Chapter Three

The Evolution of U.S. Space Policy and Plans

by John M. Logsdon

The July 1958 National Aeronautics and Space Act [II-17] and the statement of "Preliminary U.S. Policy for Outer Space" adopted by the Eisenhower administration in August 1958 [II-20] provided the framework within which the new space agency, the National Aeronautics and Space Administration (NASA), planned an initial set of programs and projects. In the subsequent thirty years, the interactions among formal statements of national space policy, various presidential decisions on specific space undertakings, and project proposals emanating from internal NASA planning have resulted in an evolving U.S. civilian space program that has been able to meet the Space Act mandate of making the United States "a leader" in space. This essay provides an overview of those interactions as they are manifested in key policy documents included in this work.[1]

The Early Years: Space Policy and Planning, 1959-1960

NASA's initial plan of activity was based on preexisting programs inherited from the Department of Defense and NASA's predecessor organization, the National Advisory Committee for Aeronautics (NACA). [III-1] Within a few months after it began operations, the agency had shaped this inheritance into a short-term program, and its new leaders, Administrator T. Keith Glennan, who had come to NASA from his position as president of the Case Institute of Technology in Cleveland, and Deputy Administrator Hugh L. Dryden, who had been the NACA Director, set about the task of developing their own plans for the new space agency.[2]

By the end of 1959, just over a year after NASA began operations, the space agency had prepared a formal long-range plan. [III-2] The plan noted that NASA's activities during the 1960s "should make feasible the manned exploration of the moon and nearby planets, and this exploration may thus be taken as a long-term goal of NASA activities." The plan called for the "first launching in a program leading to manned circumlunar flight and to a permanent near-earth space station" in the 1965-1967 period. It also called for the first human flight to the Moon sometime "beyond 1970."[3] Although the first NASA long-range plan featured a balanced program of science, applications, and human spaceflight, from the start proposals for the future of the piloted portion of its activities excited the public, and NASA, therefore, became the focal point of future thinking.

1 . This brief essay cannot purport to be a comprehensive history of the evolution of U.S. space policy; that would require at least book-length treatment. (Such a book does not now exist.) Rather, this essay attempts to put the documents selected for this section of the work in their historical context, so that they can be understood in terms of where they fit in the overall development of U.S. space policy and plans.

2. On Glennan's career, see J.D. Hunley, ed., *The Birth of NASA: The Diary of T. Keith Glennan* (Washington, DC: NASA SP-4105, 1993).

3. Office of Program Planning and Evaluation, "The Long Range Plan of the National Aeronautics and Space Administration," December 16, 1959, NASA Historical Reference Collection, NASA History Office, NASA Headquarters, Washington, DC.

Making human flights to the Moon and planets the stated long-range goal of the NASA program was, to say the least, controversial within the Eisenhower administration. NASA planners since early 1959 had been investigating the appropriate focus for NASA's human spaceflight program, once the initial Project Mercury had demonstrated the ability of the human body to withstand the rigors of launch, weightlessness, and then reentry. In particular, a group chaired by Harry J. Goett, Director of the new Goddard Space Flight Center in Greenbelt, Maryland, concluded by mid-1959 that the appropriate goal for NASA's post-Mercury human spaceflight program was to send humans to the Moon, not just for extended stays in Earth orbit.[4] Even after the lunar landing goal had been included in NASA's long-range plan, it continued to be debated within the top councils of NASA, but by early 1960 a decision was made to proceed with a lunar expedition as a major element in NASA's future planning.

The fact that NASA was contemplating sending people to the Moon did not escape the notice of those advising President Dwight D. Eisenhower on overall science and technology issues. By the end of 1960, an Ad Hoc Panel on Man-in-Space of the President's Science Advisory Committee (PSAC), chaired by chemist Donald F. Hornig of Brown University, had completed its own investigation of NASA's post-Mercury planning. [III-3] The panel concluded that "at the present time. . .man-in-space cannot be justified on purely scientific grounds. . . . On the other hand, it may be argued that much of the motivation and drive for the scientific exploration of space is derived from the dream of man's getting into space himself." The group also estimated that landing humans on the Moon would cost $26-38 billion above the $8-9 billion cost of Earth-orbiting and circumlunar flights, and could not be accomplished until after 1975.[5] The report of the PSAC panel was presented to President Eisenhower at a December 20, 1960, meeting of the National Security Council; Eisenhower's reaction was that "he couldn't care less whether a man ever reached the moon."[6]

At the end of the Eisenhower administration, then, NASA had in place a long-range plan that anticipated a budget gradually increasing during the 1960s to a $2.5 billion level in 1960 dollars, but without White House approval for its centerpiece activities—a post-Mercury program of human spaceflight aimed at an eventual lunar landing and the development of the large boosters required for such a program. Dwight Eisenhower recognized that the United States was in a space race with the Soviet Union, but he was not interested in winning that race at any cost. His attitude is best captured by the policy guidance provided in a January 1960 comprehensive statement of U.S. space policy. [II-21] That statement directed planners to, in orde

To minimize the psychological advantages which the USSR has acquired as a result of space accomplishments, select from among those current or projected U.S. space activities of intrinsic military, scientific or technological value, one or more projects which offer promise of obtaining a demonstrably effective advantage over the Soviets and, so far as is consistent with solid achievements in the over-all space program, stress these projects in present and future programming.[7]

To President Eisenhower, a race to be first on the Moon did not meet the requirement of "intrinsic value," and he was unwilling to approve future human spaceflight efforts that were steps in the direction of such an undertaking. This left NASA in a state of high uncertainty about its future prospects—uncertainty that was resolved within a few months by the new president, John F. Kennedy.

4. The work of the Goett Committee is discussed in John M. Logsdon, *The Decision to Go to the Moon: Project Apollo and the National Interest* (Cambridge, MA: MIT Press, 1970), pp. 56-57.

5. The President's Science Advisory Committee, "Report of the Ad Hoc Panel on Man-in-Space," December 16, 1960, pp. 6, 9, NASA Historical Reference Collection.

6. Hunley, ed., *The Birth of NASA*, pp. 292-93.

7. National Aeronautics and Space Council, "U.S. Policy on Outer Space," January 26, 1960, p. 11, paragraph 36, NASA Historical Reference Collection.

The Decision to Go to the Moon[8]

However, this uncertainty was not reduced by the first indication of the posture the new administration might take with respect to the civilian space program. [III-4] After his narrow victory over Richard M. Nixon in November 1960, Kennedy had formed a "transition team" to assess the national space effort. That team was headed by Jerome B. Wiesner, a Massachusetts Institute of Technology physicist who was slated to become Kennedy's science adviser. The "Wiesner Report" [III-5], released on January 10, 1961, was very critical of the quality and technical competence of NASA management and of the emphasis that had been placed on human spaceflight. It called the Mercury program "marginal" because of the limited power of its Atlas booster and criticized the priority given to the Mercury program for strengthening "the popular belief that man in space is the most important aim of our non-military space effort."[9] As the new president took office on January 20, the future course for NASA remained unclear.

Events of the next few months, however, made most of the recommendations of the Wiesner Report moot. President Kennedy announced on January 31 that James E. Webb, a politically skilled and aggressive lawyer-administrator, would become NASA Administrator, and that other senior members of NASA management would remain. Webb took office on February 14, and within six weeks met with the president with a request for a significant acceleration of the NASA program, with an emphasis on larger boosters and a new spacecraft for human spaceflight. Kennedy deferred a decision on Webb's request until the fall of 1961 deliberations on his next budget.

Then, on April 12, the Soviet Union launched the first human, Yuri Gagarin, into orbit. World and domestic reaction to the achievement was universally positive, and within a few days President Kennedy decided that the United States had to not only accept the challenge to a space race put forth by the Soviet Union, but also to enter the race with an intent to win. On April 20, he asked Vice President Lyndon B. Johnson to conduct an "overall survey of where we stand in space." [III-6] In particular, Kennedy asked: "Do we have a chance of beating the Soviets by putting a laboratory in space, or by a trip around the moon, or by a rocket to go to the moon and back with a man? Is there any other space program that promises dramatic results in which we could win?" The president asked for a report on Johnson's findings "at the earliest possible moment."[10]

The review was carried out under the auspices of the National Aeronautics and Space Council, which Kennedy had decided the vice president should chair. Even before the review began, in reaction to presidential guidance at an April 14 White House meeting, NASA had been examining the feasibility and costs of an accelerated civilian space effort. The Department of Defense provided its initial input on April 21. [III-7] Vice President Johnson asked a number of individuals inside and outside government for their views, including rocket engineer and space exploration visionary Wernher von Braun. [III-9] By April 28 the vice president could report to Kennedy [III-8] that "dramatic accomplishments in space are being increasingly identified as a major indicator of world leadership." He added that "if we do not make a strong effort now, the time will soon be reached when the margin of control over space and over men's minds through space accomplishments will have swung so far on the Russian side that we will not be able to catch up, let alone assume leadership," and that "manned exploration of the moon...is not only an achievement with great propaganda value, but it is essential as an objective whether or not we are first in its accomplishment—and we may be able to be first."[11]

8. In addition to the specific sources cited below, this account is based on Logsdon, *Decision to Go to the Moon.*

9. "Report to the President-Elect of the Ad Hoc Committee on Space," January 10, 1961, NASA Historical Reference Collection. Quotes are from p. 9 and p. 16.

10. John F. Kennedy, Memorandum for Vice President, April 20, 1961, Presidential Files, John F. Kennedy Presidential Library, Boston, MA.

11. Lyndon B. Johnson, Vice President, Memorandum for the President, "Evaluation of Space Program," April 28, 1961, p. 2, Presidential Papers, Kennedy Presidential Library.

In a meeting on May 3, the vice president brought together a diverse group that included Robert Kerr (D-OK), Chairman of the Senate Committee on Aeronautical and Space Sciences, and the ranking minority member on the committee, Styles Bridges (R-NH), together with others who had been involved in the space review. The primary purpose of the meeting was to ensure that the Senate would support an accelerated space program, but the minutes of the proceedings capture well the state of the debate at that point. [III-10] Of all the participants, NASA Administrator Webb seemed most hesitant to move quickly ahead with a set of ambitious recommendations to the president. Webb apparently wanted to make sure that the White House and Congress would commit the multiyear support needed to carry out those recommendations before he would advocate them to the president.

Webb's hesitation was quickly overcome. On Friday, May 5, the United States launched its first human, Navy Lt. Cdr. Alan B. Shepard, on a suborbital flight, to great acclaim. On the same day, Vice President Johnson learned that he would be leaving the next week for an inspection tour of U.S. military capabilities in Southeast Asia, and requested NASA and the Department of Defense to put together a recommendation to the president before he left. After an intense weekend of work, a report, delivered with a cover letter from James Webb and Secretary of Defense Robert S. McNamara, was ready by Monday morning, May 8. [III-11] The Vice President approved the report without change and transmitted it to the president; he in turn accepted the report's recommendations at a May 10 White House meeting.

The report called for a fundamental reversal of a space policy principle that had been established under President Eisenhower—that competition with the Soviet Union would be based only on projects that had other elements of "intrinsic merit." Rather, it argued that

Major successes, such as orbiting a man as the Soviets have just done, lend national prestige even though the scientific, commercial or military value of the undertaking may by ordinary standards be marginal or economically unjustified.

This nation needs to make a positive decision to pursue space projects aimed at enhancing national prestige. Our attainments are a major element in the international competition between the Soviet system and our own. The non-military, non-commercial, non-scientific but "civilian" projects such as lunar and planetary exploration are, in this sense, part of the battle along the fluid front of the cold war.[12]

The report called for an across-the-board acceleration of U.S. efforts in space and strong central planning for an integrated national space program. It noted that "we are uncertain of Soviet intentions, plans or status" with respect to sending humans to the Moon, but, because "it is man, not merely machines, in space that captures the imagination of the world," the United States should commit itself to a lunar landing program, even though it was not sure it could beat the Soviets to the Moon, because "it is better for us to get there second than not at all."[13]

President John F. Kennedy announced his decision to go to the Moon in what was billed as an unprecedented second "State of the Union" address to a joint session of Congress on May 25, 1961. [III-12] His speech had gone through a number of drafts, with one issue being whether the president should announce 1967, the fiftieth anniversary of the Russian Revolution and a date widely thought to be timely for a Soviet spectacular in space, as the intended date for the first lunar landing. His advisers convinced him that he

12. James E. Webb, Administrator, NASA, and Robert S. McNamara, Secretary of Defense, to the Vice President, May 8, 1961, with attached: "Recommendations for Our National Space Program: Changes, Policies, Goals," p. 8, NASA Historical Reference Collection.

