flight Center), *ibid.*, p. 9.

you would be using up limited resources on tasks that were no good. Visibility and flexibility imply a knowledgeable decision point close to the work.[25]

The project manager, the program manager, and their staff became the "knowledgeable decision" points "close to the work" that government and industry created to manage the development and production of specialized technological systems. "The heart of the Program Management System," explained one NASA program manager,

is the Project Manager who is responsible for the design, fabrication, test, delivery, and successful performance of a major piece of hardware, a product best exemplified by a stage of the launch vehicle. To achieve his goal, the Project Manager has clear lines of authority and responsibility as well as clear channels of coordination with supporting entities. These have been committed to clear, concise documented agreements. . . . In addition to management by product, such as the S-II Stage, the Program and Project managers also manage, to an extent, by function. These functional management elements. . .permeate the entire program. . . . These elements insure, within their disciplines, a continuous coordination between the functional elements [among other NASA organizations]. . .enabling many things to be handled at the working level. . . .[26]

Critical communication and coordination between government "customers" and industrial contractor organizations required of the latter that they develop management systems that paralleled, or mirrored, those NASA established. One Rocketdyne manager described NASA's (and DOD's) impact on the aerospace industry this way:

During the past seven years NASA has had a significant and favorable influence in the development of advanced management systems within Rocketdyne. Program planning and control requirements specified by both DoD and NASA have stimulated such management systems activity as development and implementation of the Rocketdyne Cost Management System, the Mechanized Production Control System, the Mechanized Inventory Control System coupled with the Required Inventory Control System, the Mechanized Quality Performance System, and the Mechanized Time-keeping System, to name a few. New concepts such as the well-defined program organization operating in a program/functional matrix relationship, the assignment of specific individuals to manage all activity on product-oriented elements of program work breakdown structures, and the application of the multiple accountability technique also saw their genesis during this period.[27]

Similar managerial adaptations occurred throughout the aerospace industry.

The government's and the aerospace industry's strategy for managing the design and development of large, complex, and relatively unique technical systems—or program management—had an important political dimension as well. The project (the development of a single entity or system) and the program (a cluster of interrelated projects) soon became, in effect, products and product lines marketed by the military and NASA to Congress and the White House. NASA learned, as the military had learned, that Congress, relatively stingy with funds for abstract and indefinite activities such as fundamental research, could be persuaded to open the public purse for clearly defined packages of concrete "end items" with specific missions. Concrete end items meant actual hardware contracts that might benefit particular congressional constituencies. The Apollo program, like the Manhattan Project before it, was just such a package. A *program* thus became a bureaucratic and budgetary device for framing and executing projects to explore space and advance aeronautical technology.[28] The design and execution of a successful project became the measure of success, as many of NASA's people got caught up in the annual

25. R.L. Brown (NASA Marshall Space Flight Center), *ibid.*, p. 13.

26. Edmund F. O'Connor, "General Program Management," *ibid.*, p. 247-48.

27. *Ibid.*, p. 126.

28. NACA's more modest aeronautical research role—the "service" it provided the military and aviation industry—was rapidly replaced by NASA's need to direct its research and development know-how to specific programs, in particular, the manned spaceflight sequence known as Mercury, Gemini, and Apollo. Conceptually and administratively, the NASA program became the umbrella under which projects were justified and planned, congressional authorization and appropriations obtained, private sector sources solicited and evaluated, contract awards made, and those contracts administered.

need to market the agency's projects and programs to Congress to obtain the appropriations necessary to sustain their work.

In an early (1961) reorganization, NASA sought to discourage internecine competition for resources that developed when an agency organized itself around hardware programs by identifying its own programs with broadly framed goals instead. The Apollo program represented one such goal.[29] The ultimate effectiveness of this approach, however, depended somewhat on the nature of the goal used—on the variety of realistic hardware approaches that could be used to achieve it. For example, the goal of "Space Sciences" was fairly diffuse; many hardware projects could be embraced by it. This was less true for costly projects. After Apollo, only the shuttle and the hoped-for space station—each a very specific hardware program that would require relatively large portions of the agency's total budget—emerged to satisfy the goal of manned space exploration. To appreciate the emergence and effect over time of the "program" both as a managerial and as a political device, note its absence in Hugh L. Dryden's speech on the fledgling space program, given when NASA was only a few months old.

A Culture at Risk

It would be difficult to exaggerate the significance of the policy of "contracting out" in terms of the way NASA went about its daily work. Virtually every aspect of the agency's business was ensnared in the dense forest of regulations and procedures of federal acquisitions policy. The number of procurement actions processed by NASA quadrupled from roughly 44,000 in 1960 to almost 190,000 in 1963; by 1965, NASA was processing almost 300,000 actions, or almost seven times the actions the agency was managing only five years before. The dollar value of the average NASA contract more than doubled as well. However, during the same period (1960–1965), NASA's personnel increased by only a factor of three, and only a fraction of them was qualified to manage or monitor contractors. Thus, the burden of implementing the government's "contract out" policy was borne increasingly by NASA's technical people. Engineers who had come to NASA (or earlier to NACA) to do engineering found themselves increasingly cast in the role of overburdened contract monitors, ever more remote from the "hands-on" work that had attracted them in the first place. [IV-19]

Originally an aggregate of essentially independent, in-house research organizations, NASA also struggled with the centralized controls inherent in large-scale program management. As NASA faced, after 1966, tighter budgets, competition among the former NACA laboratories, new NASA centers, and Headquarters intensified. Because the centers managed the contractors, and because the centers housed NASA's technical expertise, they acquired the power of fiefdoms—and were often so called. Nonetheless, NASA sought to retain the discipline orientation of NACA's decentralized laboratories—further accentuating a tension between aspirations of various research disciplines and program organization that would persist through much of NASA's institutional life in the next thirty years.

The agency's inherited culture struggled against centralization at the government-wide level as well. When NACA was transformed into NASA in 1958, the committee structure by which it had been administered was abandoned for a hierarchical and centralized management structure. Centralized federal administrative controls that evolved during the 1940s and 1950s—controls such as standardized personnel management, budgeting, procurement, and operating procedures—were imposed on NASA by the Bureau of the Budget (after 1970 the Office of Management and Budget, OMB), the Civil Service Commission (after 1979 the Office of Personnel Management, OPM), and ultimately, of course, the U.S. Congress.

The proportion of NASA's total in-house permanent workforce consisting of scientists and engineers gradually increased from one-third in 1958 to slightly less than one-half

29. Levine, *Managing NASA in the Apollo Era*, p. 5.

in 1970. At the same time, the ratio of NASA's contractor employees to civil service employees increased from roughly 3 to 1 in 1960 to 11 to 1 in 1965 (see Table 1). After the post-fiscal year 1966 downward slide in NASA's funding, that ratio declined. Assuming an increase in externally imposed, and thus difficult to change, administrative burdens on NASA from 1960 forward, those burdens had to be carried increasingly by the agency's civil service scientists and engineers.[30]

Among externally imposed management controls, the federal personnel system has proven as critical to NASA as federal acquisitions policy. NASA's predecessor, NACA, had struggled against civil service pay scales and hiring/promotion procedures and ceilings, which, NACA insisted, made it difficult to recruit and retain good engineers. NASA was able to obtain 525 "excepted" positions[31] to hire the talent it needed to carry out the Apollo program. However these were indeed exceptions—exceptions to a long-term, systemic disregard by the federal personnel system of its impact on the agency's culture of technical competence. That system was and remains strongly biased toward seniority and generic functions; it assumes that increases in rank and salary should be directly related to increasing supervisory or managerial responsibilities.

Compounding this systemic barrier to "advancement" for engineers has been a cultural prejudice that goes back to Greek and Roman antiquity, the notion that those who work with ideas have greater social value than those who work with their hands—or "things." For typical managers, the hierarchical and centralized structure of power in most organizations (not excepting NASA) reinforces their increasing remoteness, as they moved "up the ladder," from practical, day-to-day concerns and "hands-on" work. More than four-fifths of the NASA engineers recruited during NASA's first decade "advanced" into management positions, and among the older engineers who were employed with NASA or NACA before 1960, over 90 percent ended their careers in management positions. Occasionally, a NASA engineer has risen to the level of GS-16 without moving into management, but the widespread perception within the agency has been that the dual-career ladder works only for the very exceptional few. Thus many NASA engineers' occupations diverged increasingly from their vocations as they began to spend more of their days doing work for which they had not been trained and may have had little natural inclination. On the other hand, some NASA engineers, fearing obsolescence in engineering careers, considered management a legitimate and productive alternative for individuals with some understanding of how technical programs work.[32] Engineers turned managers could then leverage their knowledge and experience through the projects for which they were responsible.

Looking for a Mission

The Apollo program was unarguably an enormous achievement. Nevertheless, the transient motives behind the program, and the rapid mobilization of funds and personnel that made success possible, impeded the gradual evolution of a stable and broad public consensus about the nation's purpose in space. As more than 13,000 NASA engineers worked at their daily routines during the mid-1960s, pursuing the adventure to which President Kennedy had summoned them, the solid ground of common national purpose had already begun to shift ominously under their feet. By 1965, John F. Kennedy lay buried, and three years later he would be joined by Robert Kennedy, who, along with Martin Luther King, would be victims of violence. Violence in the United States, as race-related riots spread from urban ghetto to urban ghetto, was matched by U.S. violence abroad.

30. Sylvia Doughty Fries, "Apollo: A Pioneering Generation," International Astronautical Federation, 37th Congress (October 9, 1986), Ref. No. IAA-86-495.

31. Appointments are exempt from standard federal civil service classifications and salary ranges.

32. The information in this section is drawn from Sylvia Doughty Fries, *NASA Engineers and the Age of Apollo* (Washington, DC: NASA SP-4104, 1992).

Television, which had been acquired by 94 percent of all U.S. households by the mid-1960s, rendered these scenes of violence commonplace and provided a world stage for an outpouring of public protest against U.S. military involvement in Vietnam.[33] In March 1968, that champion of space exploration, President Lyndon B. Johnson—so tough in the battle against the North Vietnamese, so tough in the battle against poverty and race discrimination—formally abandoned any hope of reelection. Raising the specter of runaway inflation as costs for the war in Vietnam and the social programs of the "Great Society" mounted, Johnson's economic advisers had persuaded the president in 1965 that the budget for the space program would have to be contained. There was diminishing enthusiasm outside NASA for an ambitious space program to follow the Apollo adventure. In fiscal year 1966, NASA's budget began its downward slide (though actual outlays for 1966 were the highest of the decade).[34] [III-20]

The political consensus that had produced the visionary National Aeronautics and Space Act of 1958 began to dissipate before the first few Apollo missions were flown.[35] NASA's fiscal year 1971 budget took a battering from the Bureau of the Budget in 1969, forcing the cancellation of Apollo missions 18 through 20 and leading Webb's successor Thomas O. Paine to complain that the Bureau of the Budget had ignored the ambitious recommendations of the White House's own Space Task Group, chaired by Vice President Spiro T. Agnew. [III-25] A staunch supporter of a vigorous manned space program (and hence further Apollo manned expeditions to the Moon), Paine was willing to cease the continued production of the Saturn launch vehicle and to defer the Viking project to launch an unmanned spacecraft to land on the planet Mars to pay for further manned lunar missions. Viking survived, as did a proto-space station (Skylab) fashioned from Apollo-Saturn hardware and flown during 1973; but the mighty Saturn did not. NASA was able to persuade the Nixon administration that a new Space Transportation System (STS) featuring a reusable orbiter spacecraft and solid propellant rocket boosters, flying thirty or more times a year, would be an economical alternative to the use of large "throw away" launchers such as the Saturn.