13. *Ibid.*, pp. 13-14.

should allow some margin for unexpected delays, and so he called for the lunar landing "before this decade is out." He told Congress and the nation that "now it is time to take longer strides—time for a great new American enterprise—time for this nation to take a clearly leading role in space achievement." Kennedy added in his own hand to the prepared text the words—"which in many ways may hold the key to our future on earth."[14]

Congress quickly accepted the president's call for a more than half-billion dollar supplement to NASA's budget, and with that acceptance gave initial support to the policy of seeking across-the-board leadership—preeminence—in space. Project Apollo, NASA's lunar landing program, became the dominant feature of the U.S. quest for space leadership. Its impacts on the evolution of the U.S. space program were to be pervasive in the decades to come.

Reviewing the Apollo Commitment

President John Kennedy chose to go to the Moon as a response to the political situation in early 1961, not primarily in terms of a long-range vision for the U.S. space program. While Kennedy personally may have come to see space as a particularly important sphere of future-oriented activities, almost from the day that the president announced his intent to set the lunar landing goal, others inside and outside government questioned the wisdom of this commitment. This questioning became more vocal in 1962 and 1963, as the United States forced the Soviet Union to withdraw nuclear missiles from Cuba in October 1962 and as the two nuclear superpowers agreed on a limited test ban treaty and appeared headed toward less tension in their geopolitical rivalry. By September 1963, President Kennedy was ready to go before the United Nations and suggest an end to the space race and the conversion of Apollo into a cooperative U.S.-Russian program.[15]

These public manifestations of possible instability in the U.S. commitment to Apollo and to a preeminent space program were accompanied by major White House reviews in 1962 and 1963. The 1962 review [III-13] was precipitated by the very rapid buildup of the NASA budget, increases in the estimated cost for Apollo, and pressure to *accelerate* the planned date for the initial lunar landing by the individual NASA had chosen to head the Apollo program, D. Brainard Holmes. The controversy over whether Apollo should be carried out on an all-out, "crash" basis or in relative balance with other elements of a program aimed at U.S. space superiority went to President Kennedy for resolution in November 1962. In a follow-up letter summarizing the arguments he had made during his meeting with the president on the question [III-14], NASA Administrator Webb argued that "the objective of our national space program is to become pre-eminent in all important aspects of this endeavor and to conduct the program in such a manner that our emerging scientific, technological, and operational competence is clearly evident." He told the president that "the manned lunar landing program, although of highest national priority, will not by itself create the pre-eminent position we seek."[16]

Based on this reasoning, Webb recommended against providing additional funds for Apollo and moving up the planned date for the first lunar landing. Kennedy accepted Webb's perspective, and soon after Brainard Holmes left NASA. Perhaps more fundamental, the president's acceptance seemed to indicate that across-the-board preeminence was indeed his guiding policy objective for the United States in space.

The 1963 space program review, by contrast, appears to have been stimulated by increasing external criticism of the priority being given to the space program rather than other areas of science and technology, and was focused on those aspects of the program

14. President John F. Kennedy, Excerpts from "Urgent National Needs," Speech to a Joint Session of Congress, May 25, 1961, Presidential Files, Kennedy Presidential Library.

15. Representative Thomas Pelly, a Seattle Republican, stood up in the well of the House of Representatives three weeks later and offered an amendment to prohibit the use of government funds to finance a joint expedition. In spite of Kennedy's insistence that his U.N. proposal merely carried out the mandate for international cooperation in NASA's enabling legislation, the amendment passed. See "Major Legislation—Appropriations," *Congressional Quarterly Almanac 1963* (Washington, DC: Congressional Quarterly, 1964), p. 170.

16. James E. Webb, Administrator, NASA, to the President, November 30, 1962, NASA Historical Reference Collection.

not linked to Apollo. In April President Kennedy asked the vice president and the Space Council to conduct a comprehensive review so that he could "obtain a clearer understanding of a number of factual and policy issues relating to the National Space Program which seem to rise repeatedly in public and other contexts."[17] [III-15]

Leading the criticisms of the space program (including Apollo) were many in the scientific and educational communities.[18] For example, Vannevar Bush, who had been a primary architect of the relationship between government and science since World War II, wrote to James Webb in April 1963 with a comprehensive critique of the space effort. Bush argued "that the [space] program, as it has been built up, is not sound," that it was "more expensive than the country can now afford," and that "its results, while interesting, are secondary to our national welfare."[19]

The vice president transmitted the results of the space program review to President Kennedy on May 13, 1963. [III-16] He noted that the central difference between the Eisenhower and Kennedy administration's space programs was that "the plan of the previous Administration represented an effort for a second place runner and the program of the present Administration is designed to make this country the assured leader before the end of the decade." He argued that "our space progr[a]m has an overriding urgency that cannot be calculated solely in terms of industrial, scientific, or military development. The future of society is at stake." Johnson also told the president that all members of the Space Council concurred with the views contained in his report.[20] The president apparently agreed, for the speech he had prepared for delivery in Dallas on November 22, 1963, reaffirmed the administration's strong support for the leadership-oriented space effort he had initiated 2 1/2 years earlier.

Post-Apollo Planning During the Johnson Presidency

There was no comprehensive, presidentially approved statement of national space policy while John Kennedy or Lyndon Johnson were president, as there had been under Dwight Eisenhower; although the staff of the National Aeronautics and Space Council drafted such a document, it never received presidential sanction.[21] After the 1962 and 1963 reviews and the assassination of President Kennedy, any chance of a policy reversal that would downgrade the objective of making the United States first to the Moon disappeared, and the planning focus shifted to what objectives the country should pursue in space after Apollo. On January 30, 1964, President Johnson asked NASA for "a statement of possible objectives beyond those already approved."[22]

James Webb was very skeptical of having NASA come forward with a proposal for its future and then seeking political support for it; rather, he preferred that NASA wait for a "consensus" (which he defined as agreement among politically powerful actors) to form on future objectives for space. Then NASA could develop programs to achieve those objectives.[23] Thus the NASA response to Lyndon Johnson's 1964 request, which was transmitted to the president in February 1965, was not a long-range plan. [III-17] Rather, it described

17. John F. Kennedy, Memorandum for the Vice President, April 9, 1963, Presidential Papers, Kennedy Presidential Library.

18. For a sample of the criticisms of Apollo that emerged in the 1962-1964 period, see Amitai Etzioni, *The Moondoggle: Domestic and International Implications of the Space Race* (Garden City, NY: Doubleday & Co., 1964).

19. Vannevar Bush to James E. Webb, Administrator, NASA, April 11, 1963, p. 2, Presidential Papers, Kennedy Library.

20. Lyndon B. Johnson, Vice President, to the President, May 13, 1963, with attached report, Presidential Papers, Kennedy Library.

21. For a discussion of attempts to develop such a policy statement, see *The National Aeronautics and Space Council During the Tenure of Lyndon B. Johnson as Vice President and During His Administration as President* (January 1961-January 1969), a history prepared by the National Aeronautics and Space Council staff. Copy in Lyndon Baines Johnson Library.

22. Lyndon Johnson to James E. Webb, January 30, 1964, NASA Historical Reference Collection.

23. For Webb's views on long-range planning, see Arnold S. Levine, *Managing NASA in the Apollo Era* (Washington, DC: NASA SP-4102, 1982), particularly chapter 9 and Webb's foreword.

"a number of long-range missions that deserve serious attention."[24] The report was in many ways a catalogue of the ways that the capabilities developed during the Apollo buildup could be employed and a "wish list" of future mission possibilities, with no priority indicated among them.

James Webb's hoped-for consensus on future space objectives did not emerge before Webb left NASA in November 1968 near the end of the Johnson administration. While the White House and the majority of Congress seemed willing to sustain the commitment to Apollo, no major new programs were approved, and the NASA budget began to decline after peaking at $5.25 billion in fiscal year 1965. This situation was deeply troubling to Webb. In an August 1966 letter to President Johnson, he pointed out that NASA was already in the process of "liquidation of some of the capabilities we have built up." [III-18] Webb had received Bureau of the Budget guidelines for the next fiscal year that he believed meant that "important options which we have been holding open will be foreclosed." Recognizing the international and domestic pressures of the president, Webb said he had struggled "to try to put myself in your place and to see this from your point of view" but could not "avoid a strong feeling that this is not in the best interests of the country." Webb told the president of his problems with Congress; in order to avoid a $1 billion cut in the NASA budget proposed by Senator William Proxmire (D-WI), Webb had to seek the support of the Republican leader in the Senate, Everett Dirksen (R-IL). Senior Democrats, including Richard Russell (D-GA), chair of the Senate Space Committee, had voted for the cut, which Webb believed would have led to "catastrophic emasculation" of the NASA program.[25]

Through the remaining years of the Johnson presidency, Webb was not able to convince the president to articulate future objectives for the post-Apollo civilian space program; other issues occupied Lyndon Johnson's attention. Meanwhile, as he had said would be necessary, Webb began the process of dismantling the capabilities developed to send Americans to the Moon; in August 1968, he ordered the first steps in shutting down the production line for the giant Saturn booster developed for the lunar mission. [III-19] Decisions on the character of the post-Apollo space program would have to be made by Lyndon Johnson's successor, Richard M. Nixon. [III-20]

Post-Apollo Planning During the Nixon Presidency

When he was sworn in as president on January 20, 1969, Richard Nixon had available—as had John Kennedy—a report from a high-level transition task force on space. [III-21] That task force was chaired by Nobel Prize-winning physicist Charles Townes of the University of California. It recommended proceeding with lunar exploration after Apollo, a program to utilize Apollo hardware and capabilities, an increase in automated solar system exploration and in general better balance between the human spaceflight and automated elements of the NASA program, and more attention to the applications of space and space technologies to useful purposes. The report recommended against commitments to a large space station, low-cost boosters, or human trips to the planets. The task group felt that the program it recommended could be carried out for an annual NASA budget of approximately $4 billion.

President Nixon and his advisers, however, recognized a need for early decisions on the post-Apollo space program. On February 13, 1969, Nixon asked his vice president, Spiro T. Agnew, to chair a Space Task Group (STG) to provide "definitive recommendation on the direction which the U.S. space program should take in the post-Apollo

24. NASA, *Summary Report: Future Programs Task Group*, January 1965, p. ii, NASA Historical Reference Collection.

25. James E. Webb, Administrator, NASA, to the President, August 26, 1966, with attached: James E. Webb, Administrator, NASA, to Honorable Everett Dirksen, U.S. Senate, August 9, 1966, NASA Historical Reference Collection.

period." [III-22] Rather than use the National Aeronautics and Space Council, which was chaired by Agnew, as the basis for the review, the president named as the only other members of the STG the acting administrator of NASA, the secretary of defense, and the science adviser. He also asked the science adviser to act as "staff officer" for the group's review.[26]

NASA was not comfortable entrusting its future to the deliberations of the STG. The Nixon administration had not yet selected a NASA administrator, and the man who had been deputy to James Webb and had become acting administrator upon Webb's retirement in November 1968, Thomas O. Paine, was managing the agency. (Paine was selected as the Nixon choice to remain as administrator in March 1969.) Paine was a much different sort of individual than James Webb. He was optimistic, bullish in word and action, and a newcomer to Washington's political ways. Unlike Webb, Paine preferred that NASA have the initiative in outlining future space goals.

Paine decided to try to preempt the work of the STG and attempt to get an early commitment to what NASA saw as its major post-Apollo program, a large space station. The need for an orbital outpost had been part of NASA's planning from the earliest years, but the decision to go to the Moon, particularly using a lunar rendezvous approach, had bypassed this step in space development. As NASA began during 1967 and 1968 to focus attention on its priorities for the next large new program after Apollo, a space station rose to the top of its list. On February 26, Paine sent a lengthy memorandum on "Problems and Opportunities in Manned Space Flight" to the president. [III-23] He suggested that "the case that a space station should be a major future U.S. goal is now strong enough to justify at least a general statement on your part" to this effect.[27]

The White House did not accept Paine's arguments, and he was told that all decisions related to future programs would await the recommendations of the STG. Those recommendations took shape over the summer of 1969, with the U.S. space program at the peak of its prestige and accomplishment as Apollo 11 returned from humanity's first foray on another celestial surface.

Thomas Paine found in Vice President Agnew an ally in calling for a fast-paced, ambitious post-Apollo program. At an early STG meeting, Agnew had asked for an "Apollo for the seventies." In interviews at the Kennedy Space Center following the July 16 launch of the Apollo 11 mission, Agnew said that it was his "individual feeling that we should articulate a simple, ambitious, optimistic goal of a manned flight to Mars by the end of the century."[28]

NASA was prepared to give Agnew what he asked for. The agency's planning for its input to the STG had been built on an "integrated plan" for future human spaceflight that had been developed by George Mueller, the NASA Associate Administrator for Manned Space Flight. That plan focused on activities in the space between the Earth and the Moon. After Agnew's statements, Paine asked Wernher von Braun (who had been thinking about Mars exploration for many years) to add an early Mars expedition to the NASA plan as developed by Mueller. The revised NASA plan was briefed to the STG on August 4, 1969. It included an initial twelve-person expedition to Mars leaving Earth in November 1981, with six members of the expedition spending thirty to sixty days on the Martian surface in late 1982.

The possibility that the STG might actually recommend the program that NASA was proposing was worrisome to Secretary of the Air Force Robert C. Seamans, who represented Secretary of Defense Melvin Laird during the group's deliberations. Seamans had been a senior official in NASA from 1960 to 1967, and he was concerned that the STG would put forward a program that was not politically acceptable. Seamans made his views known to the vice president at the August 4 STG meeting and in a letter dated the same

26. Richard Nixon, Memorandum for the Vice President, the Secretary of Defense, the Acting Administrator, NASA, and the Science Adviser, February 13, 1969, NASA Historical Reference Collection.

27. Thomas O. Paine, Acting Administrator, NASA, Memorandum for the President, "Problems and Opportunities in Manned Space Flight," February 26, 1969, NASA Historical Reference Collection.

28. *New York Times*, July 17, 1969, p. 1.

day. [III-24] Seamans recommended that the NASA program for the 1970s concentrate on using its capabilities for "solution of the problems directly affecting men here on earth" and that the development of a space station or a new, reusable space transportation system (which had emerged during STG deliberations as an attractive option for the future), much less human missions to Mars, not be approved until their feasibility and desirability were more firmly established.[29]

Faced with differing views (Director of the Bureau of the Budget Robert P. Mayo participated only as an observer in the STG, but had made it clear that from a budgetary perspective he was opposed to an ambitious post-Apollo space program), the STG decided on August 4 to present several future program options to President Nixon, rather than attempt to reach consensus on a program that all could support. Over the next month, a report was prepared that outlined three options, each incorporating a space station and a Mars mission, but on different schedules and budget profiles. Another option, at a low budget level, involved terminating the human spaceflight program. As the time came for submission of the report to the president, senior White House aides, particularly Assistant to the President John Erlichman, demanded that it be modified so that the president not receive recommendations that he could not possibly accept, such as a 1982 Mars landing or ending the human spaceflight program so soon after Apollo 11.[30] Changes were hurriedly made, and the report was presented to President Nixon on September 15, 1969.

The STG report [III-25] recommended a "basic goal of a balanced manned and unmanned space program conducted for the benefit of all mankind," with, "as a focus for the development of new capability...the long-range option or goal of manned planetary exploration with a manned Mars mission before the end of this century as the first target." Beyond such general statements, however, the report recommended no commitment to any specific project or schedule of accomplishments. It left to President Richard Nixon the job of setting the future course in space for the United States.

The Nixon Space Policy

Almost six months passed before Nixon issued a formal statement of his views on space in response to the STG report. In that statement, issued on March 7, 1970, the president signaled a significant downgrading in the priority of post-Apollo space efforts; in effect, he rejected even the least ambitious of the options that the STG had recommended. In his statement, Nixon noted the need "to define new goals which make sense for the Seventies." He argued that

many critical problems here on this planet make high priority demands on our attention and our resources. By no means should we allow our space program to stagnate. But—with the entire future and the entire universe before us—we should not try to do everything at once. Our approach to space must be bold—but it must also be balanced.

The president rejected another Apollo-like undertaking, saying that "space activities will be part of our lives for the rest of time," and thus there was no need to plan them "as a series of separate leaps, each requiring a massive concentration of energy and will and accomplished on a crash timetable." Instead, "space expenditures must take their place within a rigorous system of national priorities."[31]

The six-month delay in a presidential response to the STG report was caused by a vigorous battle between NASA and White House political, budgetary, and technical advisers over the content of that response and over the level of the NASA budget for fiscal year 1971—the first post-Apollo 11, post-STG budget. While NASA believed it had in the STG

29. Robert C. Seamans Jr., Secretary of the Air Force, to Honorable Spiro T. Agnew, Vice President, August 4, 1969, NASA Historical Reference Collection.

30. For Erlichman's account of this intervention, see *Witness to Power: The Nixon Years* (New York: Simon and Schuster, 1982), pp. 144-45.

31. *Public Papers of the Presidents of the United States: Richard Nixon, 1970* (Washington, DC: U.S. Government Printing Office, 1971), pp. 250-53.

report a mandate for a continuing program of capability development and high visibility achievement, the White House viewed the space program as a place for lowered priority and budget cuts. Nixon's advisers saw few political benefits for the president in continuing to fund a large civilian space program. [III-26, III-27] By the time final budget decisions were announced in January 1970, the NASA budget had been reduced by $402 million from its level of the preceding year, production of the Saturn V heavy lift booster was terminated, and no commitment was made to develop either a space station or a reusable space transportation system, the space shuttle. Clearly, NASA was once again facing an uncertain future.

The Decision to Develop the Space Shuttle

Frustrated by the unwillingness of the Nixon administration to support the kind of space program he thought was in the country's interest and attracted by a lucrative private sector job offer, Thomas Paine announced in July 1970 that he was resigning as of September 15. Paine's deputy, George Low, became acting administrator. Low was a highly respected career NASA engineer who had taken over the Apollo spacecraft program after the 1967 Apollo capsule fire and had come to Washington to be deputy administrator in September 1969. It took until April 1971 for Paine's permanent successor to be named; he was James C. Fletcher, president of the University of Utah. Low stayed on as Fletcher's deputy, and it was the Fletcher-Low team that guided NASA through the critical 1971 decisions that shaped the agency for years to come.

NASA had hoped, as it fought its losing budget battles in the fall of 1969 and the early months of 1970, to come back to the White House at the end of 1970 and get approval for developing both a space station and a space shuttle. But in the months leading up to discussions over NASA's fiscal year 1972 budget, it became clear that there was no enthusiasm in the White House for going ahead with a space station, and that only the proposed reusable transportation system had any chance of approval. But that approval did not come in the fiscal year 1972 decisions, and Fletcher and Low believed that NASA had to get a go-ahead for the shuttle in 1971 if NASA were to maintain its identity as a large development organization with human spaceflight as its central activity. The choice of whether or not to approve the space shuttle thus became a *de facto* policy decision on the kind of civilian space policy and program the United States would pursue during the 1970s and beyond.[32]

At the White House, one individual decided that cuts in the NASA budget were going too far. He was Caspar (Cap) Weinberger, deputy director of the renamed Bureau of the Budget, now the Office of Management and Budget (OMB). In an August 12, 1971, memorandum to the president, Weinberger argued that "there is real merit to the future of NASA, and to its proposed programs." [III-28] OMB was considering, as a means of further cutting the NASA budget, not approving the start of space shuttle development and cancelling the last two Apollo missions, Apollo 16 and 17. Weinberger suggested that such cuts

would be confirming in some respects, a belief that I fear is gaining credence at home and abroad: That our best years are behind us, that we are turning inward, reducing our defense commitments, and voluntarily starting to give up our super-power status, and our desire to maintain world superiority.

America should be able to afford something besides increased welfare, programs to repair our cities, or Appalachian relief and the like.

32. For a more detailed discussion of the space shuttle decision, see John M. Logsdon, "The Space Shuttle Decision: Technology and Political Choice," *Journal of Contemporary Business* 7 (1978): 13-30; John M. Logsdon, "The Decision to Develop the Space Shuttle," *Space Policy* 2 (May 1986): 103-19; John M. Logsdon, "The Space Shuttle Program: A Policy Failure," *Science* 232 (May 30, 1986): 1099-1105.

When Weinberger argued that programs such as the space shuttle should be funded, his views found a responsive ear. In a handwritten note on Weinberger's memo, President Richard Nixon indicated "I agree with Cap."[33] OMB Director George Shultz was informed that "the president approved Mr. Weinberger's plan to find enough reductions in other programs to pay for continuing NASA at generally the 3.3-3.4 billion dollar level, or about 400 to 500 million dollars more than the present planning target."[34]

Neither NASA nor the OMB staff knew of this exchange. An often heated struggle over the agency's budget outlook and approval of shuttle development continued through the summer and fall of 1971. [III-29] In May 1971 OMB had told NASA that its budget would be further reduced and then stay level at approximately $3.0 billion/year for the rest of the Nixon presidency. This was the final blow to NASA's hope of getting approval for the approximately $10 billion needed to develop a fully reusable shuttle; between June and December 1971 the agency and its contractors examined many alternatives for a less ambitious development program. The OMB staff, fundamentally convinced that the shuttle was not a desirable program, no matter how cheaply it could be developed, resisted the various concepts NASA put forward.

One line of argument that NASA developed during the shuttle debate was that the program would be cost-effective—i.e., that the savings over the use of existing expendable launch vehicles in launch costs, payload design, and the ability to repair satellites would more than pay for the costs of developing a shuttle. This was the first time NASA had attempted an economic justification for a major program; the approach had been forced on the space agency by OMB. As the decision process regarding the shuttle reached its conclusion in the last months of 1971, NASA's contractor for the cost-effectiveness analysis, Mathematica, Inc., widely circulated a memorandum [III-30] that argued that "*A reusable space transportation system is economically feasible. . . .*"[35]

While an economic argument was one part of NASA's case for shuttle approval, other factors were more important to the agency's arguments. James Fletcher summarized them in a November 1971 memorandum to the White House: [III-31]

> *1. The U.S. cannot forego manned space flight.*
>
> *2. The space shuttle is the only meaningful new manned space flight program that can be accomplished on a modest budget.*
>
> *3. The space shuttle is a necessary next step for the practical use of space. . . .*
>
> *4. The cost and complexity of today's shuttle is one-half of what it was six months ago.*
>
> *5. Starting the shuttle now will have a significant positive effect on aerospace employment. Not starting would be a serious blow to both the morale and health of the Aerospace Industry.*[36]

After intense debate between NASA and OMB during December, a decision to approve the shuttle program was made over the New Year weekend. The perspective that Weinberger had put forward in August, NASA's arguments in the November memorandum, and the desire to start a new aerospace program that would avoid unemployment in critical states in the 1972 election year were ultimately decisive. NASA was informed of the decision on January 3, 1972. Fletcher and Low, surprised at the go-ahead, made hasty

33. Caspar W. Weinberger, Deputy Director, Office of Management and Budget, via George P. Schultz, Memorandum for the President, "Future of NASA," August 12, 1971, Richard M. Nixon Project, National Archives and Records Administration, Washington, DC.

34. Jon M. Huntsman, The White House, Memorandum for George P. Shultz, "The Future of NASA," September 13, 1971. Original memorandum in the files of the Nixon Project, National Archives. Huntsman was one of those in the White House responsible for making sure that presidential decisions were communicated to appropriate officials. Copies of this memorandum were sent to Nixon advisors H.R. Haldeman and Alexander Butterfield and to Caspar Weinberger in OMB.

35. Klaus P. Heiss and Oskar Morgenstern, Memorandum for Dr. James C. Fletcher, Administrator, NASA, "Factors for a Decision on a New Reusable Space Transportation System," October 28, 1971, p. 1, NASA Historical Reference Collection.

36. James C. Fletcher, Administrator, Memorandum for Jonathan Rose, Special Assistant to the President, November 22, 1971, with attached: "The Space Shuttle," NASA Historical Reference Collection.

preparations to fly to California for a January 5 meeting with President Nixon, who was at his western White House in San Clemente, after which shuttle approval would be made public. At that meeting, the president asked NASA to stress the view that the shuttle made economic sense, but "even if it were not a good investment, we would have to do it anyway, because space flight is here to stay."[37] [III-32]

Although it was not specifically part of the set of decisions reached at this time, NASA had justified the costs of developing the shuttle on its use to replace existing expendable space launch vehicles, particularly the Delta, Atlas, and Titan. NASA had also modified the shuttle design during 1970 and 1971 to meet the requirements of the Department of Defense, and the anticipation was that the shuttle would launch all DoD payloads as well as those of the civilian sector. [III-29, III-30, III-31, III-32] The decision to proceed with the space shuttle under these assumptions was the central space choice of the 1970s. It was not, except by default, a policy decision regarding U.S. objectives in space, however. For the rest of the 1970s, the United States would carry out those space missions that could be afforded within a fixed NASA budget after shuttle development costs had been paid. Once the shuttle entered operations, U.S. space objectives would be largely defined in terms of those missions enabled by shuttle capabilities. This was certainly a different approach to space policy than that of the preceding decade.

Space Policy Under President Jimmy Carter

During the brief presidency of Gerald Ford, no major space policy decisions or initiatives were taken, although Ford was generally sympathetic toward the program and as he left the White House approved the start of two major missions. They became the Galileo probe to Jupiter and the Hubble Space Telescope.

President-elect Jimmy Carter did not create a blue-ribbon transition group for space, as had John Kennedy and Richard Nixon. The Carter space transition document was the product of a single individual, who took a generally skeptical tone toward NASA and its programs. [III-33] The document noted:

1. . . .NASA directs our R&D resources towards centralized big technology, maintaining the defense R&D orientation of the aerospace industry.
2. The Shuttle has become the end, rather than the means, because NASA space policy has been shaped by the Office of (Manned) Space Flight. The Offices of Space Science, Applications, and Aeronautics Technology get the funds that are left over.[38]

The Carter administration returned to a practice last followed under President Eisenhower: the development, through an inter-agency process coordinated at the White House level, of formal statements of national space policy. The first of these statements [III-34] was issued on May 11, 1978; it dealt with both national security and civilian uses of space, and large portions of the statement remain classified. A June 20, 1978, White House press release announcing the results of the initial Carter policy review noted that "the major concerns that prompted this review arose from growing interaction among our various space activities" and that the May policy statement resulting from the review did not "deal in detail with the long-term objectives of our defense, commercial, and civil programs." The White House release indicated that its next step would be a comprehensive review of civilian space policy.[39]

37. George M. Low, Deputy Administrator, NASA, Memorandum for the Record, "Meeting with the President on January 5, 1972," January 12, 1972, NASA Historical Reference Collection.