The fortunes of NASA's authorizing legislation, the "Space Act," reflects a similar diminished priority for a great national adventure in space as successive amendments stripped the statute of its originally well-focused declaration of purpose. In 1964 NASA's ten top executives lost their special pay status. In 1973 the National Aeronautics and Space Council, which could have served as a vehicle by which the executive branch crafted an interagency consensus around a well-defined program, was abolished. From 1974 onward, NASA's authorizing statute became burdened with numerous charges to the agency, occasionally having only the most tangential relation to NASA's original purpose. At the same time, the addition of these new statutory directives reflected admiration for the agency's technical and managerial know-how. After all, "if NASA could send men to the Moon, why couldn't they also. . . ?" NASA was directed to develop and demonstrate "solar heating and cooling technologies" in 1974, to monitor and investigate the "chemical and physical integrity of the Earth's upper atmosphere" in 1975, to develop "more energy efficient and petroleum conserving and environment preserving ground propulsion systems" in 1976, to develop and demonstrate "electric and hybrid [ground] vehicle" technologies in 1976, and to develop advanced automobile propulsion systems *and* to assist "in bioengineering research, development, and demonstration programs designed to alleviate and minimize the effects of disability" in 1978. In the early 1980s NASA lost its privileged position as the U.S. arbiter of non-military space activity, as the agency was denied authority to

33. For one view of the decade, see Allen J. Matusow, *The Unraveling of America: A History of Liberalism in the 1960's* (New York: Harper & Row, 1984).

34. Robert A. Divine, "Lyndon B. Johnson and the Politics of Space," in Robert A. Divine, ed., *The Johnson Years: Vietnam, the Environment, and Science*, Vol. II (Lawrence: University Press of Kansas, 1987), pp. 217-53.

35. The last Apollo mission was the Apollo-Soyuz Test Project jointly conducted with the Soviet Union. An Apollo command and service module, equipped with a specially adapted docking module, joined with a Soyuz spacecraft in July 1975. The spacecraft spent two days docked together in orbit while American astronauts and Soviet cosmonauts ate and visited together and performed joint scientific investigations.

promulgate regulations for the granting of licenses for NASA patents and, in 1984, as the agency acquired statutory direction to "seek and encourage to the maximum extent possible the fullest commercial use of space." By 1988 NASA found itself required to contract with industry for Expendable Launch Vehicle (ELV) services.[36]

As public support for the civilian space program remained soft,[37] the number of government employees NASA was able to support declined to about two-thirds (in 1988) of the almost 36,000 people on the NASA payroll in 1966.[38] Faced with deteriorating support, NASA executives had a legitimate desire to protect the field centers, whose most skilled technical employees were essential to the agency's ability to go about its work. By designating "roles and missions" for each of the centers, NASA attempted to avoid duplication and assure each installation essential functions related to the particular project work assigned to it.[39] [IV-14] The elaborate institutional machinery developed to carry out Apollo could not be so easily disassembled, however, given the interlocking interests it had created among NASA's installations, contractors, and geographic regions and their representatives in Washington.

And so the organization that built America's civil space program in the high-noon of the Cold War groped about for a marketable mission. In 1971 Deputy Administrator George M. Low even contemplated recasting NASA as a national technology agency, responsible not only for aeronautics and space research and development, but also for a wide range of "technological solutions" for national problems such as alternative power and energy sources, environmental pollution, improved transportation systems, health care systems, productivity of services, education, and housing.[40] [IV-12] That others were thinking in this vein as well is apparent from the non-aerospace responsibilities added to NASA's authorizing legislation during the 1970s.

NASA's civil servants and various advisory groups carried out periodic studies during subsequent years to define NASA's goals, or to articulate a vision, for the civil space program. [IV-15, IV-16] There were, of course, those visionaries within the agency who had worked with NASA for decades and believed that if they tried harder the public could be persuaded not only to recognize the promise of an ambitious space program, but to pay for it. Such visionaries combined with bureaucratic entrepreneurs a decade later to persuade President Ronald Reagan in 1984 to pronounce his blessing on a program to design, build, and operate a true space station—an orbiting U.S. outpost in space that had been a NASA dream since the agency was first established.[41]

36. *National Aeronautics and Space Act of 1958, as Amended.* Printed for the use of the National Aeronautics and Space Administration (January 1990).

37. As measured by NASA appropriations, which have not recovered their 1965 level in constant dollars. See also "Towards a New Era in Space: Realigning Policies to New Realities," Committee on Space Policy, National Academy of Sciences and National Academy of Engineering (Washington, DC: National Academy Press, 1988).

38. NASA contractor employees outnumbered civil servants 3 to 1 in the early 1960s, ballooned to 10 to 1 in 1966, and subsided to about 2 to 1 in the 1980s. Nimmen and Bruno with Rosholt, *NASA Historical Data Book, Vol. I,* p. 118; *NASA Pocket Statistics* (Washington, DC: NASA, 1986), p. C-27. Numbers of current contractor employees can only be estimated.

39. Associate Director for Center Operations, on "Catalog of NASA Center Roles," April 16, 1976. Part of the intent of the "roles and missions" concept may have been to reduce inter-center rivalry, but institutional specialization has apparently done little to relieve institutional particularism.

40. George M. Low, Deputy Administrator, NASA, Memorandum for the Administrator, "NASA as a Technology Agency," May 25, 1971.

41. Sylvia Doughty Fries, "2001 to 1994: Political Environment and the Design of NASA's Space Station System," *Technology and Culture* 29 (July 1988): 568-93.

A Space Transportation System

Meanwhile, during the 1970s the more pragmatically minded bowed to the budgetary pressures that had come to dominate Washington's political climate. In 1971 NASA persuaded the Nixon White House that the proposed shuttle program[42] would "take the astronomical costs out of astronautics."[43] The agency had contracted with an economic research firm to investigate the economics of the proposed shuttle system. The economists reported in 1971—on the basis of figures and formulas that had to have been somewhat speculative—that such a system would be economical *assuming* a flight rate of "between 300 and 360 shuttle flights in the 1979-1990 period, or about 25 to 30 space shuttle flights per year."[44] [III-30] Even more portentous was what such a flight rate, in turn, assumed that NASA—its organizational strength rooted in its history as an advanced technology research and development organization—would be just as successful as the operator of a routine transportation system.

NASA Deputy Administrator George M. Low acknowledged that the agency would have to change to operate a cost-effective space transportation system, though whether he grasped just how fundamental a change was involved is not clear. [IV-13] The cost of "doing business in space, coupled with limited and essentially fixed resources available for space exploration," observed Low to his senior management team, "places severe limitations on the amount of productive work that NASA can do, unless we can develop means to lower the unit cost of space operations." Low correctly attributed that "high cost" to the "great sophistication" with which most space systems are designed in order to "operate acceptably with low allowable weight" and to the fact that "most systems are individually tailored for their mission, used once or twice, and then never used again. Thus the economies of producing a number of like systems are never attained." NASA would now, asserted Low, have to abandon the strategy of developing "individually tailored technologies" and, instead, "focus on *multiple-use, standardized* systems" (emphasis added).[45] In 1983, with the shuttle's series of flight tests completed, Congress added to the statutory activities in which NASA was authorized to engage "the *operation of a space transportation system. . .*" (emphasis added).

Although Low may not have thought of it in these terms, he was, in effect, asking the NASA organization to turn back the clock to a time when U.S. manufacturers evolved management strategies to achieve the efficiencies of standardized, volume production to exploit an expanding market. It was a bold risk that he was taking. To the extent that the nation's civil space program hinged on the success of the shuttle program, NASA would have to undertake the most profound reversal in its organizational culture that any organization could be asked to make. Would it succeed? Could the agency and its industrial partners unlearn the management strategies and habits they had had to learn in order to design and produce the complex and reliable aerospace systems that carried men to the Moon? Would NASA's inherited research culture be able to respond to the administrative and logistical demands of routine operational efficiency? And would an expanding market for space transportation support the need to divert scarce resources into the routine operation of "multiple-use, standardized systems"?

A partial answer came in the form of the report issued by the Presidential Commission on the space shuttle *Challenger* accident that had occurred January 28, 1986. [IV-17] Chaired by former Secretary of State William P. Rogers, the commission concluded that the fiery end of the STS-51L mission was caused by "the failure of the pressure seal in the aft field joint of the right Solid Rocket Motor. The failure was due to a faulty design unacceptably sensitive to a number of factors. These factors were the effects of temperature,

42. Properly referred to as the "Space Transportation System" (i.e., the Shuttle Orbiter, External Tank (non-recoverable), and twin Solid Rocket Boosters).

43. Statement by the President, the White House, January 5, 1972.

44. Mathematica, Inc., "Economic Analysis of the Space Shuttle System," National Aeronautics and Space Administration Contract NASW-2081 (January 1972).

45. George M. Low, Deputy Administrator, NASA, Memorandum to Addressees, "Space Vehicle Cost Improvement," May 16, 1972.

physical dimensions, the character of materials, the effects of reusability, processing, and the reaction of the joint to dynamic loading."[46] That was the *technical* cause. The commission was also impressed by other proximate causes of the accident to which it ultimately gave great weight: a top-level decision to launch that had been inadequately informed about the sensitivity of the O-rings on the Solid Rocket Boosters' aft field joints to the inordinately cold temperatures prevailing at the time of the launch, a "silent" safety, reliability, and quality assurance program, *and* an organizational failure to adapt to the requirements of a truly operational transportation system. These included lack of schedule discipline and inadequate logistics to support the flight rate that would enable the agency to deliver the economies promised when President Ronald Reagan announced in 1982 that "the first priority of the STS program is to make the system fully operational and cost-effective in providing routine access to space."[47] [III-38]

For the next two and a half years NASA redesigned known weaknesses in the shuttle's systems, elevated the status of the safety, reliability, and quality assurance organization, and tightened decision-making channels between its centers and headquarters. The result was a successful "return to flight" in September 1988. Wags remarked that the flight of STS-26 was probably the safest shuttle mission imaginable. Underlying management issues—especially whether NASA could, or even should, attempt to transform itself into an operations organization—proved more stubborn. When the agency undertook an assessment of its "management practices and. . .the effectiveness of the NASA organization," it turned for help to one of its most respected *program managers*, General Phillips.

Not surprisingly, the Phillips group, which reported back to NASA in December 1986 [IV-18], recommended (among other things) stronger program management, to be achieved through "strong headquarters program direction for each major NASA program, with clear assignment of responsibilities to the NASA centers involved," and improved "discipline and responsiveness to problems of the program management system." At the same time, the group insisted that "NASA must accept that it will be responsible for space-flight operations for the foreseeable future." That NASA had not, to that point, fully accepted its operational responsibility was suggested by the fact that the agency's "present structure of organization and management does not assure adequate attention to operations requirements in system design or in the planning and conduct of operations and logistic support in the era of frequent shuttle flights and long-term operation of the space station."

To buttress the agency's ability to meet the operational needs of the shuttle program, the Phillips group called for the creation of a new associate administrator for operations, whose organization would include space tracking network and data systems and—eventually—the Kennedy Space Center. Two years later NASA did create an associate administrator-level Office of Space Operations, but it was not clear whether the new organization was merely old wine (the former Office of Space Tracking and Data Systems) in a new bottle. The competing demands of operations and research and development continued to trouble the agency whenever (as in 1990 and early 1991) its heightened safety procedures detected problems with shuttle hardware, requiring protracted "stand downs" of one or more shuttle spacecraft.