38. Nick MacNeil, Carter-Mondale Transition Planning Group, to Stuart Eizenstat, Al Stern, David Rubenstein, Barry Blechman, and Dick Steadman, "NASA Recommendations," January 31, 1977, Jimmy Carter Presidential Library, Atlanta, GA.

39. "United States Space Activities," Announcement of Administration Review, June 20, 1978, in *Public Papers of the Presidents of the United States: Jimmy Carter, 1978* (Washington, DC: U.S. Government Printing Office, 1979), pp. 1135-37.

The results of that policy review were incorporated in Presidential Directive/NSC-42, "Civil and Further National Space Policy," dated October 10, 1978. [III-35] This directive took a measured approach to future U.S. goals in space:

First: Space activities will be pursued because they can be uniquely or more efficiently accomplished in space. Our space policy will become more evolutionary rather than centering around a single, massive engineering feat. Pluralistic objectives and needs of our society will set the course for future space objectives.
Second: Our space policy will reflect a balanced strategy of applications, science and technology development. . . .
Third: It is neither feasible nor necessary at this point to commit the US to a high-challenge, highly-visible space engineering initiative comparable to Apollo.[40]

With this set of guidelines, it was clear that the space program during the Carter administration would be one seeking efficiencies and payoffs from existing capabilities. After considering cancellation of the shuttle program and being dissuaded because of the need for the shuttle to launch satellites critical to his arms control initiatives, Jimmy Carter gave highest priority to completing shuttle development.[41]

Space Policy Under President Ronald Reagan

Unlike his predecessor, Ronald Reagan did assemble a prestigious panel, largely composed of veterans in the space field, as part of his transition effort. The group was headed by George M. Low, who had left NASA in 1976 to become president of Rensselaer Polytechnic Institute. Not surprisingly, the team's report [III-36] was bullish on the space program. It noted:

The year 1980 finds NASA in an untenable position. . . . This unhealthy state of affairs can only be rectified by a conscious decision. Continuation of the prior administration's low level of interest and lack of clear direction would result in an unconscionable waste of human and financial resources.

"NASA and the space program are without a clear purpose and direction," said the transition team. In his cover letter transmitting the report, Low said that the transition team members had asked him to "emphasize our view that NASA and its civil space program represent an opportunity for positive accomplishment by the Reagan administration...NASA can be many things in the future—the best in American accomplishment and inspiration for all citizens."[42]

The Reagan administration selected experienced individuals as the new leaders of NASA. Chosen as administrator was James E. Beggs, an aerospace industry executive who had worked under James Webb in the late 1960s; the designee as deputy administrator was Hans Mark, who had been director of NASA's Ames Research Center before coming to Washington as under secretary and then secretary of the Air Force during the Carter administration. The approach to the space agency that the new pair of NASA managers would take was foreshadowed in a paper prepared by Mark and a senior engineering associate, Milton Silveira, that was widely circulated among the top people in NASA soon after the new leaders assumed control; Beggs accepted the paper as a framework for NASA

40. Presidential Directive/NSC-37, "National Space Policy," May 11, 1978, NASA Historical Reference Collection.

41. See Hans Mark, *The Space Shuttle: A Personal Journey* (Durham, NC: Duke University Press, 1987), chapter IX, for an account of the Carter administration decisions on the space shuttle.

42. George M. Low, Team Leader, NASA Transition Team, to Richard Fairbanks, Director, Transition Resources and Development Group, December 19, 1980, with attached: "Report of the Transition Team, National Aeronautics and Space Administration," George M. Low Papers, Archives and Special Collections, Rensselaer Polytechnic Institute, Troy, NY.

planning.[43] That approach gave top priority to making the space shuttle operational and then utilizing it frequently while getting approval for a major new development project, the space station. [III-37]

Like the Carter administration before it, the Reagan White House carried out an early, comprehensive review of national space policy. The results of that review were incorporated in a classified national security decision directive issued July 4, 1982. [III-38] The directive provided "the broad framework and the basis for the commitments necessary for the conduct of U.S. space programs." It gave particular emphasis to the role of the space shuttle, which was to be "a major factor in the future evolution of United States space programs."[44] The directive also transferred White House responsibility for reviewing space policy from the Office of Science and Technology Policy, where it had been vested during the Carter administration, to the National Security Council, and created a Senior Interagency Group (SIG) for Space, chaired by the president's assistant for national security, to oversee the Reagan-era space policy process.

During the following six years, SIG (Space) was the focal point for a series of debates, policy statements, and directives on various aspects of U.S. space efforts. Issues that stimulated these debates included a desire to foster the commercial uses of space, the decision to begin a space station program, controversy over the pricing policy for the space shuttle, and actions required to recover from the January 1986 *Challenger* accident. In 1988, President Reagan approved a revised statement of national space policy that incorporated the results of these individual decisions and directives. [III-42] Reflecting a theme that had been present in U.S. space policy since the beginning, the directive noted that "a fundamental objective guiding United States space activities has been, and continues to be, space leadership."[45]

The Space Station Decision[46]

At his Senate confirmation hearing in June 1981, James Beggs was asked his view on what should be the next major U.S. undertaking in space. He replied that "it seems to me that the next step is a space station."[47] Between the second half of 1981 and the end of 1983, NASA carried out an intense, and ultimately successful, campaign to gain presidential approval to develop a large, permanently occupied space station as the "next logical step" in space development. Like the space shuttle before it, developing and operating a space station promised to influence the U.S. space program for years to come.

NASA spent most of 1982 laying the foundation for station approval by conducting internal and contractor studies, with a particular focus on identifying the missions that a station might perform. Beggs and Mark pursued a two-pronged strategy for gaining station approval. One path was to work with other government agencies and external constituencies to build a broad coalition in support of the station; the other was to convince President Ronald Reagan that it was in the U.S. interest to go ahead with the program.[48]

The forum for developing an interagency consensus on the station was the National Security Council's SIG (Space). At a March 30, 1983, meeting, SIG (Space) approved terms of reference for a study that would provide the basis for a presidential decision on whether to proceed with the program. To give added weight to the study, a national security

43. Mark, *Space Station*, p. 128.

44. National Security Decision Directive Number 42, "National Space Policy," July 4, 1982 (partially declassified June 14, 1990).

45. Office of the Press Secretary, "Fact Sheet: Presidential Directive on National Space Policy," February 11, 1988, NASA Historical Reference Collection.

46. For more details on the space station decision, see Howard E. McCurdy, *The Space Station Decision: Incremental Politics and Technological Choice* (Baltimore, MD: Johns Hopkins University Press, 1990); Mark, *Space Station.*

47. McCurdy, *The Space Station Decision*, p. 40.

48. See Mark, *Space Station*, chapter XIV, for a discussion of this strategy.

decision directive signed by the president and incorporating these terms of reference was drafted. After being briefed on the station program, Reagan approved the directive on April 11. [III-39] The directive identified five policy issues to be studied:

How will a manned Space Station contribute to the maintenance of U.S. space leadership and to the other goals contained in our National Space Policy?. . . How will a manned Space Station best fulfill national and international requirements versus other means of satisfying them?... What are the national security implications of a manned Space Station?. . . What are the foreign policy implications of a manned Space Station?. . .What is the overall economic and social impact of a manned Space Station?

These questions were to be answered with respect to four possible future scenarios:

- *Space Shuttle and Unmanned Satellites*
- *Space Shuttle and Unmanned Platforms*
- *Space Shuttle and an Evolutionary/Incrementally Developed Space Station*
- *Space Shuttle and a Fully Functional Space Station*

The directive called for study results to be available "not later than September 1983."[49]

In the course of the next several months, NASA discovered that getting a positive recommendation on the station from SIG (Space) was not going to be possible. First of all, the effort got bogged down as the NASA-led team considered the multiple options of the study directive. The process of developing a shorter policy paper containing recommendations to which all SIG (Space) members could agree became stalemated in August; there was significant opposition from the national security members of the group to going ahead with the station. In particular, Secretary of Defense Caspar Weinberger argued against the station project. [III-41] Without SIG (Space) agreement, it seemed, there would be no recommendation to Ronald Reagan to approve the space station.

Over the next few months, however, NASA was able to find an alternative path to get the issue of whether or not to go ahead with the station before the president. It had been James Beggs' position all along that President Reagan would approve the station program, given the opportunity; this had been the second prong of the NASA strategy. NASA's allies in the White House succeeded in getting the station question on the agenda of a December 1, 1983, meeting of the Cabinet Council on Commerce and Trade, one of the organizations that the Reagan administration had created for policy development; the national security community did not have a controlling position among the council's membership.

The NASA presentation to the meeting, which was attended by the president, asked for a decision to proceed with the space station program. [III-40] Primary emphasis in the presentation was given to the station's contribution to U.S. leadership around the world, a theme that Beggs knew was close to Ronald Reagan's heart. The presentation also emphasized the commercial potential of station-based activities, and underlined the fact that the Soviet Union already had a small space station and was expected to develop a larger facility. In concluding the presentation, James Beggs told the president and others in the Cabinet Room that "the time to start a space station is now."[50]

President Reagan approved the station program in an Oval Office meeting a few days later. On January 25, 1984, in his annual State of the Union message, Reagan told Congress and the nations that

America has always been greatest when we dared to be great. We can reach for greatness again. We can follow our dreams to distant stars, living and working in space for peaceful, economic, and scientific

49. National Security Decision Directive 5-83, "Space Station," April 11, 1983, National Security Archive, Washington, DC.

50. "Revised Talking Points for the Space Station Presentation to the President and the Cabinet Council," November 30, 1983, with attached: "Presentation on Space Station," December 1, 1983, NASA Historical Reference Collection.

gain. Tonight I am directing NASA to develop a permanently manned space station and to do it within a decade.[51]

Looking Toward the Future

The space station was frequently justified by James Beggs and others in NASA as "the next logical step." When asked "step toward what" NASA most often pointed out the many missions that had been proposed for a permanently occupied orbiting laboratory. During the 1982-1983 debate over station approval, the agency resisted pressure from Presidential Science Adviser George A. Keyworth II to identify the station with the ambitious goal of preparing for human journeys to Mars. The memory of the negative response to the 1969 Space Task Group recommendation for Mars exploration was still strongly in the minds of many at NASA, and Beggs judged that the time was not propitious for linking station approval to such a visionary objective.

Pressure also came from Congress for NASA to articulate its long-term vision of the future in space. In 1984, Congress passed a bill requiring the president to name a National Commission on Space to develop a future space agenda for the United States. The White House in March 1985 chose Thomas Paine as chairman of the commission, who, since leaving NASA fifteen years earlier, had been a tireless spokesman for an expansive view of what should be done in space. The fourteen other commissioners were a diverse group, ranging from Apollo 11 astronaut Neil Armstrong and test pilot Chuck Yeager to the U.S. Ambassador to the United Nations, Jeanne Kirkpatrick.

The commission took most of a year to prepare its report; in addition to its own deliberations, the group solicited public input in hearings throughout the United States. The commission report, *Pioneering the Space Frontier*, was published in a lavishly illustrated, glossy format in May 1986; a summary videotape was also prepared.

The National Commission on Space recommended "a pioneering mission for 21st-century America"—"to lead the exploration and development of the space frontier, advancing science, technology, and enterprise, and building institutions and systems that make accessible vast new resources and support human settlements beyond Earth orbit, from the highlands of the Moon to the plains of Mars."

The report also contained a "Declaration for Space" that included a rationale for exploring and settling the solar system and outlined a long-range space program for the United States.[52]

The United States in 1986 was not in a particularly receptive mood for such bold proposals; the tragic *Challenger* accident in January 1986 had focused attention on the problems with the U.S. space program, not its prospects. But as the year ended, NASA once again began to focus on its long-range objectives. James Fletcher, who had returned for a second tour of duty as NASA administrator in the wake of the shuttle tragedy, asked former astronaut Sally K. Ride to chair a task force to develop options for NASA's future. The group's report, *Leadership and America's Future in Space*, was presented to Fletcher in August 1987.

The Ride report identified four "leadership initiatives" that NASA might choose to pursue, individually or in combination:

*1. **Mission to Planet Earth**: a program that would use the perspective afforded from space to study and characterize our home planet on a global scale.*

*2. **Exploration of the Solar System**: a program to retain U.S. leadership in exploration of the outer solar system, and regain U.S. leadership in the exploration of comets, asteroids, and Mars.*

51. Quoted in McCurdy, *Space Station Decision*, p. 190.

52. The Report of the National Commission on Space, *Pioneering the Space Frontier* (New York: Bantam Books, 1986), excerpts.