Compromise

Underscoring the uncertainty of NASA's mission and its standing within the constellation of Federal programs, President George H. Bush reestablished in April 1989 an interagency policy council for the nation's space activities when he created the National Space

46. *Report of the Presidential Commission on the Space Shuttle Challenger Accident, Vol. I* (Washington, DC: U.S. Government Printing Office, June 6, 1986), p. 72.

47. Quoted in *Report of the Presidential Commission on the Space Shuttle Challenger Accident*, p. 164.

Council, chaired by the vice president. Through the Advisory Committee on the Future of the U.S. Space Program, established in 1990 under the auspices of NASA and the National Space Council, a consensus emerged that NASA's primary business should continue to be what it had been in the 1960s—the scientific exploration of space and aerospace research and development. [IV-20] Asserting that "perfection" should be the single most important aim for NASA's organizational culture, the "Augustine Committee," informally named for its chairman, Norman R. Augustine, chairman and CEO of the Martin Marietta Corporation, explained:

. . . perfection can most closely be approached in an organization whose ethos is one of excellence and where this ethos permeates everything it does. . . . It must be clear to all that, in this culture, excellence is more important than schedule and more important than cost—even though these too are important—and that management at all levels can be reliably counted upon to act with this as its set of values (emphasis author's).[48]

At the same time, the committee recognized that, so long as NASA was responsible for the shuttle, the agency would have to adapt to the demands of a successful operating organization. The comments of many who spoke with the committee "frequently referred to the consuming effect this [flight operations] responsibility can have on NASA's senior management, limiting the time available for the planning and direction of leading-edge technological developments." Committee witnesses also expressed the belief that "the merging of operations into a largely developmental organization does not foster the building of a professional operations cadre which can best manage this vital responsibility."[49]

The committee added a refinement to the issue that had been provided by a 1988 National Academy of Public Administration (NAPA) study, also led by Phillips, of NASA Headquarters management. The NAPA study did not fault NASA for its weaknesses in operations management. Rather, it argued,

the term "operational" as applied to commercial aircraft, to ships, or to mass-produced articles of defense will most likely never apply to space systems in that same context. What we do see, however, are large, complex space systems such as the Shuttle and the Space Station that are or will be largely driven by operational issues—turnaround time between flights, manifesting, retrofitting of design changes for safety, cost or payload capability purposes, logistics, training of basic and science crew members, and so on. These are not the basic work of research and development leading to new concepts and ideas for future space systems, nor for expanding knowledge of the universe and discerning the implications of that knowledge for life on this planet or elsewhere.[50]

The NAPA report supported the earlier Phillips report recommendations and what the Augustine committee would recommend: "an organizational separation, from the top of the agency down, on the two matters of space flight operations and space system development." A new associate administrator position for space flight operations should be established, whose responsibilities should include space shuttle operations, ELV (expendable launch vehicle) operations, and the tracking and data systems organization. This individual should then be given the formidable task of "injecting operational requirements into new programs to assure that they can be effectively operated over their lifetimes at reasonable cost."[51] Just what leverage this individual would have at budget time over the prevailing research and development culture of the agency, the committee did not say. Shuttle operations themselves, however, might be less likely to receive short shrift, added the committee, if responsibility for the space shuttle was "eventually moved from a development oriented center [viz., Johnson Space Center] to the operationally oriented Kennedy

48. *Report of the Advisory Committee on the Future of the U.S. Space Program* (Washington, DC: U.S. Government Printing Office, December 1990), p. 16.

49. *Ibid.*, p. 38.

50. National Academy of Public Administration, Samuel C. Phillips, Chairman, *Effectiveness of NASA Headquarters: A Report for the National Aeronautics and Space Administration*, February 1988. Quoted in *ibid.*, p. 38.

51. *Ibid.*, p. 38.

Space Center." What NASA should strive for, urged the committee, is "safe operation [of the Shuttle], performed as efficiently and routinely as its complexity permits, and not burdened by excessive layers of management that are the legacy of the development era and recovery from the Challenger accident."[52]

And so, a compromise was struck. NASA should retain its identity and role as a research and development organization, the identity with which most of its people were comfortable and upon which its self-esteem depended, and it would not have to lose its most visible achievement—the shuttle—to do so. Suggestions that space shuttle operations be transferred to some other, and perhaps especially created, government entity, or to the private sector, had been rejected. But some significant portion of the organization would have to learn how to operate a transportation system. Whether Congress, or NASA's internal budgetary politics, would yield the wherewithal to do so remained to be seen.

How effectively an organization imbued with the values and habits of a research and development mission could adapt to the requirements of the efficient and cost-effective operation of a space transportation system was (setting aside perennial funding issues) one of the two principal issues facing the NASA organization at the beginning of the 1990s. The other was an old issue, one that could be traced back to the 1950s: the wisdom and consequences of the federal government's policy of "contracting out" for the bulk of its research and development work as well as for supplies and services.

In the spring of 1990, NASA's administrator asked the National Academy of Public Administration to revisit that question for NASA. The NAPA study, completed in January 1991, found still valid the 1962 Bell Report's guideline for what, and what should not, be contracted out. The government should *not* contract out. . .

decisions on what work is to be done, what objectives are to be set for the work, what time period and what costs are to be associated with the work, what the results are expected to be, and the evaluation, and the responsibilities for knowing whether the work has gone as it was supposed to go, and if it has not, what went wrong, and why, and how can it be corrected. . . .[53]

Having surveyed, with interviews and questionnaires, over 2,000 NASA scientists and engineers, the NAPA study team concluded that contracting out had indeed led to an erosion of strength among NASA's civil service scientists and engineers. Critics argued that that was a predictable conclusion, given the persons surveyed. It then proceeded to develop recommendations, most of which called on NASA's top management to provide better scrutiny of, and clearer guidelines for, the kinds of activities being contracted to the private sector. The context for these recommendations was the NAPA group's finding that "hands-on science and engineering work experience is essential to developing scientists and engineers with a level of knowledge that provides a sixth sense for spotting problems early, for being a smart buyer of technical products and services, and for being astute overseers of the work of technical contractors" and that NASA was not providing enough opportunities for this kind of work.[54]

The Augustine Commission, for its part, agreed that "an appropriate balance between in-house and external activity also should be developed." But this group saw the balance differently. In the more than three decades that had passed since NASA was created, there had developed a solid basis of space technology skills in both industry and academia; it was no longer necessary for NASA to match every development being contracted with comparable in-house laboratory skills. Citing the recent experience of national security aerospace research and development procurement, the committee argued that NASA could "buy smart" with fewer civil service project and program personnel. "NASA should concentrate its 'hands-on' expertise," the committee recommended, "in those areas unique to its mission, and avoid the excessive diversion of technical or mission

52. *Ibid.*, p. 40.

53. Quoted in National Academy of Public Administration, *Maintaining the Program Balance: The Distribution of NASA Science and Engineering Work Between NASA and Contractors and the Effect on NASA's In-House Technical Capability*, 2 vols. (Washington, DC: U.S. Government Printing Office, January 1991), Vol. I, p. 6.

54. *Ibid.*, Vol. I, p. x.

specialists to functions which could be performed elsewhere. Contract monitoring is best accomplished by a cadre of professional systems managers with appropriate experience. Increased use of performance requirements, rather than design specifications, will further increase the effectiveness of this approach."[55]

The Augustine Commission also called for more competitive government salaries for scientists and engineers, "pay for performance," and full use of existing flexibility within the government's personnel system. NASA should be a "pathfinding" agency for the development of an "advanced" federal personnel system that would reward excellence and special skills over seniority and generic tasks. Should NASA fail to persuade the Office of Personnel Management to allow the agency to revamp its personnel system, NASA might convert additional centers to federally funded research and development centers affiliated with major universities.[56] Whether NASA would succeed remains to be seen. Even if NASA were able to increase the number of high-caliber scientists and engineers within its ranks, would the practice of contracting out most of the agency's research and development work—leaving its own people to function as contract monitors—undermine its gains?

Conclusion

NASA's ongoing struggle to maintain its organizational momentum in the face of seemingly insuperable obstacles—public uncertainty, as well as its own, as to its overarching purpose; the constraining tendencies of federal regulations designed to keep political, bureaucratic, and technical power in check; and the need, time after time, to plead for funds and justify itself—is worth understanding not only because of what the agency does, but for what it represents. One obstacle NASA could not escape was the need to develop a large organization to carry out its work. That organization would perforce become a federal bureaucracy.

A creative bureaucracy seems to most a contradiction in terms. We rightly understand that the essence of a bureaucracy is depersonalized routine. Indeed, bureaucracies came into being so that the execution of laws and regulations in emerging nation-states might become less arbitrary, less capricious, and more accountable than it had been under personalized monarchical rule. No modern society with any aspiration to democracy would countenance surrendering its resources and destiny to a handful of solitary dreamers, however enticing the dream. Thus "organizing for exploration" was and remains the challenge facing the United States if it would venture across the frontier of outer space. The fact that managing the organization created to conduct that journey has proven difficult is less a sign of the failings of the travelers—though being human they have had failings enough—than a sign of the enormity of their task.

Document IV-1

Document title: J.R. Killian, Jr., "Memorandum on Organizational Alternatives for Space Research and Development," December 30, 1957.

Source: Dwight D. Eisenhower Papers, Eisenhower Library, Abilene, Kansas.

In the wake of Sputnik I and II, there was a wholesale reexamination of the U.S. organization for space-related activities. In 1955, when a scientific satellite program was initiated, it was given a low priority in comparison to other military efforts. At the time there was concern that even a small civilian space program, if given too many resources, could adversely affect critical ballistic missile programs. The issue was not so much one of cost, but the scarcity of human resources and development and test facilities. However, the political firestorm set off by the Soviet satellite brought into question the relatively low priority given the scientific space program. From the time the first Sputnik was launched

55. *Report of the Advisory Committee*, pp. 40-41.
56. *Ibid.*, pp. 40-42.

until NASA was established, almost all elements of the government were engaged in the debate on how best to redress the situation and reestablish the prestige of the United States. The failure of the first Vanguard launch on December 6, 1957, only intensified the calls for change. Sputnik also created the necessary impetus in the White House for the creation of the position of presidential science advisor. On November 7, James R. Killian, president of MIT, was appointed to this position. One of Killian's first duties was to address the issue of alternatives for space research organization. Some of his thoughts in this early memorandum eventually formed the basis of the administration's future policy toward the creation of a space agency.

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[1] December 30, 1957

Memorandum on Organizational Alternatives for Space Research and Development

This memorandum is based upon the following assumptions:

A. That the Department of Defense proceeds with its announced plan for a Special Projects Division, reporting directly to the Secretary and including, as one of its major responsibilities, space research and development for the DOD.

B. That there is a broad area of non-military basic research relating to space which will command the interest and participation of scientists and engineers in a variety of non-government and government institutions.

With these assumptions in mind, we can proceed to a discussion of how the Government's sponsorship of space research and development can be handled and how the military and non-military programs can be related.

There have been proposals for a new Government agency analogous to either NACA or the AEC to handle all space research and development. In appraising this approach, the following considerations are of importance:

A. The DOD is committed to a space program and is in process of setting one up, although the nature of the program has not been clearly defined.

[2] B. Those aspects of space research and development which relate to the use of missile engines, and the testing and launching of vehicles must be closely associated with DOD missile programs. The necessity of such close association may dictate the placing of responsibility in the DOD for the development, testing, and use of rocketry for putting up space vehicles. It would seem unwise for a new agency, independent of the DOD, to have to create and use test facilities other than those built by DOD.

It seems of greatest importance that the DOD's own space program be very closely related to its missile program or for the two programs at some time to be merged.