*3. **Outpost on the Moon**: a program that would build on and extend the legacy of the Apollo program, returning Americans to the Moon to continue exploration, to establish a permanent scientific outpost, and to begin prospecting the Moon's resources.*

*4. **Humans to Mars**: a program to send astronauts on a series of round trips to land on the surface of Mars, leading to eventual establishment of a permanent base.*

In its conclusion, the report referred to the central vision statement of the National Commission on Space, quoted above, and recommended that "the United States needs to define a course of action to make this vision a reality."[53]

Conclusion

Many influences shaped U.S. space policy and the U.S. space program in the three decades between 1958 and 1988. Throughout, leadership in space has been a consistent policy objective, and human exploration of space a constant theme. As a response to the needs of the time, the United States sent twelve people to the surface of the Moon between 1969 and 1972, but this first instance of human exploration of another celestial body did not lead to a sustained program of human exploration. That still lay in the future in 1988; the final Reagan administration statement of space policy set as a long-range goal "to expand human presence and activity beyond Earth orbit into the solar system."[54] While much happened in the early years of the space program, much remains.

53. Dr. Sally K. Ride, *Leadership and America's Future in Space: A Report to the Administrator* (Washington, DC: National Aeronautics and Space Administration, August 1987), pp. 21, 58.

54. Office of the Press Secretary, "Fact Sheet: Presidential Directive on National Space Policy," February 11, 1988, NASA Historical Reference Collection.

Document III-1

Document title: Special Committee on Space Technology, "Recommendations to the NASA Regarding A National Civil Space Program," October 28, 1958.

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

By the end of 1957 the National Advisory Committee for Aeronautics (NACA) was heavily involved in space-related research, which constituted forty to fifty percent of its total effort. Sensing that NACA might be the obvious choice for taking the lead in the American space effort after Sputnik, on January 12, 1958, General James Doolittle, chairman of NACA, created a Special Committee on Space Technology. While NACA Director Hugh Dryden addressed the institutional issues involved in transforming NACA into NASA, the Committee on Space Technology was charged with addressing specific areas of space technology deserving early attention. NASA was formally established on October 1, 1958, and the committee issued its final report at the end of that month. The following document reprints the recommendations to NASA on "A National Civil Space Program" offered by the Special Committee on Space Technology on October 28, 1958.

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[1]

Summary

The major objectives of a civil space research program are scientific research in the physical and life sciences, advancement of space flight technology, development of manned space flight capability, and exploitation of space flight for human benefit. Inherent in the achievement of these objectives is the development and unification of new scientific concepts of unforeseeably broad import.

Space Research - Instruments mounted in space vehicles can observe and measure "geophysical" and environmental phenomena in the solar system, the results of cosmic processes in outer space, and atmospheric phenomena, as well as the influence of space environment on materials and living organisms. A vigorous, coordinated attack upon the problems of maintaining the performance capabilities of man in the space environment is prerequisite to sophisticated space exploration.

Development - Flight vehicles and simulators should be used for space research and also for developmental testing and evaluation aimed at improved space flight and observational capabilities. Major developmental recommendations include sustained support of a comprehensive instrumentation development program, establishment of versatile dynamic flight simulators, and provision of a coordinated series of vehicles for testing components and sub-systems.

Ground Facilities - Properly diversified space flight operations are impossible without adequate ground facilities. To this end serious study aimed toward providing an equatorial launching capability is recommended. A complete ground instrumentation system consisting of computing centers, communication network, and facilities for tracking and control of and communication (including telemetry) with space vehicles is required. At least part of the system must be capable of real time computation and communication. A competent satellite communications relay system would be most valuable in this regard, and it is recommended that NASA take the lead in determining the specifications of such a system. A coordinated national attack upon the problems of recovery is recommended.

Flight Program - The first recovery vehicles will probably be ballistic, but the control and safety advantages of lifting re-entry vehicles warrant their development. [2] A million-pound-plus booster can be achieved about three years sooner by clustering engines than by developing a new single-barrel engine, but the cluster would not have the growth potential of the larger engine. Further growth potential requires the development of the single-barrel engine. Both developments are needed.

Strong research effort on novel propulsion systems for vacuum operations is urged, and development of high-energy-propellant systems for upper stages should receive full support.

Three generations of space vehicles are immediately available. The first is based on Vanguard-Jupiter C, the Second on IRBM boosters, and the third on ICBM boosters. The performance capabilities of various combinations of existing boosters and upper stages should be evaluated, and intensive development concentrated on those promising greatest usefulness in different general categories of payload.

Introduction

Scientifically, we are at the beginning of a new era. More than two centuries between Newton and Einstein were occupied by the observations, experiments and thought that produced the background necessary for modern science. New scientific knowledge indicates that we are already working in a similar period preceding another long step forward in scientific theory. The information obtained from direct observation, in space, of environment and of cosmological processes will probably be essential to, and will certainly assist in, the formulation of new unifying theories. We can no more predict the results of this work than Galileo could have predicted the industrial revolution that resulted from Newtonian mechanics.

The observation of the nature and effects of the space environment are necessarily paced by the development of space flight capabilities. This report presents suggestions regarding research policies and procedures that should aid in the establishment and improvement of capabilities for space flight and space research.

In preparing this report, the Special Committee on Space Technology has been assisted by the Technical committees of the NACA and the ad hoc Working Groups of the Special Committee. The membership of the Working Groups is listed in an appendix to this report.

The reports of the Working Groups are primarily program-oriented, and while they are not referenced specifically, they have furnished the basis for the preparation of this report. These will be presented to the NASA as separate Working Group reports, independent of this report.

[3] **Objectives**

A national civil space research program to explore, study, and conquer the newly accessible realm beyond the atmosphere will have the following general objectives:

1.Scientific research and exploration in the physical and the life sciences.

Submerged as he always has been beneath the "dirty window" of the atmosphere, man has necessarily inferred the nature of the physical universe from local observations and glimpses of what lies beyond his essentially two-dimensional earth-bound habitat. Little of the radiation and few of the solid particles from outer space reach the earth's surface, yet practically all aspects of man's earthly environment are determined ultimately by extraterrestrial factors. The radiation that does reach the surface is so distorted by passage through the atmosphere that only incomplete observations can be made on the nature of other celestial bodies and the contents of interstellar space.

With the information derived from experiments and directed observations in the actual space environment, man will achieve a better understanding of the universe and of nature phenomena and life on the earth.

An excellent start toward determination of the near-space environment has already been made in connection with the IGY, and the pattern of international cooperation that has developed with this program indicates that mutual understanding and respect among the nations of the earth may be generated by concerted attack upon scientific problems. Inasmuch as national scientific excellence is, to a great extent, now evaluated by the people of the earth in terms of success in the exploration of space, it behooves the United States to achieve and maintain an unselfish leadership in this field.

2. Advancement of the technology of space flight.

[4] Propulsion systems have been developed having the demonstrated capability of putting small instrumented packages into orbit about the earth. However, the reliability of the total vehicle and control system needs improvement in order to conduct much of the desired space program. Larger power plants, and new higher-energy fuels and the equipment to produce them must be developed. If orbits about the earth are to be expanded into practical interplanetary trajectories, new propulsion systems having very low fuel consumption and modest thrust will be required in order that the trajectory can be controlled to perform the mission.

A good start has been made on the development of instrumentation for observing the environment in space. Instrumentation for controlling and navigating the vehicle and for communicating with the earth will require extensive development. Because of the server weight restrictions, all instrumentation must be severely miniaturized. Ground-based communications systems must be expanded to provide for the control of and communication with vehicles on lunar or planetary missions, and for properly controlled re-entry and recovery.

Novel structural problems are posed by space vehicles. Heavy loads of steady acceleration, shock and vibration occur during boost, while weightlessness during unpowered space flight makes possible the use of nonconventional mechanical design principles. For vehicles which must re-enter the earth's atmosphere, problems of structural integrity under high re-entry heating rates, larger thermal gradients, and thermal shock are very important. All of these requirements must be met with an absolute minimum of structural weight.

Extensive human engineering developments are required in order for manned space flight to be successful. Because of the rigorous but largely unknown space environment, these developments will depend critically upon the information obtained in the early probing flights.

A successful National Space Program, therefor requires continuing improvement and development in the pertinent fields of technology.

3. Manned space flight.

Instruments for the collection and transmission of data on the space environment have been designed and put into orbit about the earth. However, man has the capability of correlating unlike events and unexpected observations, a capacity for overall evaluation of situations, and the background knowledge and experience to apply judgment that cannot be provided by instruments; and in many other ways the intellectual functions of man are a necessary complement to the observing and recording functions of complicated instrument systems. Furthermore, man is capable of voice communication for sending detailed descriptions and receiving information whereby the concerted judgment of others may be brought to bear on unforeseen problems that may arise during flight.

[5] Although it is believed that a manned satellite is not necessary for the collection of environmental data in the vicinity of the earth, exploration of the solar system in a sophisticated way will require a human crew.

4. Exploration of space for human benefit.

The practical exploitation of satellites and space vehicles for civil purposes and for human benefit may be as important as–or even more important than–the immediate military uses for space flight. Perhaps the most important example is the use of satellite vehicles for active or passive communications relay. This could extend what are effectively line-of-sight communication links for thousands of miles between points on the ground, with very great bandwidths and none of the capriciousness now characterizing long-range HF communications.

Many indirect benefits will also be derived from the technological developments that will make space flight practical. The necessarily high technological standards required for space flight will certainly accelerate improvement in transportation, communications and other contributions to human welfare.

The unpredictable long-term benefits of space-accelerated scientific and technological advancement will almost certainly far exceed the foreseeable benefits.

Aside from the intentional omission of military and political objectives, the foregoing objectives appear to be in consonance with those mentioned in "Introduction to Outer Space," by the President's Science Advisory Committee (Killian Committee), and with the objectives stated in the National Aeronautics and Space Act of 1958, which is the enabling legislation for the National Aeronautics and Space Administration.

Basic Scientific Research

Space Research

Geophysical observations from satellites and non-orbiting space probes enable the gravitational and magnetic fields in the vicinity of the earth to be mapped to altitudes limited only by the capabilities of the flight vehicle. The interactions among these fields and the particles and radiations approaching the earth from the sun and other [6] space can be studied, and related to the composition and behavior of the gaseous envelope of the earth from troposphere to exosphere. Satellite observations of large-scale cloud movements and other atmospheric phenomena can do much to put meteorology on a more sound scientific basis. As propulsion and guidance systems are improved, "geodetic" and "geophysical" studies can be extended to the moon and other planets.

Telescopes and spectroscopes mounted on earth satellites can utilize the complete radiation spectrum from vacuum ultraviolet to radio frequencies to observe the sun, the planets, stars, and interstellar space. Direct measurements of the space environment should include the nature, direction and intensity of electromagnetic and corpuscular radiation, and the nature and distribution of meteorites. The mass density in space can be measured, and large-scale magneto-hydrodynamic phenomena in and beyond the ionosphere can be studied. These observations and direct measurements will offer tremendous improvements in understanding of cosmic processes.

In addition to scientific observations and environmental measurements, satellite experiments will enable evaluation of the effect of the space environment on all types of material and biological specimens and hardware components. Re-entry phenomena can be studied, and here for the first time, it is possible to investigate the effects of extended periods of weightlessness on instrumentation and living subjects.

Experiments with man and other living organisms, both plant and animal, during extended periods in the space environment may offer new insight to human physiology and psychology and into life processes generally.

Upper Atmosphere Research

Upper atmosphere experiments, utilizing both rocket-propelled and balloon-supported vehicles, can, at reasonable cost, give direct information on both the vertical and time-wise variations of various atmospheric parameters and cosmic radiations. Heat-transfer, ablation, vehicle-control dynamics, and pilot-vehicle interactions can be studied under approximately re-entry conditions. Limited-time biological studies and human physiological and psychological studies under almost space conditions, and with limited periods of weightlessness, can also be investigated.

Ground-Based Supporting Research

In addition to direct study of the space environment, much ground-based research must be conducted as a basis for the space flight program. This will include such factors as radiation effects [7] on materials, instruments, and living organisms, and means of radiation protection. Other physical phenomena pertinent to space flight and re-entry include radio propagation; and behavior, in a space-type environment, of materials, transducers power supplies, and so forth for instrument components; hypersonic gasdynamics, both continuum and noncontinuum; and magnetogasdynamics.

Human factors pertinent to space flight present a real challenge. Those amenable to ground-based study include, among others, acceleration and vibration tolerance and protection, and the influence of new physiological and psychological factors (other than weightlessness) on the performance capabilities of the crew members. A major cooperative effort between the NASA, and the Department of Defense, and other groups concerned with aeromedical and space flight problems is necessary.