These considerations seem to indicate clearly that the DOD must play a major role in space research and development if we are to use the nation's manpower and facilities in this area to the greatest advantage.

The DOD will, of course, be primarily concerned with those aspects of space research and development which will have military value. It is hard at this stage, however, to separate out of space R&D those elements, however basic and purely scientific, which would not contribute to military objectives. It seems entirely feasible for DOD to be the major sponsor and entrepreneur of space research and development, both military and "non-military."

There are many scientists and others, however, who are opposed to the centralization of all space R&D under the DOD. There are deeply felt convictions that the more

purely scientific and non-military aspects of space research should not be under the control of the military. In the first place, [3] such an arrangement might improperly limit the program to narrowly concerned military objectives. In the second place, it would tag our basic space research as military and place the United States in the unfortunate position before the world of apparently tailoring all space research to military ends.

The problem of planning our non-military basic space research, then, becomes one of devising the means for non-military basic space research while at the same time taking advantage of the immense resources of the military missile and recon satellite programs, there are several possible ways of doing this:

A. The D.O.D. as a part of its program would establish a central space laboratory with a very broad charter which would permit the conduct of the most basic sort of research as well as R and D, having obvious military objectives. We see the pattern for this is such a Laboratory as the Los Alamos Scientific Laboratory of the A.E.C. Such a laboratory might also have the authority to sponsor research in civilian institutions.

B. The Department of Defense might confine itself to its military mission and some other agency or agencies external to the D.O.D. might engage in basic research. One obvious way of doing this would be to encourage N.A.C.A. to extend its space research and to provide it with the necessary funds to do so. A second [4] method (and this one might be handled along with an N.A.C.A. program) would be to provide funds either through the Department of Defense or otherwise to the National Research Counsel, the Council in turn sponsoring a series of projects in universities and industrial laboratories. The N.A.C.A. itself might do sub-contracting as indeed it does now to a limited extent. The problem here would be not to burden the N.A.C.A. with so large a program that the nature of N.A.C.A. would be changed. In its present form, it has been very successful but an undue enlargement of its program might reduce its effectiveness.

If either the N.A.C.A. or N.R.C. methods or both were followed, it would be necessary to carefully work out a cooperative arrangement with the D.O.D., for the D.O.D. would have to be an active partner with these agencies.

Such combination of sponsorship and programs would probably be the most advantageous way of carrying on space research for meeting both military and non-military objectives.

In considering these various alternatives and means, it is important to keep in mind existing resources available in the D.O.D., the Army's ABMA has a highly competent group for space research. The Air Force's BMC has important resources, including a going program for the development of a recon satellite. Cal Tech's Jet Propulsion Laboratory has advantages and resources for space research—a laboratory which has been closely associated with the Army. In the interest of conserving [5] man power and utilizing skill and experience already in being, these agencies must be considered in planning a new program. Some one or combination of these might well be made the nucleus of an extended program.

There should be some mechanism, however, which gives coherence to the broad program and which avoids a program encouraging inter service rivalries.

The overall plan must permit and provide for bold, imaginative research and planning. It must recognize the importance of providing the means and incentives for pure scientists to move effectively into space research without regard to practical applications. We must realize that in addition to such obvious objectives as space travel and reconnaissance, there are extraordinary opportunities to extend our knowledge of the earth and its environment and enormously to extend astronomical observations. It may well be that these kinds of pure, non-practical research objectives may prove to be the most important and in the end the most practical.

The overall plan, then, must keep steadily in view the need for those means and programs which will command the interest and participation of our best scientists. We

must have far more than a program which appeals to the "space cadets." It must invoke, in the deepest sense, the attention of our best scientific minds if we as a nation are to become a leader in this field. If we do not achieve this, then other nations will continue to hold the leadership.

December 29, 1957 J.R. Killian, Jr.

Document IV-2

Document title: L.A. Minnich, Jr., "Legislative Leadership Meeting, Supplementary Notes," February 4, 1958.

Source: Dwight D. Eisenhower Papers, Eisenhower Library, Abilene, Kansas.

The Soviets had orbited *Sputnik I* four months prior to the meeting recorded by Minnich. By this time, it was all but certain that a new space agency would be created; however, its responsibilities, form, and location were still undecided. The question of the military or civilian character of a new agency was discussed in a regularly scheduled meeting among the president, vice president, other White House officials, and Republican leaders in Congress. The issue was raised in response to the impending reorganization of the Department of Defense, which was necessitated in part by the increasing sophistication and cost of weapons systems. Missiles and other space-related hardware were responsible for a significant portion of the technological revolution sweeping the military services at the time. At this time (February 1958), President Eisenhower had apparently not yet decided that most of the U.S. space program should be carried out under civilian auspices.

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[1] ...**Outer Space Program** - A question was raised as to whether a new Space Agency should be set up within Department of Defense (as provided in the pending Defense appropriation bill), or be set up as an independent agency. The President's feeling was essentially a desire to avoid duplication, and priority for the present would seem to rest with Defense because of paramountcy of defense aspects. However, the President thought that in regard to non-military aspects, Defense could be the operational agent, taking orders from some non-military scientific group. The National Science Foundation, for instance, should not be restricted in any way in its peaceful research.

Dr. Killian had some reservations as to the relative interest and activity of military vs. peaceful aspects, as did the Vice President who thought our posture before the world would be better if non-military research in outer space were carried forward by an agency entirely separate from the military.

There was some discussion of the prospect of a lunar probe. Dr. Killian thought this might be next on the list of Russian efforts. He had some doubt as to whether the United States should at this late date attempt to press a lunar probe, but the question would be fully canvassed by the Science Advisory Committee in the broad survey it had under way. [2] Dr. Killian thought the United States might do a lunar probe in 1960, or perhaps get to it on a crash program by 1959. Sen. Saltonstall had heard, however, that it might even be accomplished in 1958, if pressed hard enough.

[2] Dr. Killian outlined for the Leadership the various phases of future development (along the lines of the subsequent press release listing projects in the "soon," "later," and "much later" categories).

Sen. Knowland complained about having to get his information about Space research from the Democratic Senator from Washington (Jackson)—which was just as bad as having to learn from Mr. Symington anything there was to know about the Air Force.

The President was firmly of the opinion that a rule of reason had to be applied to these Space projects—that we couldn't pour unlimited funds into these costly projects where there was nothing of early value to the Nation's security. He recalled the great effort he had made for the Atomic Peace Ship but Congress would not authorize it, even though in his opinion it would have been a very worthwhile project.

And in the present situation, the President mused, he would rather have a good Redstone than be able to hit the moon, for we didn't have any enemies on the moon.

Sen. Knowland pressed the question of hurrying along with a lunar probe, because of the psychological factor. He recalled the great impact of Sputnik, which seemed to negate the impact of our large mutual security program. If we are close enough to doing a probe, he said, we should press it. The President thought it might be OK to go ahead with it if it could be accomplished with some missile already developed or nearly ready, but he didn't want to just rush into an all-out effort on each one of these possible glamor performances without a full appreciation of their great cost. Also, there would have to be a clear determination of what agency would have the responsibility.

The Vice President reverted to the idea of setting up a separate agency for "peaceful" research projects, for the military would be deterred from things that had no military value in sight. The President thought Defense would inevitably be involved since it presently had all the hardware, and he did not want further duplication. He did not preclude having eventually a great Department of Space....

Document IV-3

Document title: S. Paul Johnston, Memorandum for Dr. J. R. Killian, Jr., "Activities," February 21, 1958, with attached: Memorandum for Dr. J. R. Killian, Jr., "Preliminary Observations on the Organization for the Exploitation of Outer Space," February 21, 1958.

Source: NASA Historical Reference Collection, NASA History Office, NASA Headquarters, Washington, D.C.

On February 4, 1958, President Eisenhower announced that science advisor James R. Killian had appointed a panel to recommend the outlines of a space program and the organization to manage it. The so-called "Purcell Panel" (General James H. Doolittle, Chairman, NACA; Edwin Land, President, Polaroid Corporation; Herbert York, Director, Livermore Laboratory; and Edward Purcell, Professor of Physics, Harvard University), augmented by William Finan of the Bureau of the Budget and the staff support of S. Paul Johnston, Director of the Institute for Aeronautical Sciences, assessed organizational alternatives for the proposed agency. The task of inventing an organization to manage a space program was a difficult one. The number and strength of the claimants for the right to direct the space program had peaked in the wake of Sputnik. Several bills were already pending before Congress, which gave responsibility for space programs to the Department of Defense or to the Atomic Energy Commission. Johnston's thoughts on the subject eventually found their way into the March 5, 1958, memorandum [IV-4] to the president containing the formal proposal that NACA be reconstituted and given the responsibility for managing the nation's space program.

Memorandum for Dr. J. R. Killian, Jr.

FROM: S. Paul JOHNSTON
SUBJECT: Activities

1. During the past week, in accordance with your suggestion, I have conferred on the problem of organization and its legal implications with the following:

James A. Perkins, Vice President, Carnegie Corporation; John Cobb Cooper, Legal Consultant, Professor, International Air Law, McGill University; Dr. James Fisk, Vice President, Bell Telephone Laboratories; John J. Corson, McKinsey & Company; Don K. Price, Vice President, Ford Foundation; Dr. Edward Mason, Harvard University; Dean David Cavers, Harvard Law School

The above are in addition to the people we have talked to in the Bureau of the Budget at the meeting which you attended on Monday.

2. As a result of the above conferences I have prepared the attached memorandum which summarizes the various views which have been expressed on the organizational problem and which makes a recommendation which is my own by which appears to be consistent with the discussions of the past week. To date this has been discussed only with Dr. James Fisk.

S. P. Johnston

Attachment

[1] THE WHITE HOUSE
WASHINGTON
February 21, 1958

MEMORANDUM FOR DR. J. R. KILLIAN, JR.

Preliminary Observations on the Organization for the Exploitation of Outer Space

The exploitation of any unknown areas involves two distinct objectives, - one, *exploration* and two, *control.* The first is largely a scientific operation and the second largely military.

At the present time plans for the exploitation of outer space fall more nearly into civilian-scientific areas rather than into military areas. The "take" from the probing of outer space by rockets, satellites and interplanetary vehicles will be of more direct interest to the scientist than to the strategist. We can discount at this point most of the "Buck Rogers" type of thinking which anticipates hordes of little men in space helmets firing disintegrators into each other from flying saucers. Certainly, ICBM's will transit portions of outer space in performing their missions, but for the moment the chief military interest lies in better methods of surveillance, communications and long-range weather forecasting.

The potential space explorations in the immediate future are well outlined in a paper dated 14 February 1957 titled "Basic Objectives of a Continuing Program of Scientific Research in Outer Space" by Hugh Odishaw, Executive Director of the U.S. National Committee for the IGY of the National Academy of Sciences. A good layman's summary of the same subject appeared in a recent issue of LIFE magazine by Dr. Van Allen.

The *control* of outer space, basically a military matter, involves many troublesome questions of international law. The problem of the vertical extent of national sovereignty has yet to be determined. It appears to depend on the capability of any nation to deny access to space above its territory by physical means. No body of international law yet exists covering [2] the use of outer space. As a matter of fact, no acceptable definition has yet been evolved as to where "air-space" and "outer-space" begin and end. Maritime law has no such problem because, under most conditions, one is either afloat or ashore. The limits of the "high seas" have been determined by international agreement on the basis of very easily made physical measurements. With respect to outer space, however, such questions are wide open (a discussion of these problems is to be found in our files in papers on the subject by Professor John Cobb Cooper and others).