Research Techniques and Equipment Development

Vehicle Instrumentation

Vehicle instrumentation presents formidable development problems because of the conflicting requirements of minimum weight, adequate resistance to the accelerations and vibrations of launching and ability to operate correctly for extended periods of time under the conditions of space flight. For scientific observations, a complete range of instrumentation will be required for observing the external environment and recording or telemetering the data. Other special instrumentation will be required to observe experiments conducted within the vehicle.

Navigation and guidance equipment, and instruments for attitude sensing and control for the communication, are required for operation of the vehicle, particularly on extended flights into space. An integrated display of information on the internal environment and the vehicle operation will be required for manned flights. Improved auxiliary power sources will be needed for all types of vehicle-borne instruments.

It is recommended that the NASA organize and give consistent support to a comprehensive program of instrumentation development, comprising not only instruments useful in the development, flight testing, and operation of space vehicles, but also the instruments needed for a broad program of environmental and other experimental research. Special attention should be paid to the novel design possibilities offered by operating such instruments in free fall and in vacuo.

[8] *Ground Simulation of Environment and Operational Problems*

The development and testing of a space vehicle, its components and, for a manned vehicle, its crew require ground simulation of the environment operating problems that will be encountered. The completeness of the simulation may well determine the success or failure of the mission. This will be a continuously changing problem as new information is obtained on the environment and as the operational ranges and durations increase.

Wind tunnels and jets of various types, ballistic rangers and structural test facilities, can simulate, to a reasonable extent aerodynamic effects encountered during launching and re-entry. Vacuum chambers with assorted loading devices and radiation sources will be useful for both instrumental structural tests.

The capacity of a human crew to participate in the operation of a space vehicle is still an unknown quantity. As fast as such capabilities are demonstrated they should be utilized to the extent profitable in operation of the vehicle. Therefore, flight simulators should be designed and built in which the flight dynamics and internal environment of space vehicles can simulated as closely as possible. Such facilities would be used for pilot evaluation and training and for evaluation of the dynamic characteristics of the vehicle-pilot combination.

Flight Testing Techniques

To aid in the advanced development of space vehicles and sub-systems, and to complement the ground-based simulators, it is recommended that the NASA use reliable high-performance rocket-propelled test vehicles which would be standardized for as many tests as possible. In order to minimize the development cost of such vehicles, they should presumably be based on military developments in the missile field.

Two other techniques are recommended for larger-scale tests and for systems development and testing. One of these is a large, high-altitude, balloon-supported laboratory in which most conditions of space environment could be simulated. This balloon-supported laboratory would not only allow a substantial amount of research on the equipment needed by the space crew and on the effects of space environment needed by the space crew and on the effect of space environment on the capsule and its inhabitants, but could also be valuable for basic environmental studies.

[9] The other is a nonorbiting rocket-propelled research vehicle capable of carrying at least two men, or an actual man-carrying satellite capsule. This vehicle should be capable of a number of minutes of free coast well above significant atmospheric influences. Such a vehicle should be used for development and final flight-testing of actual space flight controls and operational instrumentation. In addition, flight crew could be trained and evaluated under longer periods of weightlessness than are possible within the atmosphere.

With the establishment of artificial earth satellites, space flight has become a reality, albeit on only a very limited scale. For more extended space missions, the long-time effects of the space environment on the vehicle and its contents must be known and designed for. This can best be studied in earth satellite vehicles. Strong technological support should be provided for all phases of vehicular development. Specifically, a substantial fraction of space flight missions should be allocated to such technological projects as components tests, materials tests, engine-restart tests, solar power supply systems, et cetera.

Ground Facilities for Space Flight Operations

Range Capabilities and Requirements

In view of the plans to expand the NASA Wallops Island facility for technique development and relatively small probe and satellite launchings, and with the Atlantic and Pacific Missile Ranges capable of substantial further development, there is no present need for another major nonequatoral launching complex. It may be desirable, however, for the NASA to establish permanent field stations at both the Atlantic and Pacific Missile Ranges.

On the other hand, the unique properties of an equatorial orbit lead to a distinct need for an equatorial launching site. These are:

1. Narrow track over the earth's surface.
2. Best departure point for interplanetary operations.
3. Capability for all other orbits.
4. Minimum requirement for ground stations and communication system.

These considerations bringing the Committee to the conclusion that the NASA should establish a study, survey and planning group [10] aimed toward early provision of an equatorial launching capability, including necessary logistic support, for the United States. Fixed-base and ship-based launchings should be considered by the group before reaching a final decision.

Ground-Based Instrumentation Systems

The ground-based instrumentation needs of the civilian space program encompass such things as:

1. Communication with and transmission of commands to vehicles both near the earth and in interplanetary space.
2. Active and passive tracking of space vehicles.
3. Reception of telemetry signals from space.
4. Calculation of real-time search ephemeris data.
5. Calculation of final orbits for scientific analysis.

The instrumentation necessary can thus be listed as:

1. A network of stations suitably located for tracking of a communication with vehicles in interplanetary space. These stations must be tied together with reasonably rapid communication links. The stations will consist of very large antennas, sensitive receiving equipment, and high-power transmitting equipment.
2. A network of radio receiving stations to obtain orbital information from active satellites. These stations may be, in part at least, the same as those in the preceding paragraph.
3. A network of optical stations to make very precise optical observations on some satellites, and a supplementary set of optical observing stations, probably similar to the present Moonwatch teams, for rough orbital data.
4. A set of telemetry receiving stations which will be in part, but not necessarily completely, at the other radio sites.
5. A special network of stations for re-entry experiments.
6. Computing facilities to calculate and publish search ephemeris data.
7. Computing facilities to generate orbital data of sufficient accuracy to satisfy scientific needs.

[11] This complete instrumentation network should be coordinated with similar activities of the Department of Defense, but the special requirements of the civilian space program are such as to require the NASA to establish and operate some of the stations. The technical requirements of the space communication channels, telemetry, et cetera, should likewise be coordinated with the Department of Defense.

In view of the radio frequency requirements of the space program for communication with space vehicles, it is recommended that NASA take the necessary steps to insure that frequency assignments for this purpose are available.

Overseas stations of the NASA could be operated by local technical groups, universities, et cetera, and this phase of the problem should be actively pursued by NASA, for reasons both of efficient and economical operation and of international cooperation.

It is not recommended that the NASA offer to support the continued operation of the present IGY tracking system for an interim period after the expiration of the present IGY support. It is recommended, however, that a study be made of possible radio tracking systems to replace or supplement the present Minitrack stations. It is believed that a permanent radio tracking system should be capable of receiving signals at higher frequencies and from larger numbers of satellites, should probably offer greater angular coverage, and may require a different geographical plan. Special attention needs to be given to the reception of signals of broader bandwidth to take care of future satellites which may have a relatively large quantity of information to transmit back to earth.

Real-Time Communication

Certain projects will require real-time computation of orbits and communication of the data to other ground stations at large earth distances. A capability for communication with the satellite essentially all the time may also be desirable, particularly for manned flights. It appears, however, that such a situation may not be completely feasible, either technically or economically, in the near future, and therefor the communication system which can be provided may prove to be one of the limiting factors in the design of the experiment. Hard wire, which is considered to be the only currently available communication system whose reliability approaches 100 percent, extends only from Hawaii to Italy by commercial cable. All radio systems of substantial range are less reliable, except for line-of-sight operations such as communication satellites might provide. Since many agencies are concerned with this matter, and many important design decisions must be taken to yield the most [12] generally useful satellite communications relay system, NASA should take the initiative in coordinating the various requirements and settling on a preferred system at the earliest possible date. Furthermore, projects requiring real-time communication should formulate a rather complete communications plan early in the project-planning stage.

Recovery

The requirements of recovery of instrumented and manned satellites from orbital flight pose problems involving equipment, communication, and operation which are of very great magnitude. The escape maneuver during both the launch and recovery phases will require recovery capability over large areas of the Atlantic Ocean, the Pacific Ocean, and possibly the United States Zone of the Interior.

It appears that a coordinated national effort is required to cope with this problem.

It is recommended, therefor, that NASA establish a working group on recovery systems which will summarize the experience obtained to date, will define the problems to be solved, and propose operational techniques and equipment which should be developed.

One possible solution would be for the Atlantic, Pacific, and White Sands Missile Ranges to establish coordinated operational groups for these three areas, making maximum use of existing organization and facilities, for all national space programs requiring recovery techniques.

Space Surveillance

It is not considered necessary for NASA to set up the ground equipment and to maintain current ephemerides of all passive satellites, although, of course, ephemerides will be required for all satellites during the course for their experiments and for all satellites intended for recovery.

It is considered important that some kind of control be applied to limit the life of any satellite radio transmitter to a reasonable duration of experiment, in order to prevent cluttering up useful parts of the radio spectrum. However, no non-military need is anticipated, at this time, for a "vacuum cleaner" to remove from orbit the satellites that have outlived their usefulness.

[13] **Flight Program**

Re-entry Vehicles

Types of and uses for non-satellite probes and instrumented satellites have already been commented upon. Manned satellites, however, must be capable of safely re-entering the earth's atmosphere and being recovered. As a result of study of a number of suggested satellite vehicles for manned flight, it is concluded that:

1. The ballistic (pure drag) type vehicle can probably be put in operation soonest because:

   a. The booster problem is simplest by virtue of the low weight of this satellite vehicle.

   b. The aerodynamic heating problem is well understood.

   c. The development of the vehicle appears to be straight-forward.

2. The high-drag, high-lift vehicle study should be carried on concurrently because:

a. The ability to steer during re-entry eases the recovery problem, since it reduces the accuracy required of the retrograde rocket timing and impulse, and allows the vehicle to be flown to or near the ground or sea recovery stations.

b. The danger of excessive accidental decelerations due to malfunction in either the boost phase or re-entry phase of flight is greatly diminished.

3. The low-drag, high-lift vehicle looks less attractive for application to manned space flight for the near future. The advantages of better range control and greater maneuverability after re-entry may eventually make this vehicle more desirable.

Propulsion

There has been much discussion of the relative merits of developing a large booster engine or of clustering small ones. Both of these developments are required.

[14] Schedule studies clearly indicate that a booster of one million pounds thrust or more could be available about three years earlier of it were based on the clustering of existing rocket engines. This would lead to a fourth generation of space vehicles (with Vanguard Jupiter C being the first; IRBM-boosted space vehicles being the second; ICBM-boosted vehicles the third generation.) Progress in the rocket engine field offers a high degree of confidence that multiple-barrel boosters of one to one and a half million pounds total thrust could be ready for flight test in two to three years. Fifth-generation boosters based on the one million pounds-plus thrust, single-barrel engine (whether using one such engine or several) would offer orbital payloads up to 100,000 pounds, and would be available three years later.

It is strongly recommended that a study be made to assess the advisability of developing recoverable first-stage boosters. Recovery techniques should be optimistic from a system point of view.

Strong research effort on novel propulsion systems for vacuum operations is urged, and development of high-energy-propellant systems for upper stages should receive full support.

Vehicles for Early Experiments

In the preceding section several generations of space vehicle boosters are identified in general terms. The first generation, already in being, is capable of putting into orbit payloads of approximately 30 pounds. Such a vehicle enables the observation of a relatively small number of space environmental factors, or the conduct of simple experiments in the space environmental factors, or the conduct of simple experiments in the space environment. The second generation, with payload capabilities up to roughly 300 pounds, enables more sophisticated or larger numbers of experiments and environmental observations. The third-generation vehicles should make possible payloads of 3,000 pounds or more. Heavy or bulky observing instruments with provision for long-time attitude control and data transmission can be carried, and minimal manned space flights should be possible.

In each of these generations a number of boosters and upper stages are either available or under development. Proper combinations of these should make possible a wide spectrum of payloads and performances. Furthermore, it is likely that early generation vehicles will continue to be used even after later generation vehicles are available. Therefor the NASA should make a thorough study of the capabilities of existing stages to determine whether there are any serious gaps in the spectrum, and to select particular combinations of further development and use in these early experiments. [15] With properly selective effort going into the early generations, a more vigorous development program for later generations of boosters and vehicles should be possible.

Conclusion

Scientific advances of the broadest import can result from substantially improved understanding of cosmic processes and their influence upon the environment, and therefor the inhabitants, of the earth. The acquisition of such understanding depends critically upon the establishment of observational vantage points outside the insulation of the earth's atmosphere. The discussions and suggestions regarding research policies, procedures and programs presented in this report are intended to further the rapid and efficient development of the requisite space flight capabilities. All of these suggestions include recommendations, either stated or implicit, for cooperation or close coordination within related work by other civil and military agencies. More detailed discussions and program recommendations in particular fields are treated by Working Group reports....

Document III-2

Document title: Office of Program Planning and Evaluation, "The Long Range Plan of the National Aeronautics and Space Administration," December 16, 1959, pp 1-3, 9-11, 17-18, 26, 44.

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

This initial ten-year plan for NASA was developed during the agency's first year of operation. Because it contained both target dates for various accomplishments and budget estimates for the decade, it received a "Secret" security classification, and was later declassified.

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[1] **Introduction**

The long-term national objectives of the United States in aeronautical and space activities are stated in general terms in the enabling legislation establishing NASA. It is the responsibility of NASA to interpret the legislative language in more specific terms and to assure that the program so generated provides an efficient means of achieving the following objectives expressed in PL 85-568, Sec. 102(c) as:

"The aeronautical and space activities of the United States shall be conducted so as to contribute materially to one or more of the following objectives:

(1) The expansion of human knowledge of phenomena in the atmosphere and space;

(2) The improvement of the usefulness, performance, speed, safety, and efficiency of aeronautical and space vehicles;

(3) The development and operation of vehicles capable of carrying instruments, equipment, supplies, and living organisms through space;

(4) The establishment of long-range studies of the potential benefits to be gained from, the opportunities for, and the problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes;

(5) The preservation of 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;

(6) The making available to agencies directly concerned with national defense of discoveries that have military value or significance, and the furnishing by such agencies, to the civilian [2] agency established to direct and control non-military aeronautical and space activities, of information as to discoveries which have value or significance to that agency;

(7) Cooperation by the United States with other nations and groups of nations in

work done pursuant to this Act and in the peaceful application of the results thereof; and

(8) The most effective utilization of the scientific and engineering resources of the United States, with close cooperation among all interested agencies of the United States, in order to avoid unnecessary duplication of effort, facilities, and equipment."

In operational terms, these objectives are instructions to explore and to utilize both the atmosphere and the regions outside the earth's atmosphere for peaceful and scientific purposes, while at the same time providing research support to the Department of Defense. These objectives can be attained only by means of a broad and soundly conceived program of research, development and operations in space. In the long run, such activities should make feasible the manned exploration of the moon and the nearby planets, and this exploration may thus be taken as a long-term goal of NASA activities. To assure steady and rapid progress toward these objectives, a NASA Long Range Plan has been developed and it is presented in this document.

In interpreting the Plan, it must be remembered that the implications for the national economy reach far beyond the specific program goals. For example, the space science activities cover the frontiers of almost all the major areas of the physical sciences, and these activities thus provide support of the physical sciences in specific applications in the fields of electronics, materials, propulsion, etc., will contribute, directly or indirectly, to all subsequent military weapons developments and to many unforeseen civilian applications. Reciprocally, the NASA program is provided with [3] support, direct or indirect, from all the related research and development activities outside NASA.

The Plan is presented at a level of effort which corresponds to an efficient and steadily growing capability. The rate of progress could be improved by an increased funding level, primarily by improving the certainty of the timely completion of the many essential engineering developments. On the other hand, a significantly lower scale of funding could be accommodated only by arbitrarily limiting the activities to a narrow line and by greatly reducing the rate of approach to the long-term goals.

[9]

Table I

NASA Mission Target Dates

Calendar Year	
1960	First launching of a Meteorological Satellite.
	First launching of a Passive Reflector Communications Satellite.
	First launching of a Scout vehicle.
	First launching of a Thor-Delta vehicle.
	First launching of an Atlas-Agena-B vehicle (by the Department of Defense).
	First suborbital flight of an astronaut.
1961	First launching of a lunar impact vehicle.
	First launching of an Atlas-Centaur vehicle.
1961–1962	Attainment of manned space flight, Project Mercury.
1962	First launching to the vicinity of Venus and/or Mars.
1963	First launching of two stage Saturn vehicle.
1963–1964	First launching of unmanned vehicle for controlled landing on the moon.
	First launching Orbiting Astronomical and Radio Astronomy Observatory.
1964	First launching of unmanned lunar circumnavigation and return to earth vehicle.
	First reconnaissance of Mars and/or Venus by an unmanned vehicle.
1965–1967	First launching in a program leading to manned circumlunar flight and to permanent near-earth space station.
Beyond 1970	Manned flight to the moon.

[10]

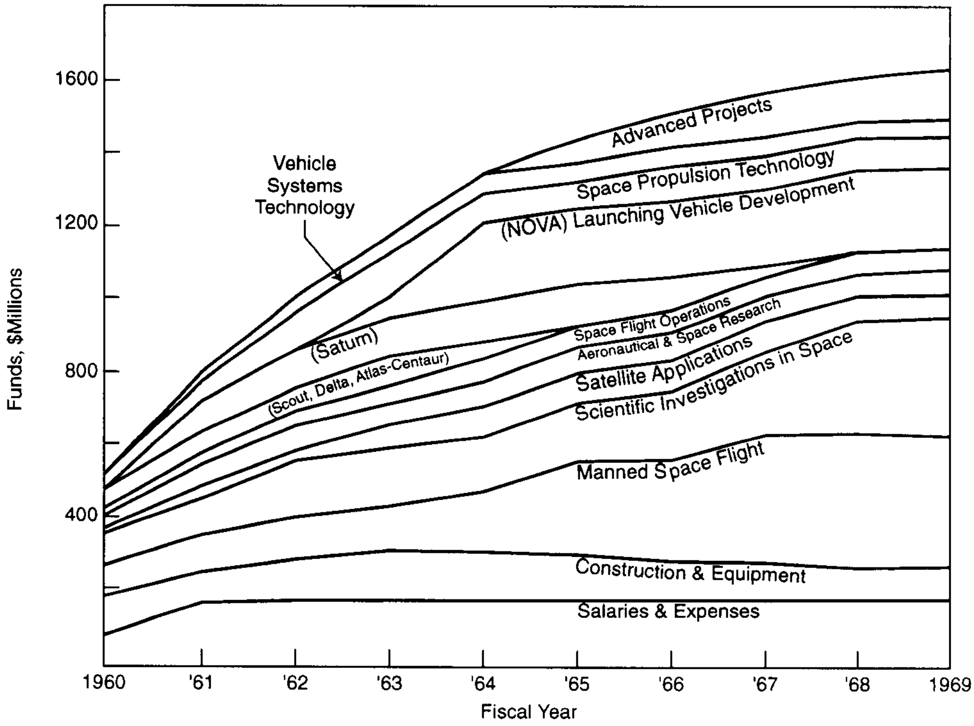
Table II
Current Funds & Anticipated Funding Requirements

Fiscal Year	1960*	1961	1962	1963	1964	1965	1966	1967	1968	1969
Research & Development							*Extrapolated*			
Launching vehicle Development	57	140	163	230	375	325	295	235	210	210
Space Propulsion Technology	39	51	118	120	90	75	95	95	95	95
Vehicle Systems Technology	13	30	47	49	50	50	50	50	50	50
Manned Space Flight	87	108	120	135	180	260	260	340	360	360
Scientific Investig. in Space	82	95	140	145	150	165	215	230	300	300
Satellite Applications	11	27	36	60	75	80	75	70	65	65
Aeronautical & Space Research	28	61	70	70	70	70	70	70	70	70
Space Flight Operations	16	33	42	50	55	60	60	60	60	60
Total Research & Development	333	545	736	859	1045	1085	1120	1150	1210	1210
Construction & Equipment	100	90	113	137	130	125	110	105	95	95
Salaries & Expenses	91	168	175	175	175	175	175	175	175	175
Advanced Projects					70	100	120	120	120	
Total Funds Required	524	802	1024	1171	1350	1455	1505	1550	1600	1600

*Includes 1959 Supplemental and 1960 Supplemental Request

[11]

Figure I
Current & Anticipated Funding Requirements



[17]

Table IV
Performance of NASA Launching Vehicles

Vehicle	1st Stage Thrust 1,000 Lbs.	Mission		
		Low Earth Orbit	Moon Probe	Planet Probe
In Use:		Spacecraft Wt. Lbs.		
Redstone	80	Used in Project Mercury Develop.		
Atlas	360	Project Mercury Capsule		
Juno II	150	100	20	
Thor-Able	150	200	80	
Atlas-Able	360		370	
Under Development				
Scout	100	200–240		
Thor-Delta	150	400–500	60	
Thor-Agena B(1)	150	1,200–1,500	350(2)	200(2)
Atlas-Agena B(1)	360	4,500–5,500	750–1,000	350–500
Atlas-Centaur	360	8,000–9,000	2,300–2,700	1,500–1,900
Saturn (initially)	1,500	28,500	9,000	7,000

1. DOD Development
2. With additional stage

[18]

Table V
Launching Vehicle Development

Fiscal Year	60	61	62	63	64	65	66	67	68	69
Scout										
Flights	4	2 2								
Funds, $M	2.8									
Thor-Delta										
Flights	1 1	1 2 1 1	5(a)							
Funds, $M	13.3	12.5	3							
Atlas-Vega										
Funds, $M	4.0									
Atlas Centaur										
Decision Points		Δ[1]								
Flights		1	5	4	5	5				
Funds, $M	37.0	47.0	55	65	50					
Saturn										
Configuration Analysis	■									
Decision Points	Δ[2]									
Flights			2	2	3	4	4	4		
Funds, $M	(70)(b)	81(c)	105	115	115	115	85	25		
Nova										
Feasibility Studies	■	■	■							
Decision Points				Δ[3]						
Flights									1	2
Funds, $M				50	210	210	210	210	210	210
Total R&D Funds, $M(d)	57.1	140.5	163	230	375	325	295	235	210	210

(a) Beginning in 1962 Thor-Delta replaced by Thor-Agena B

(b) *Funded by Department of Defense*

(c) Total FY 1961 funding for Saturn $140M—includes $46M for S&E and 13M for C&E not shown

(d) Vehicle Procurement beyond development phase shown on this table is funded by the using project.

1. Decide time of replacement of Atlas-Agena with Atlas-Centaur
2. Select upper stages for the Saturn vehicle
3. Determine configuration of the Nova vehicle

[26]

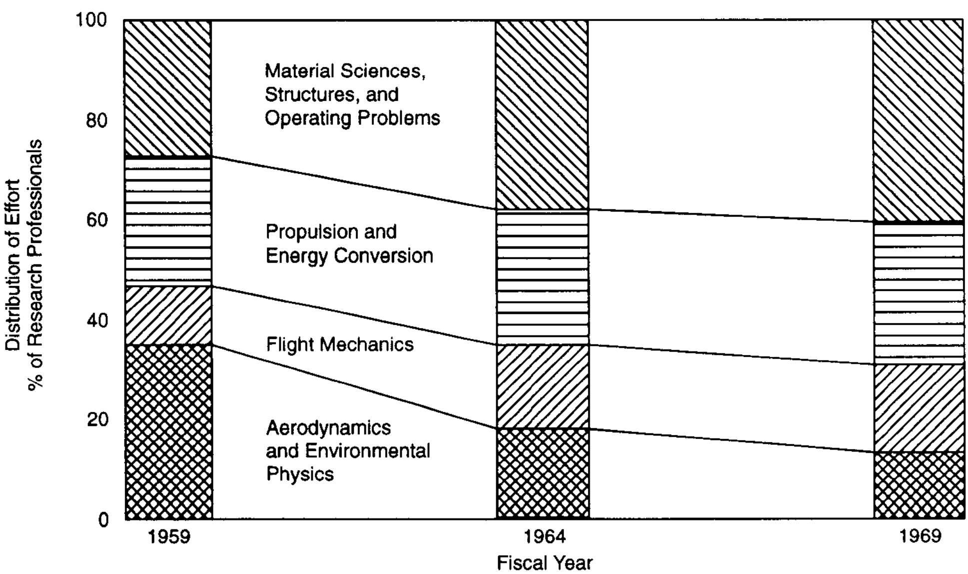
Table VII
Vehicle Systems Technology

Fiscal Year	60	61	62	63	64	65	66	67	68	69
Guidance & Control										
Agena/Centaur										
Injection Develop & Test										
Improve										
Mid Course—Develop & test[a]										
Terminal—Develop & Test[b]										
Saturn/Nova										
Study										
Develop & Test										
Attitude Control										
Develop & test										
Refine (0.01°)										
R&D Funds, $M	3.2	18.2	29	25	22	19	17	16	15	15
Power Generation										
Nuclear										
Snap VIII Develop										
Upper Stage Study										
Possible Develop										
R&D Funds, $M	1.9	4.5	12	17	21	24	25	27	28	28
Solar										
Sunflower Develop										
R&D Funds, $M	2.6	4.7	5	6	6	6	6	6	6	6
Chemical										
R&D Funds, $M			1	1	1	1	1	1	1	1
Miscellaneous, $M	5.0	3.0								
Total R&D Funds, $M	12.7	30.4	47	49	50	50	50	50	50	50

(a) Initial flight use in Mid-1961, refined and improved by 1963. (b) Initial flight use in 1963, refined and improved by 1965.

[44]

Figure II
Distribution of Aeronautical & Space Research Effort by Problem Area



Document III-3

Document title: President's Science Advisory Committee, "Report of the Ad Hoc Panel on Man-in-Space," December 16, 1960.