The control of radio-communications in our upper atmosphere and in space is another problem which must be settled by international agreement if a completely chaotic

condition is to be avoided. Within the next ten years the probabilities are that dozens, if not hundreds, of objects will be in orbit around the earth. Apart from the question of sorting scientific intelligence from this "celestial junkyard" it will be highly important from a military point of view to be able to distinguish an incoming ICBM from other less lethal objects.

By any standards of comparison, the problems involved are tremendous and the programs which must be undertaken in their solution will be lengthy and costly. The technical feasibility studies and the forecasts that have been made by Doctors Purcell, York and others, anticipate the development of such items as booster rockets of one million to five million pounds of thrust in a period of 15 to 25 years. It is estimated that such development programs, quite apart from the missile requirement of the military, may cost anywhere from 500 million to a billion a year. We are, therefore, considering something of the general order of magnitude of the AEC. Obviously the Bureau of the Budget will exert an important influence in deciding whether the national economy can stand such a drain for such purposes.

General Organizational Requirements

In considering the proper organization to handle a project of such magnitude two factors must be taken into consideration—first, how to get the program off the ground immediately, i.e., how to get something started *now* with the facilities that are presently available and, second, how to gear-up for a long-range program to take care of the 5-10-25 year development. This leads to the thought that some sort of *Ad Hoc* organization could be set up in a very short time, possibly by Executive Order of the President, to take care of the immediate requirements. Such a group would [3] not only act as a temporary operating organization but would also initiate studies that would lead toward a more permanent organization on some basis that could be agreed upon by all departments of government and for which the necessary enabling legislature could be obtained.

Whatever plan is adopted, either for the short or for the long-range period, it would appear that certain basic characteristics should be incorporated. First of all, for reasons stated above, it should be a *civilian managed* organization both at the policy and at the operating levels. It must have wide contractual powers, and it must be free from the limitations of the Civil Service in hiring personnel. It must have access to, and be able to draw upon, all existing scientific talent in the country, both within government, and without, and it must be able to utilize the physical facilities that already exist in industry, universities, government laboratories and military installations. It must be able to purchase whatever hardware, systems or components it needs from all available sources. It must have its own physical facilities for testing completed vehicles and it must also be empowered to operate airborne and space vehicles.

Possible Organizational Patterns

To date four specific proposals have been made as to possible organizations to accomplish these ends. These include:

1. the formation of an entirely new agency of government;
2. assignment of the project to the AEC;
3. establishment of the NACA as the controlling agency, with assistance from National Science Foundation, National Academy of Sciences, the military services, etc.;
4. assignment of the project to the Advanced Research Project Agency of the Department of Defense (ARPA).

In the following paragraphs some of the advantages and disadvantages of the above suggestions will be briefly noted.

1. New Agency

The establishment of a wholly new agency may prove to be the eventual solution to the problem. Such an agency should report directly to the Executive Office of the President. It should be empowered by law to perform all the functions stated above and be given the necessary funds to accomplish them.

[4] The major difficulty would be in the time required to establish such an agency. New legislation would be required which might involve a very long time to debate and to formulate. It would need a new staff both on the management and on the scientific sides. This would take a long time to recruit, and in view of the overall shortage of scientific personnel in the country, would draw off key people from other necessary jobs. This procedure would also take a long time.

It would also need new facilities, with the inevitable delays in reaching decisions as to what was needed and where new laboratories should be located, before the planning and construction phases could begin.

In summary, the establishment of a new agency would require a very great legislative effort and a very long time to get into operation.

2. Atomic Energy Commission

Strong Congressional support is in evidence for assigning the mission to the AEC.

There is no question but that the AEC is organizationally sound and is a going concern. It already has the necessary authorization to contract for anything it needs and also is free from civil service restraint in hiring people. Its scope could very easily be expanded so that it could legally perform any additional assignment.

On the other hand, the technology of flight both in and out of the atmosphere is not a part of the normal AEC area of competence. Although it is true that nuclear propulsion for aerial and space vehicles comes within its field, consensus seems to be that practical utilization of such propulsion is 5 to 10 years away. AEC, therefore, has an interest in a very small part of the space exploitation picture but it has had little experience in such matters as high-speed aerodynamics, control, guidance, structures, telecommunications, etc.

Furthermore, the AEC is already engaged in a huge operation of great national importance. If it were asked to undertake an additional program of the magnitude contemplated for space exploration, its efforts [5] in each one might be so diluted that long delays in the production of end items would be inevitable and its overall effectiveness seriously impaired.

Although the AEC has unquestionably adequate management and all the authority it would need, it would be required to expand both its facilities and its staff into wholly new technical areas if it were given the space exploitation job.

3. National Advisory Committee for Aeronautics

Persuasive arguments can be made for assigning the responsibility for space exploration to the NACA. The Committee itself has suggested that with the support of the National Science Foundation and the National Academy of Sciences it could undertake the job by expanding its facilities.

The NACA is basically a civilian-operated, independent government agency. It has a long history of accomplishment. Its relations with the Congress and with the Executive Departments are good and it has an international standing for competence in scientific fields.

The NACA has been in the space exploitation field for a long time. Most of the work that has been done in extremely high altitude and high-speed aerodynamics on which the design of missiles and rockets has been based has been done in its laboratories. It has already made great progress in research in some of the very sophisticated propulsion systems required for space flight. It has recently established a special subcommittee in space flight technology made up of outstanding scientists in the field. Extending its interests into space technology would appear to be a logical evolutionary step from its research activities of the past 40-odd years.

The NACA budget for the coming year is of the order of 80 million and it has been authorized to expand its present personnel of 8,000 to 9,000. Its three laboratories (Langley, Ames and Lewis) and its missile firing range at Wallop's Island represent an aggregate investment of about 350 million dollars.

It has been argued that the difference between the size of current NACA operation and the proposed operation is so great that the result [6] would be, in effect, the establishment of a wholly new agency to which the NACA would be attached. There is no reason to believe, however, given proper authority and adequate funds, that the NACA could not expand its management functions to handle the larger assignment effectively as it did in 1942 to meet the comparably tremendous demands of World War II.

A moderate amount of legislation would be needed to assign the job to NACA. Its contractual authorization would have to be expanded, and the present civil service limitations on personnel would have to be relieved.

4. ARPA - Department of Defense

A strong case can be made for integration of the space program into the Department of Defense under ARPA on the grounds of immediate action. A great deal of hardware is already available, essential facilities (e.g., JPL, ABMA) exist. The facilities are well staffed and the experience level is high.

It has been suggested that whatever form of organization is agreed upon to initiate the space exploration program it should be attached temporarily to ARPA. If this were done it would appear to be important that some provision be made so that the entire outfit could be detached and assigned to some other agency in the future if it subsequently appeared desirable. It might happen that military interests might outweigh the purely scientific and civil aspects to the detriment of the latter. It would be difficult to avoid security restrictions, and participation in international programs of a purely scientific nature might thereby be hampered.

Under its present directive it seems that ARPA could take on the job with a minimum of additional legislation.

Suggested Compromise Program

Of the four proposals discussed above, No. 2, - i.e., assigning the project to the AEC, seems the least practical. As an example of appropriate organization and good management, it deserves careful study, but the problems under discussion here seem somewhat outside its main fields of interest.

None of the other proposals would satisfy *all* the requirements in themselves. A possible compromise suggests itself which might satisfy the requirement for immediate action and also lay the groundwork both as the organization and legislation for future action.

[7] This consists, in effect, of the immediate establishment of a provisional Space Exploration Control Group headed by a special assistant to the President and composed of the operating heads of the several government agencies who are already involved in research, development or operation of space vehicles. Several outstanding individuals from non-government organizations might also be included, but the total group should not be large. Their main function would be the implementation of national space policy as determined by the President and Congress, utilizing all assets and facilities which already exist in established government agencies and in industry. Their secondary function should be the determination of the kind of agency which should be established to put space exploitation on a permanent basis to handle the requests of the foreseeable future.

The suggested procedure might be outlined as follows:

[8] A. Short Range - By Executive Order for Immediate Action

1. *Appoint a Special Assistant to the President for Space Exploration* (This should be the *Chairman of the NACA* - See Footnote)

2. Appoint a *Provisional Board of Regents for Space Exploration* consisting of:
   a. Special Asst. to President for S.E. (Chairman)
   b. Scientific Advisor to President
   c. Director, AEC
   d. Director, NACA
   e. President, NSF
   f. Director, NAS
   g. Director, ARPA
   h. Two civilians, possibly from industry or science
3. Empower above to
   a. Establish immediate space objectives
   b. Establish program priorities
   c. Coordinate programs of associated agencies toward meeting established objectives
   d. Utilize funds already appropriated to the associated agencies to implement immediate objectives.
4. Instruct Special Assistant for Space Exploration to make immediate plans for the establishment of a Permanent Space Exploration Agency and to prepare the necessary legislation.

[9] B. *Long Range - By Legislation for Continuing Action*
1. Organize a permanent *Space Exploitation Agency*
2. Authorize the Agency to:
   a. establish, maintain and operate its own testing and operational facilities
   b. enter into whatever contractual arrangements may be necessary with government and civilian agencies
   c. hire personnel without regard to Civil Service restrictions
   d. operate air/space Vehicles

Document IV-4

Document title: James R. Killian, Jr., Special Assistant for Science and Technology; Percival Brundage, Director, Bureau of the Budget; Nelson A. Rockefeller, Chairman, President's Advisory Committee on Government Organization, Memorandum for the President, "Organization for Civil Space Programs," March 5, 1958, with attached: "Summary of Advantages and Disadvantages of Alternative Organizational Arrangements."

Source: Dwight D. Eisenhower Papers, Eisenhower Library, Abilene, Kansas.

As the preceding documents have shown [IV-1, IV-2, IV-3], there was substantial attention given within the Executive Office of the President during the December 1957-March 1958 period to how best to organize the nation's space effort. This memorandum was the culmination of that attention and laid the basis for President Eisenhower's decision to create a new civilian space agency.

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[1] Memorandum for the President

SUBJECT: Organization for Civil Space Programs

The Problem

As you know, there will soon be presented for your consideration civil space programs for the United States which will entail increased expenditures and the employment

of important numbers of scientists, engineers and technicians.[1]

This Committee, in conjunction with the Director of the Bureau of the Budget and your Special Assistant for Science and Technology, have given consideration to the manner in which the executive branch should be organized to conduct the new program. This memorandum contains our joint findings and recommendations. The memorandum (1) discusses some of the factors which should be taken into account in establishing the government's organization for these civil space programs, (2) recommends a pattern of organization, and (3) indicates certain interim actions which will be necessary. Also attached is a summary of the advantages and disadvantages of certain alternative organizational arrangements.

[2] Discussions to date suggest that an aggressive space program will produce important civilian gains in the form of advances in general scientific knowledge and protection of the international prestige of the United States. These benefits will be in addition to such military uses of outer space as may prove feasible.

Establishing a Long Term Organization

Because of the importance of the civil interest in space exploration, the long term organization for Federal programs in this area should be under civilian control. Such civilian domination is also suggested by public and foreign relations considerations. However, civilian control does not envisage taking out from military control projects relating to missiles, anti-missile defense, reconnaissance satellites, military communications, and other space technology relating to weapons systems or direct military requirements.

[3] We have considered a number of different approaches to civil space organization. It is our conclusion that one of these alternatives provides a workable solution to the problem. The other principal alternatives have serious shortcomings which argue against their selection as a basis for space organization.

Recommendation No. 1. We recommend that leadership of the civil space effort be lodged in a strengthened and redesignated National Advisory Committee for Aeronautics.

The National Advisory Committee for Aeronautics (NACA), in a resolution adopted on January 16, 1958, has proposed that the national space program be implemented by the cooperative effort of the Department of Defense, the NACA, the National Academy of Sciences and the National Science Foundation, together with the universities, research institutions, and industrial companies of the nation. NACA further recommended that the development of space vehicles and the operations required for scientific research in space phenomena and space technology be conducted by the NACA when within its capabilities. NACA is now formulating a program which is expected to propose expansion of existing programs and the addition of supplementary research facilities.

[4] Factors Favoring NACA as the Principal Civil Space Agency

1. NACA is a going Federal research agency with a large scientific and engineering staff (approximately 2,000 of its 7,500 employees are in these categories) and a large plant ($300,000,000 in laboratories and test facilities). It can expand its research program and increase its emphasis on space matters with a minimum of delay and can provide a functioning institutional setting for this activity.

2. NACA's aeronautical research has been progressively involving it in technical problems associated with space flight and its current facilities construction program is designed to be useful in space research. It has done research in rocket engines (including advanced

1. These programs do not include those projects relating to space vehicles and exploration which will be carried out in the Department of Defense under the direction of the Advanced Research Projects Agency (ARPA).

chemical propellants), it has developed materials and designs to withstand the thermal effects of high speeds in or on entering the earth's atmosphere, it conducts multi-stage rocket launchings, and in the X-15 project it has taken the leadership (in cooperation with the Navy and Air Force) in developing a manned vehicle capable of flights beyond the earth's atmosphere.

[5] 3. If NACA is not given the leading responsibility for the civil space program, its future research role will be limited to aircraft and missiles. Some of its present activities would have to be curtailed, and the logical paths of progress in much of its current work would be closed. It would, under such circumstances, be difficult for NACA to attract and retain the most imaginative and competent scientific and engineering personnel, and all aspects of its mission could suffer. Moreover, it is questionable whether it would be possible to define practicable boundaries between the missile and high performance aircraft research now performed by NACA and the space vehicle projects.

4. NACA has a long history of close and cordial cooperation with the military departments. This cooperation has taken place under a variety of arrangements, usually with little in the way of formalized agreements. Although new relationship problems are bound to arise from an augmented NACA role in space programs, the tradition of comity and civil-military accommodation which has been built up over the years will be a great asset in minimizing friction between the civil space agency and the Department of Defense.

[6] 5. Although much of its work has been done for the military departments, NACA is a civilian agency and widely recognized as such. A civilian setting for space programs is desirable and NACA satisfies this requirement.

6. Some of the principal problems in using NACA, as listed below, can be overcome by relatively limited accommodations to existing law and by appropriate administrative action. These measures are described in later paragraphs.

Problems in Using NACA as the Agency with Primary Responsibility for Civil Space Programs

1. NACA has in the past been concerned chiefly with research involving air breathing aircraft and missiles. NACA's competence in certain fields related to space flight (such as electronics and space medicine) will need to be augmented. NACA has also had little experience in the direct administration of large scale developmental contracts.

2. Many of the scientists who have done the most work on rocket engines and space vehicles are now employed by Defense Department agencies and by private contractors of the military services. Some means of utilizing such experienced personnel will have to be found which does not unduly impair the capacity of the Department of Defense to continue defense related aspects of missile and space activity.

[7] 3. The NACA is not in a position to push ahead with the immediate demonstration projects which may be necessary to protect the nation's world prestige. Therefore the military services may have to be relied on for such demonstrations while NACA is equipping itself for the full performance of the space job.

4. NACA suffers from some of the limitations imposed on civil service agencies, and some scientists are known to favor reliance on private research organizations operating under government contracts. Ceilings and numerical restrictions on the salaries of top scientific staff and the general lag in Classification Act salaries are among the obstacles to administration through government laboratories which pose problems in utilizing NACA.

5. NACA now spends around $100,000,000 per year. A civil space program may eventually entail additional annual expenditures substantially in excess of this amount. It is obvious that important changes in NACA will be required by such an expansion, and the agency may have some difficulty in assimilating the additional staff and functions.

[8] **Recommendation No. 2. We recommend that NACA's basic law be amended to give NACA the authority and flexibility to overcome or mitigate the problems noted above so that NACA can carry out its total program effectively.**

Specifically the amendments should:

a. Rename the NACA the National Aeronautical and Space Agency to get away from the limited connotations of the term "aeronautics" when used alone and to recognize that NACA has long since ceased to be an "advisory committee" as the term is customarily used.

b. Retain a board for top policy direction. Some changes in the composition of the present NACA board may be appropriate.

c. Provide for the appointment of a Director by the President by and with the advice and consent of the Senate.

d. Provide a system for the fixing of compensation of employees which, under appropriate Presidential controls, will permit the agency to pay rates which are reasonably competitive with the rates paid by non-Federal employers for comparable work. (This amendment will ease the salary limitations under the Classification Act of 1949 which have caused so much concern in and out of NACA.)

[9] Certain additional miscellaneous powers may also have to be given NACA if further investigation reveals that they are not already available and confirms that they will be of material assistance to the agency.

The above powers would give NACA as much flexibility as can reasonably be achieved by contract laboratories and would at the same time permit retention of the traditional NACA practice of conducting such research and testing through its own government employee staffed facilities as it determines to be desirable in carrying out a space program.

There will remain the need to refine relationships with the Department of Defense in space matters and to draw upon and utilize staff and experience now lodged in the laboratories of the military services and their contractors, but the reorganized NACA would be equipped to work out these problems in a flexible manner. Some Presidential intervention may prove necessary to bring about or implement agreements between the space agency and Defense, and it may also be desirable for the President to be given the specific authority to transfer to NACA space activities directly related to the civil program which are now being performed by other agencies.

[10] Overlapping between NACA's civil space program and the work of Defense on military projects should be kept to a minimum. This can be done if Defense, in a manner analogous to the practice followed on developing aircraft and missiles, makes appropriate use of NACA for supporting research and development on military space vehicles. An arrangement of this kind could reduce duplication without undermining the basic Defense Department responsibility for developing weapons systems and other military equipment.

Interim Measures

Recommendation No. 3. If you approve our recommended approach to space organization, we further recommend that a number of interim and short-term measures be given immediate attention.

Specifically, we propose:

a. An all-out attempt should be made to draft needed legislation within the next few weeks so that there will be some chance of final action during the current session of the Congress. At the same time decisions should be made with respect to the supplemental appropriations which will be required for NACA to get its part of the space program under way. If congressional [11] action can be secured on both matters before adjournment, the full civil space program under arrangements designed to serve long term needs can be launched this year.

If it proves impossible to obtain the enactment of the comprehensive legislation strengthening NACA during the current session, the passage of the general Classification Act revisions now pending, the authorization of addition super-grade and Public Law 313 positions, and the securing of supplemental appropriations would still enable NACA to get under way with a space program.

b. While awaiting congressional action we suggest that the President advise the NACA's top committee that it is being charged with the responsibility for developing and arranging for the execution of the civil space program. NACA will at first have to rely heavily upon the Department of Defense and its instrumentalities for interim development and demonstration projects. However, the problems created by such arrangements will be minimized once the President gives NACA the clear-cut authority required for it to select and monitor the advanced space projects entrusted to the Department of Defense during the transitional period.

[12] c. None of the immediate measures is more essential and fundamental than defining as clearly as possible just what the nation plans to do in the space field. At the same time an effort must be made to estimate with reasonable exactness the annual additional costs of the civil space program.

Immediate Action

If you concur in the recommendations set forth above, the director of the Bureau of Budget will proceed, in cooperation with this Committee, your Special Assistant for Science and Technology and other departments and agencies concerned, to develop for your consideration specific proposals for legislative and executive action.

James B. Killian, Jr.,
Special Assistant for
Science and Technology

Percival Brundage,
Director, Bureau
of the Budget

Nelson A. Rockefeller,
Chairman

[1]**Attachment**

Summary of Advantages and Disadvantages of Alternative Organizational Arrangements

1. Use of a private contractor to carry out the civil space program under supervision of NACA.

A variation of our recommended organizational approach is to select NACA as the civilian agency to supervise contracts with a private laboratory charged with developing and testing space vehicles. This is the pattern followed by the Atomic Energy Commission in much of its research. This approach has also been used to some extent by the military services in developing missiles.

Advantages

Contract operation is preferred by some scientific personnel as a means of circumventing government salary and administrative controls. It would retain NACA in a supervisory capacity while making use of selected private research organizations.

Disadvantages

This approach is in conflict with the traditional NACA practice of carrying out research largely through its own government-employee staffed laboratories: there is no

assurance that a private research laboratory can be found to do the work on a sufficiently urgent schedule; and such greater flexibility as private laboratories may enjoy can also be provided NACA through the changes in law previously described.

[2] **Conclusion**

No real gains would flow from this alternative which could not be achieved under the preferred organization. It would be better to permit NACA to make its own decisions as to the extent to which it would use contracting authority in executing the space research program. It is assumed, of course, that NACA will, in fact, make fairly extensive use of research contracts, but on a selective basis.

2. Utilization of the Department of Defense

The recent Supplemental Military Construction Authorization Act authorizes the Secretary of Defense, for a period of one year, to carry on such space projects as may be designated by the President. It confers permanent authority for the Secretary or his designee to proceed with Missile and other space projects directly related to weapons systems and military requirements.

Advantages

The Department of Defense is now doing most of the current missile and satellite work: it has the bulk of the scientists and engineers active in these fields in its employ or on the rolls of its contractors; it will have to continue work on space vehicles on an interim basis for demonstration purposes; it is experienced in working with and utilizing the facilities of NACA; and it may be possible for a civilian agency of the Department to carry out the program.

[3] **Disadvantages**

The Department of Defense is a military agency in law and in the eyes of the world and placing the space program under it would be interpreted as emphasizing military goals: the space program is expected to produce benefits largely unrelated to the central mission of the Department of Defense; there is some danger that the non-military phases of space activity would be neglected; the Department is already so overloaded with its central military responsibilities that care should be taken to avoid charging it with additional civil functions; cooperation with other nations in international civil space matters could be made more difficult; and adequate civil-military cooperation can be achieved under the recommended organization without assigning inappropriate functions to Defense.

Conclusion

Since the space program has a relatively limited military significance, at least for the foreseeable future, and since the general scientific objectives should not be subordinated to military priorities, it is essential that the arrangements for space organization provide for leadership by a civilian agency.

[4] **3. Utilization of the Atomic Energy Commission**

There are now pending before the Congress bills which would authorize the Atomic Energy Commission to proceed with the development of vehicles for the exploration of outer space. Among these bills are S. 3117 (introduced by Senator Anderson) and S. 3000 (introduced by Senator Gore). The justification for these proposals is the role already being played by the Atomic Energy Commission in developing nuclear propelled jet and rocket engines.

Advantages

The Atomic Energy Commission is a civilian agency with competence in directing scientific research and development projects: it has had experience in managing research contracts and in working with the military agencies; and it is now charged with developing a nuclear rocket engine which may eventually be used to propel space vehicles.

Disadvantages

The Atomic Energy Commission is concerned chiefly with the use of a single form of energy and it is expected that chemical propellants, not atomic energy, will be the chief power source for space vehicles for years to come. Moreover, the Commission has virtually no experience or competence in most aspects of the design, construction and testing of space vehicles.

[5] Conclusion

The Atomic Energy Commission has a contribution to make in the space field. However, it should limit its work to the aspects of the space problem in which nuclear energy may have practical applications. An administration position along these lines has already been conveyed to the Chairman of the Atomic Energy Commission.

4. Creation of a Department of Science and Technology

Senators Humphrey, McClellan and Yarborough recently introduced S. 3126, a bill to create a Department of Science and Technology. The bill calls for the establishment of a new executive department which at the outset would contain or be given the functions of the National Science Foundation, the Patent Office, the Office of Technical Services of the Department of Commerce, the National Bureau of Standards, the Atomic Energy Commission and certain divisions of the Smithsonian Institution. The Secretary would also be authorized to establish institutes for basic research.

Advantages

The proposed department would provide a civilian setting for the administration of space programs, and it would give this and other scientific activities the prestige and accessibility to the President associated with departmental status.

[6] **Disadvantages**

The proposed department will be highly controversial, and there is no assurance that it can be established in time to assume the responsibility for civil space programs. It is also unlikely that science, of itself, will provide a sound basis for organizing an executive department.

Conclusion

There would be little prospect of getting such a reorganization approved and functioning in the near future. Even if the department could be created, it might not provide as good a setting for a high priority space program as that proposed under the preferred organization.

Document IV-5

Document title: Maurice H. Stans, Director, Bureau of the Budget, Memorandum for the President, "Responsibility for 'space' programs," May 13, 1958.

Source: Dwight D. Eisenhower Papers, Eisenhower Library, Abilene, Kansas.

Prior to the creation of NASA in 1958, the nation's space efforts were housed in various branches of the military services. The Naval Research Laboratory managed the

VANGUARD project; the Army was responsible for Explorer I, which led to the discovery of the Van Allen radiation belts; and the Army, Air Force, and Navy were responsible for a variety of booster programs. In addition, the Advanced Research Projects Agency (ARPA) had been created in early 1958 to house military space activities not closely linked to specific service missions. Although program content was generally dominated by military requirements, substantial portions of the military space program had no immediate relationship to established defense needs. However, many of these projects eventually proved essential to the human and scientific exploration of space. By March 1958, it had already been decided that a new civilian agency would best serve the scientific and prestige needs of the nation. What was absent was a plan for allocating responsibility for the various facets of the nation's space program. Even so, the desire to avoid duplication of effort and establish a new space agency in the shortest possible time necessitated the transfer of whole programs and in some cases military facilities to NASA. At the time no other alternative was tenable to those making the decisions. But, as the memorandum suggests, elements of the Department of Defense attempted to resist the transfer of their programs to the new civilian agency.

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[1] # Memorandum for the President

Subject: Responsibility for "space" programs

In your letters of April 2, 1958, you directed the Secretary of Defense and the Chairman of the National Advisory Committee for Aeronautics to review and report to you which of the "space" programs currently underway or planned by Defense should be placed under the direction of *the new civilian space agency proposed* in your message to Congress. These instructions specifically stated that "the new Agency will be given responsibility for *all* programs except those peculiar to or primarily associated with military weapons systems or military operations."

It now appears that the two agencies have reached an agreement contemplating that certain space programs having no clear or immediate military applications would remain the responsibility of the Department of Defense. This agreement would be directly contrary to your instructions and to the concept underlying the legislation the administration has submitted to Congress.

The agreement is primarily the result of the determination of the Defense representatives not to relinquish control of programs in areas which they feel might some day have military significance. The NACA representatives apparently have felt obliged to accept an agreement on the best terms acceptable to Defense.

Specifically, Defense does not wish to turn over to the new agency all projects related to placing "man in space" and certain major component projects such as the proposed million pound thrust engine development. The review by your Scientific Advisory Committee did not see any immediate military applications of these projects.

The effect of the proposed agreement would be to divide responsibility for programs primarily of scientific interest between the two agencies. This would be an undesirable and unnecessary division of responsibility and would be highly impractical. There would not be any clear dividing line, and unnecessary overlap and duplication would be likely. The Bureau of the Budget would have an almost hopeless task in trying to keep the two parts of the program in balance, and problems on specific projects would constantly have to come to you for resolution. The net result of the proposed arrangement would be a less effective program at higher total cost.

[2] On the other hand, it will be relatively simple to work out practical working arrangements under which responsibility and control of the programs in question would clearly be assigned to the new agency as contemplated in your instructions, and the military interest would be recognized by the participation of the Department of Defense in the

planning and, where appropriate, the conduct of the programs.

In the circumstances, it is recommended that you direct that the two agencies consult with the Bureau of the Budget and Dr. Killian's office to be sure that any agreement reached is in accordance with the intent of your previous instructions. It is especially important that announcement of the agreement now being proposed be avoided at this stage of the consideration by the Congress of legislation to establish the new space agency.

If you approve this recommendation, there are *attached memoranda* to return to the Secretary of Defense and the Chairman of the National Advisory Committee for Aeronautics for your signature.

(Handled orally per President's instructions. AJG) 5/13/58

Signed by Maurice H. Stans
Director
5/13/58

5/14/58
I notified the Secretary of Defense (General Randall) and Dr. Dryden.

AJG

Document IV-6

Document title: W.H. Pickering, Director, Jet Propulsion Laboratory, to Dr. T. Keith Glennan, NASA, March 24, 1959.

Source: NASA Historical Reference Collection, NASA History Office, NASA Headquarters, Washington, D.C.

NASA was not created from whole cloth; rather, it was an amalgamation of a number of pre-existing programs and facilities. However, the attempt to meld different institutional cultures into a single organization was not without its problems. Management methods as well as institutional expectations often differed. The lingering animosity that was to plague the relationship between NASA Headquarters and the Jet Propulsion Laboratory (JPL) was present from the start of the relationship, as this letter demonstrates.

The Vega project mentioned in Pickering's letter was a JPL-favored three-stage booster for launching lunar missions. It was based on a modified Atlas ICBM, developed by Convair as the first stage, and a JPL-developed third stage. The project was canceled in December 1959 in favor of the Air Force Centaur. The Centaur was similar to the Vega, but its second stage used liquid hydrogen as a fuel. This stage was eventually developed, but not under JPL management, and used with the Atlas and Titan missiles to launch a variety of spacecraft.

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[1] March 24, 1959
Dr. T Keith Glennan
National Aeronautics and Space Administration
1520 H Street, N.W.
Washington 25, D.C.

Dear Keith:

I was very glad to have had the opportunity to discuss some of our problems with you on Saturday, but I feel that I would like to enlarge on some of these topics with you. In so doing, I hope that you will regard this as a private communication between ourselves. My

motives are essentially an attempt to clarify my position on some of these matters.

I. The Importance of the Vega Project to the U.S. and to NASA.

I believe that the Vega project is one of the most important actions which NASA must take this year. Vega is the first vehicle which NASA will build under its own direction for scientific and civilian purposes. If Vega is not started almost immediately then;

A. The Mars 1960 date will not be obtained with consequent loss of prestige to both the U.S. and NASA.

B. Vega will be scheduled only a few months ahead of Centaur and, therefore, a powerful argument will be presented that Vega is unnecessary. If this prevails, then the NASA space program will be subordinate to the Air Force military requirements for Centaur.

II. Why has not the Vega Project been Started Already?

As this letter is being written it appears that there is every hope that the project will, in fact, be finalized within the next week, but I think it is desirable to review some of the causes for the delay in getting it underway. I believe these have been, first, the reluctance of Headquarters to initiate authorization and funds for Vega activities to JPL, or to initiate a letter order with Convair. Second, the reluctance of Headquarters to delegate negotiating responsibility to JPL to work with Convair to develop the best possible program within the [2] JPL-Headquarters agreed upon objectives and money.

III. Problem Areas Which Exist Between Headquarters and JPL.

I am listing a number of bald statements without amplification or justification, but I think these are significant.

A. Headquarters is not yet willing to treat JPL like one of its own Laboratories, or at least in the manner in which JPL believes Headquarters treats its own Laboratories.

B. Headquarters appears to be too concerned with technical details of projects.

C. JPL does not seem to understand Headquarter's operating principles. JPL tries to cooperate when asked to do something by Headquarters, but is all too frequently frustrated when the expected results are not forthcoming.

D. JPL is concerned that Headquarters has not apparently established a Vega program office which will, in fact, be a focal point for all Vega program activities.

E. JPL would like to feel that Headquarters trusts us enough to ask for help or advice when needed, and also to invite us to pertinent meetings in which we are concerned.

F. JPL is prone to compare the Headquarters negotiations on the Vega program with the similar type of negotiations necessary when the Sergeant program was set up with the Army. The result is not flattering to Headquarters.

IV. What are the Problem Areas which JPL Believes Face NASA?

A. The flight program is too diversified and contains too many shots. Even the reduced schedule of approximately one shot per month is a very heavy program.

B. I believe that NASA faces some difficult problems with the Air Force, particularly in Vega and Centaur.

C. NASA should actively work to obtain its own launch and hanger facilities, both at AMR and PMR.

[3] D. NASA must clarify the relationship between Vega and Centaur when both are under NASA sponsorship. I believe that in spite of the obvious problems, the best answer is for JPL to be technically responsible for both. But, if this is planned, then JPL needs to be made cognizant of the present Centaur contractual and technical progress.

E. I think it is essential for NASA to move into the Goldstone area with at least a token propulsion activity. NASA needs to demonstrate an imaginative program to the public. A start on an advanced propulsion facility should be an excellent example.

V. What Needs to be Done?

It appears to me that the most urgent thing in the JPL-NASA picture is to get the Vega program going. It should be established as a program even if the objectives are not all as desired. The present contract is a down payment on a continuing program, not a final contract. It should be written as flexibly as possible. For example, an initial buy of six

rounds is probably adequate for now. A firing rate of perhaps six per year could well be required so that it will be a continuing purchase of Vega vehicles.

In writing these comments to you, I hope you will not regard them as just petty criticisms. I have tried to put down some of the things which are bothering my people, and I believe it is fair to say that we at the Laboratory are trying to take a NASA view of the problem rather than a Laboratory view. I think that we all expected that we would encounter problems with our NASA operations, and I do not know that these problems have been any more serious than we had expected. However, I do feel the importance of trying to establish the best possible relationship between the Laboratory and Headquarters so that the Space Program will progress as effectively as possible.

Sincerely,
W.H. Pickering
Director

Document IV-7

Document title: T. Keith Glennan, *The Birth of NASA: The Diary of T. Keith Glennan* (Washington, DC: NASA Special Publication-4105, 1993), pp. 1-6.

The Eisenhower administration chose as first NASA Administrator T. Keith Glennan, who had been president of Case Institute of Technology in Cleveland, Ohio, since 1947. Up until almost the time that Glennan was asked to take the job, the leading candidate had been NACA Director Hugh Dryden. But Dryden was a career civil servant, a Democrat, and thought by some, particularly in Congress, to be insufficiently bold in his approach to the emerging space program. Glennan was an engineer who prior to World War II had worked primarily in the motion picture industry. He had one previous tour of duty in Washington, as a member of the Atomic Energy Commission from 1950 to 1952. In this excerpt from his diary, Glennan discusses how he came to NASA and the philosophy he brought to the position.

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[1] In spite of my membership on the Board of the National Science Foundation, the agency providing the funding for the Vanguard Project, I had taken no more than casual interest in the efforts of this nation to develop a space program following the successful orbiting of Sputnik I by the Russians on 4 October 1957. The aftermath was marked by a continuous chorus of lament over the fact that the Soviet Union had stolen a march on the United States in fields that had seemed to be the special province of our own country. In reaction, President Eisenhower appointed Jim Killian of MIT as his Science Advisor. I thought this a most excellent appointment and sent a telegram to Jim congratulating him and stating that I would be happy to assist in any possible way.

In April 1958, the president sent to the Congress a bill calling for the establishment of an agency to develop and manage a national space program. Quite naturally, there was much debate about the actual management of this program—should it be handled by the military departments or by a civilian agency? The proponents of the civilian management won out, and the bill was passed and signed into law on 29 July by President Eisenhower. It called for the creation of the National Aeronautics and Space Administration using the then existing National Advisory Committee for Aeronautics as its foundation. That distinguished 43-year-old agency employed some 8,000 people, with major laboratories in Cleveland; Langley, Virginia; and Moffett Field, California. There were smaller field stations at Edwards Air [2] Force Base in California and at Wallops Island, Virginia. Its budget for the 1959 fiscal year had been set at $101 million as I recall.

The policy statement in the preface of the Act called for the establishment and prosecution of a program aimed at the development of useful knowledge of the space

environment and the exploration and exploitation of that environment for peaceful purposes and for the benefit of all mankind. In recognition that space might well be used for military purposes, the law provided that any activities concerned principally with the defense of the nation were the responsibility of the Department of Defense.

As already stated, I paid about as much attention to all of these events as the ordinary citizen—not much more. Imagine my surprise when on 7 August 1958 I received a call from Jim Killian asking me to come immediately to Washington. I flew down on that same day and met with him at his apartment that evening. He said his purpose was to ask me, on behalf of President Eisenhower, to consider becoming administrator of the new agency, which of course was the National Aeronautics and Space Administration (NASA). He handed me a copy of the bill, which I had not previously seen. I read it through rather hurriedly and pointed out immediately the built-in conflict that seemed to me to be present whereby the Defense Department most certainly would dispute the claim of the civilian agency to important elements of any program that might be initiated. After some considerable discussion, I agreed to meet with the president the next morning.

The meeting with President Eisenhower was brief and very much to the point. He said he wanted to develop a program that would be sensibly paced and vigorously prosecuted. He made no mention of concern over accomplishments of the Soviet Union although it was clear he was concerned about the nature and quality of scientific and technological progress in this country. He seemed to rely on the advice of Jim Killian. I agreed that I would give the matter consideration and would give him a reply within a few days.

Discussions with Killian were followed by a visit to Don Quarles, Deputy Secretary of Defense. I had known Quarles for years, since my stay in New London during World War II. It was apparent that few people had been asked to recommend a candidate for the NASA job, and I gained the impression that Quarles had only heard about the proposal that I be offered the post. He urged me to take it but expressed some unhappiness over the fact that he had not acted more promptly on a matter troubling him—head of the research and development activity in the Office of the Secretary of Defense. He stated that he had intended to offer that job to me. Although flattered, I assured him that I would not have been able to accept because of my conviction that only a scientist should handle that job.

[3] Returning to Cleveland, I discussed these matters with my wife Ruth, several of my associates on the campus, and members of the board of trustees. Frederick C. Crawford [chairman of the board of trustees at Case Institute of Technology] urged me to take the post, and after two or three days of soul searching I called Killian to say I would accept—but only if Hugh Dryden, the director of the NACA, would endorse the appointment and would agree to serve as my deputy. Events began to move rapidly. Fred and I agreed that it would be desirable to ask Kent Smith to serve as acting president during my absence since John Hrones [Case's vice president for academic affairs] had been with us only a year and was not acquainted with all facets of the campus. Fred and I talked with Kent and Thelma and, in spite of the fact that they had planned a year abroad, Kent agreed to take on the job.

The swearing-in was set for 19 August in Washington. Ruth, Polly, and Sally drove down with me and Ruthie and Jack Packard attended the ceremony in the executive offices of the White House. A crowd of friends attended the brief ceremony, and the family had a chance to speak with President Eisenhower who [4] presided and handed us our Commissions, Hugh Dryden having been sworn in at the same time. Together with the Packards, we had lunch at LaSalle du Bois with everyone a bit punch drunk over events of the day. Ruth Packard and my Ruth immediately started a search for an apartment, and I returned to the NACA offices to become acquainted with members of the staff of that organization, soon to be absorbed by NASA.

Although my visit had been billed as casual, I found myself thrust into the problems of the new agency. Dryden called in Abe Silverstein and some of the top operating people who wanted to discuss budget. I will not try to describe the budget cycle in Washington

agencies; suffice it to say that we were attempting to put together a budget that should have been initiated months before. Staff members were seeking my approval of a figure toward which they might work on the budget, which had to be submitted within weeks. Imagine my consternation when they proposed that we seek $615 million. The Case budget at that time was in the neighborhood of $6 or $7 million and I doubt that I had much feel for $615 million. Members of the staff made the point that when NASA was to be declared "ready for operations" we would be taking over from the Defense Department projects, together with manpower and funds already appropriated. It appeared that we would have about $300 million for FY 1959 (July 1958-June 1959). Their arguments must have been convincing, for I approved a budget for FY 1960 using the guideline figure of $615 million. This, then, was my introduction to what was to become one of the major activities of the federal government.

In accepting the appointment I had stipulated that I would take a vacation before reporting for duty and had set the reporting date at 9 September. In addition to taking a vacation, I had to complete my annual report for Case. We were able to find a cottage on Martha's Vineyard and after depositing the children in Cleveland we drove immediately to Wood's Hole and took the ferry to the Vineyard. This was a delightful spot, and I was able to complete my report even though I spent time on the telephone counseling with Dryden and others about additional top personnel.

I want to record my first brush with the inflexibility of bureaucratic procedure. The Case trustees had voted to continue my salary throughout the balance of 1958, paying me in a lump sum determined to be a legal procedure. I did not want to accept a check from the federal government until I was on the job, so I asked our financial officer at NASA to determine how this could be managed since my salary was supposed to begin when I was sworn in. He shook his head but agreed to make the attempt. When I returned to Washington on 9 September, I called him in. He stated that the only possible way to manage this affair was for me to accept the payment and to return it to the federal government as a gift. I would have to pay income tax. Since there seemed no way of circumventing these regulations, I decided to keep the salary although I suppose I could have paid the tax and returned the balance of the salary less the tax. The whole procedure seemed so unbusinesslike that I guess I acted as much in pique as from any sense of conviction.

Now my work began in earnest. Ruth was engaged, with the help of Mr. Bacome, a Cleveland decorator, in making the apartment livable. [5] We bought drapes, a bookcase and a room divider, a daybed, and a rug and shipped furniture from Cleveland. As I look back over my appointment schedules for those days, I wonder how I kept anything straight. I was concerned with acquiring a number of good men to fill top positions in the agency and I seem to have spent a good bit of my time on this task. Hardly a day passed without a visit from the representatives of some industrial concern—usually the president—and meetings with top people in the Department of Defense and some of the other agencies with which we would be dealing.

Although NACA contained many fine technical people, it had been an agency protected from the usual in-fighting found on the Washington scene. Its staff, composed of able people, had little depth and little experience in the management of large projects. Considerable thought had been given by the staff to the organization that might develop, and these plans served to get us underway. It became apparent almost immediately that further studies would be needed and that some good people would have to be hired.

Let me discuss the philosophy with which I approached this job—a philosophy about which I had thought while vacationing at Martha's Vineyard. First, having the conviction that our government operations were growing too large, I determined to avoid excessive additions to the federal payroll. Since our organizational structure was to be erected on the NACA staff, and their operation had been conducted almost wholly "in-house," I knew I would face demands on the part of our technical staff to add to in-house capacity. Indeed, approval had been given in the budget to initiate construction of a so-called "space control center" laboratory at Beltsville, Maryland, an action I approved. But I was convinced that the major portion of our funds must be spent with industry, education, and other institutions.

Second, it seemed to me that we were starting virtually from scratch and with little in the way of rocket-propelled launching systems. Thus it seemed to me that we should mount an aggressive program that would build on the advancing state of the art as we came to understand more about technologies with which we were dealing. Third, it seemed clear that we should not lose sight of the propaganda values residing in successful launches—yet we had to be aware of the limitations imposed upon us by the lack of availability of proven launch vehicle systems. This was because the military missile program was just reaching the testing stage and these same rocket-propelled units were going to have to serve as "booster systems" or, as we came to call them, launch vehicle systems for our space shots.

Fourth, in the nature of things it seemed necessary that we structure our program in accord with our own ideas of fields to be explored and the pace at which progress could and should be made. This meant we must avoid the undertaking of particular shots, the purpose of which would be propagandistic rather than directed toward solid accomplishment. Fifth, we faced the prospect of carrying to completion the projects [6] started by the Advanced Research Projects Agency of the Defense Department, called into being by Secretary Neil H. McElroy during the period between 4 October 1957 and the operational beginnings of NASA. At the same time we must be planning our own broadly-based program of science and technology and organizing to accomplish all these tasks.

Document IV-8

Document title: Anonymous, "Ballad of Charlie McCoffus," n.d.

Source: Johnson Space Center, Historical Documents Collection, Houston, Texas.

The doggerel that collects in people's desk drawers or on hallway bulletin boards sometimes tells more about an organization's culture than the dry, cautious language of bureaucratic prose. The "field centers" of the National Aeronautics and Space Administration shared little besides NASA's budget and a suspicious contempt for "headquarters" efforts to impose some coherent administrative order on the lot of them. Resentment of "headquarters" was strongest among former NACA aeronautical research laboratories. The oldest was Langley Memorial Aeronautical Laboratory, dedicated in 1920 and named for Smithsonian Institution Secretary Samuel P. Langley.

Ballad of Charlie McCoffus*

A young field engineer named Charlie McCoffus
Worked all day in the field and at night in the office,
Preparing reports and estimates too
To be picked all to bits by the Washington crew.

For the boys in D. C. and their double lensed specs,
Their sallow complexions and fried collar necks,
Care not for the time or trouble they make
If a comma is missing, or a carbon misplaced.

They fire it back with ill conceived jeers
To harass the poor hardworking field engineers.

* A ballad used by Langley in the early days!

To get back to Charlie he struggled along
Till an ache in his head told him something was wrong.
He went to the doctor and "Doctor" says he,
"There's a buzz in my brain. What's the matter with me?"

Well the medico thumped as the medicos do
and tested his pulse and his reflexes too,
And his head and his heart and his eyes and each lung
And Charlie said "Ah" and stuck out his tongue.

Then the doctor said "Well what a narrow escape!
But a brief operation will put you in shape.
I must take out your brain for a complete overhauling,
In the interim take a respite from your calling."

The weeks passed by and Charlie McCoffus
Never called for his brain at the medico's office.
The doctor got worried and gave Charlie a ring,
"You'd better come over and get the damn thing."

"Thanks Doc, I don't need it" said Charlie McCoffus.
"I have been transferred to the Washington Office."

So Charlie now wears a fried collar to work,
And hides in the lairs where the auditors lurk,
And his letters bring tremors of anger and fear
To the heart of each hardworking field engineer.

And the pride and the joy of the Washington Office
Is the brainless predacious young Charlie McCoffus.

Document IV-9

Document title: *Report to the President on Government Contracting for Research and Development*, Bureau of the Budget, U.S. Senate, Committee on Government Operations, 87th Cong., 2d sess. (Washington, DC: U.S. Government Printing Office, 1962), pp. vii-xiii, 1-24.

Public debates over the proper spheres of government and private enterprise, which became more intense with the growth of the federal establishment during and after World War II, drew a distinction between the "public sector" and "private sector" that was often more fiction than fact. By the end of the 1950s, there were entire industries that depended heavily on federal contracts, and there were federal agencies, such as the Atomic Energy Commission, whose facilities were operated almost entirely by private contractors. Was the government improperly transferring its authority and responsibilities to private industry? As early as 1961, the White House created a task force to examine this question. The group's report, issued in April 1962, became informally known as the "Bell Report," after its chairman, David Bell, Director of the Bureau of the Budget. This excerpt contains the body of the report's analysis and conclusions.