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

When NASA submitted its 1962 fiscal budget request to the Bureau of the Budget in May 1960, President Eisenhower learned for the first time of the agency's plans for a lunar landing program. He asked Presidential Science Advisor George Kistiatowsky to study "the goals, the missions and the costs" of the manned spaceflight program that NASA had in mind. The study was chaired by Brown University chemistry professor Donald Hornig and was presented to the president at a December 20, 1960, meeting. Eisenhower has been quoted as saying at this time that he was not willing to "hock his jewels" (referring to the decision by Spanish monarchs Ferdinand and Isabella to finance the initial expedition of Christopher Columbus) to send people to the Moon. The handwritten figures included in this report have been omitted.

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[1]

Report of the Ad Hoc Panel on Man-in-Space

1. Introduction

We have been plunged into a race for the conquest of outer space. As a reason for this undertaking some look to the new and exciting scientific discoveries which are certain to be made. Others feel the challenge to transport man beyond frontiers he scarcely dared dream about until now. But at present the most impelling reason for our effort has been the international political situation which demands that we demonstrate our technological capabilities if we are to maintain our position of leadership. For all of these reasons we have embarked on a complex and costly adventure. It is the purpose of this report to clarify the goals, the missions and the costs of this effort in the foreseeable future, particularly with regard to the man-in-space program.*

This report has been made possible by the complete cooperation of the National Aeronautics and Space Administration. Officials of the NASA presented a very impressive description of their detailed plans for development, utilization and costs of the Saturn vehicle. They also provided technical information on possible follow-on vehicles, advanced propulsion techniques, and possible development and funding schedules, As far as we can tell, the NASA program is well thought through, and we believe that the mission, schedules and costs are as realistic as possible at this time. We had to project their plans beyond 1970, and such projections must be seen as only crude estimates.

[2] **2. The Man-in-Space Program**

The initial American attempt to launch a manned capsule into orbital flight, Project Mercury, is already well advanced. It is a somewhat marginal effort, limited by the thrust of the Atlas booster. It has as its goal the launching of a one man capsule into orbit around the earth and its successful return to earth. The fact that the thrust of any available American booster is barely sufficient for the purpose means that it is difficult to achieve a high probability of a successful flight while also providing adequate safety for the Astronaut. Achieving reliability on both accounts will strain our capabilities. A difficult decision will soon be necessary as to when or whether a manned flight should be launched. The chief justification for pushing Project Mercury on the present time scale lies in the political desire either to be the first nation to send a man into orbit, or at least to be a close second.

*No attempt has been made to include manned space programs initiates, or to be initiated, by the DOD.

The marginal capability cannot be changed substantially until the Saturn booster becomes available. The NASA program for utilizing Saturn involves the development of the so-called Apollo spacecraft. The Saturn rocket which is being developed now (C-1) should be capable of launching a spacecraft of about 19,000 lbs into a low earth orbit. The proposed Apollo spacecraft weight of 15,000 lbs is well within this limit and would enable orbital qualification flights of the Apollo spacecraft (some manned) about 1966-1968. Such a manned flight would occur after about 25 Saturn C-1's have been tested and much depends on whether a demonstrated reliability can be attained in this rather small number of tests. The Apollo spacecraft, as presently envisioned, would carry three men who would exercise control from within the spacecraft and be able to return to earth within a fairly well defined area. The chief purpose of the early Apollo missions would be to gain experience in manned flight, to learn more of the problems encountered by crews under such new conditions and to aid in the development of a spacecraft for more ambitious missions.

The full capabilities of the Saturn booster cannot be utilized until a large hydrogen-oxygen second stage has been developed. The C-2 Saturn, utilizing the new high-performance stage, is expected to enter the test phase about 1965 and may be available for manned flight (No. 17) in 1968 or 1969. There is again a question as to whether 16 flights will be enough to demonstrate sufficient reliability for its use in manned missions.

The Saturn C-2 is expected to lift about 40,000 lbs into low earth orbit and it is planned to utilize this capability to send up an "orbiting laboratory" capable of staying aloft for two weeks or more. It is our opinion that an [3] orbiting laboratory of this size could produce considerably more scientific information if it were wholly instrumented rather than manned. Alternatively, we believe that the valid scientific missions to be performed by a manned laboratory of this size could be accomplished using a much smaller unmanned instrumented spacecraft which would in turn require a smaller booster system. The large manned orbiting laboratory might be of value as a life sciences laboratory to acquire physiological and psychological data on humans, to study life support mechanisms, to perform biological studies, and to carry out engineering tests under gravity free conditions. In short, its major mission appears to be the preparation for further steps in the manned exploration of space.

To take such steps, the Apollo spacecraft may be launched into successively more elliptical orbits which carry it further and further from the earth, culminating about 1970 in a manned flight around the moon and back to the earth. The Apollo program in itself does not reach what might be considered to be the next major goal in manned space flight, i.e. manned landing on the moon. It does, however, appear to represent a logical approach to that goal in that it will develop space craft and crews for space flight and will enable us to gain experience in navigation and successful return from increasingly difficult trips. In the meantime it should be possible to obtain far more detailed information about the moon by unmanned spacecraft and lunar landing craft than the crew of the circumlunar flight could gain.

None of the boosters now planned for development are capable of landing on the moon with sufficient auxiliary equipment to return the crew safely to earth. To achieve this goal, a new program much larger than Saturn will be needed. It is likely to take one of three forms:

1. An all-chemical liquid-fueled rocket, the Nova, might be developed to take the trip directly. It would require a booster with about 6 times the thrust of the Saturn and utilyzing either kerosene or hydrogen-oxygen. The upper stage of the Nova would require hydrogen-oxygen and at least one stage would probably be an existing stage from the Saturn development program.

2. If a suitable nuclear upper stage could be developed, the Nova vehicle could conceivably become a combination chemical-nuclear system. This system would still require the development of a first stage chemical booster with thrust of the same order of magnitude as that described for the all chemical system. If the nuclear development should be as successful as its proponents hope, it might open the way for future developments beyond

the [4] possibilities envisioned for chemical rockets. However, a sound decision on the promise of nuclear rockets cannot be made until about 1963.

3. Rendezvous techniques, utilizing either Saturn C-2 vehicles or some type of advanced Saturn vehicles, could be employed to lift into an earth orbit the hardware and fuel necessary to perform the manned lunar landing mission. In this system, a series of vehicles would be launched into a temporary earth orbit where they would rendezvous to enable fueling of the spacecraft and, if necessary, assembly of the component parts of the spacecraft. This spacecraft would then be used to transport the manned payload to the moon and thence back to Earth. These techniques will require considerable development, and are at present only in a preliminary study phase.

It is clear that any of the routes to land a man on the moon require a development much more ambitious than the present Saturn program. Not only must much bigger boosters probably be developed, but rockets and guidance mechanisms for the safe landing and then for return from moon to earth by means of additional rockets must be developed and tested. Nevertheless, it must be pointed out that this new, major step is implicit in undertaking the proposed manned Saturn program, for the first really big achievement of the man-in-space program would be the lunar landing.

The succeeding step, manned flight to the vicinity of Venus or Mars represents a problem an order of magnitude greater than that involved in the manned lunar landing. Not only does it appear to be insoluble in terms of chemical rockets, thus requiring the development of suitable nuclear rockets or nuclear-powered electric propulsion devices, but it also poses serious problems in terms of life support and radiation shielding for journeys requiring times ranging from many months to years.

3. Unmanned Programs Related to Man-in-Space

A great part of the unmanned program for the scientific exploration of space is a necessary prerequisite to manned flight. The programs which are now planned fall in the following general categories:

1. The general scientific exploration of space. This will take place in a continuing series of flights. This program has been moving along well and has been marked by solid scientific achievement; it could probably be carried on to a high state of advancement using launch vehicles no larger than Centaur (an Atlas with hydrogen-oxygen upper stage).

[5] 2. A rough landing on the moon, with television recording of the impact and with a surviving seismometer to make measurements on the lunar surface, may be made in 1962 or 1963 using an Atlas-Agena-B vehicle.

3. The Centaur rocket, which should make its first flight in 1961, will make it possible to fly instruments past Venus and Mars, making close-up scientific observations for a short time, in 1962 or 1964. It may even be possible to land a 10 lbs instrument capsule through their atmospheres.

4. The Centaur should also make it possible to soft land 190 lbs of scientific gear on the surface of the moon (1964-1966) and to make surface observations from a very close orbit about the moon, including photography comparable to satellite photography of the earth (Samos).

5. The Saturn C-2 will be the first vehicle which can carry an adequately instrumented spacecraft, weighing perhaps 325 lbs, into an orbit about Venus or Mars, and to land a 225 lbs capsule through their atmosphere, giving us direct atmospheric and surface measurements for the first time in about 1967 or 1968. It may then be possible to obtain definite evidence regarding life on Mars. Although such studies can be started with the Saturn C-1 in 1965 or 1966, they really require the C-2 to give reasonable instrument weights.

6. A roving automatic vehicle equipped with television and other sensing instruments to make observations on the surface of the moon can first be landed with the C-2 in about 1967, and is included in present NASA plans.

7. It should also be possible to soft land so object on the moon which is large enough to send a capsule back to earth with a few pound sample of the surface of the moon. This also requires the C-2 and could be tried beginning in about 1968.

8. No booster smaller than the C-2 can carry scientific instruments to the vicinity of Mercury or Jupiter. This, too, should be possible around 1968 to 1970.

9. For unmanned scientific investigations with roving vehicles on the planets, or for more ambitious instrumented missions out of the plane of the ecliptic, even the Saturn C-2 does not provide sufficient payload-carrying capability.

[6] **4. Relation between Manned and Unmanned Space Exploration**

Certainly among the major reasons for attending the manned exploration of space are emotional compulsions and national aspirations. These are not subjects which can be discussed on technical grounds. However, it can be asked whether the presence of a man adds to the variety or quality of the observations which can be made from unmanned vehicles, in short whether there is a scientific justification to include man in space vehicles.

It is said that an astronaut's judgment, decision-making capability and resourcefulness can increase the probability of successful accomplishment of a space mission and expand the variety and quality of observations performed. On the other hand, man's senses can be satisfactorily duplicated at remote locations by the use of available instrumentation and advances in the state of the art are continually increasing the ability to transmit information back to a central receiving point. With such an instrumented system, the decisions requiring man's mental capabilities can be performed by many men in a normal environment and with the aid of elaborate computational aids, where necessary.

The following considerations seem pertinent:

1. Information from unmanned flights is a necessary prerequisite to manned flight.

2. The degree of reliability that can be accepted in the entire mechanism is very much less for unmanned than for manned vehicles. As the systems become more complex this may make a decisive difference in what one dares to undertake at any given time.

3. From a purely scientific point of view it should be noted that unmanned flights to a given objective can be undertaken much earlier. Hence repeated observations, changes of objectives and the learning by experience are more feasible.

It seems, therefore, to us at the present time that man-in-space cannot be justified on purely scientific grounds, although more thought may show that there are situations for which this is not true. On the other hand, it may be argued that much of the motivation and drive for the scientific exploration of space is derived from the dream of man's getting into space himself.

[7] **5. Cost of the NASA Man-in-Space Program**

The NASA man-in-space program, exclusive of the Mercury Project, revolves around the use of the Saturn and Nova vehicles. Development of the Saturn is far enough along that its characteristics are fairly well known, and the costs of its development and use can be predicted with reasonable accuracy. The Nova, required for direct manned operations on the moon, is based on the use of the 1.5 million lbs thrust engine, six of which would probably power the first stage. The character of the vehicle as a whole cannot be clearly determined until the characteristics of this engine are understood. However, the present tentative designs of the Nova configuration are probably adequate to support the very rough cost analysis presented here.

This analysis is based on the rule-of-thumb principle, generally supported by past experience, that the cost of a program of this nature, including development, flight test and use, should be approximately proportional to the dry weight of the booster vehicle and payload on which the program is based. The dry weight of the Nova vehicle is about six times that of the Saturn vehicle, and accordingly a factor of six should be applied to the costs of the two programs. It is pointed out, however, by the NASA that there is some reason to believe that a somewhat smaller factor might be appropriate. There is a good deal of basic engineering that will carry over from Saturn to Nova, and certain of the Nova stages may already have been developed for Saturn. Such considerations are doubtless valid, but they could not justify the use of a factor smaller than four. In the analysis that follows two values of the multiplicative factor are used: four, representing the lower bound on what might be achieved, and six, representing a reasonably conservative estimate.

It is further assumed that the time span required for the development and exploitation of the capabilities of the Nova are the same as that for Saturn. It is assumed, however, that the Nova development follows that of Saturn by seven years. Thus, by 1968 Nova is in a state of development corresponding to that of Saturn in 1961.

With these assumptions in mind, the method of arriving at the yearly costs given in the figure can be stated.

1. The known and estimated costs for the development and use of Saturn are plotted on the curve so labeled in Figure 1. The costs following 1970 are not NASA estimates, but are predicated on the likelihood of some continuing use for this vehicle.

[8] 2. The "Saturn" curve is now displaced to the right by seven years, and the ordinate multiplied by the factors four and six. This produces the solid sections of the curves labeled "Nova" in Figure 1. The dashed left-hand tails of the Nova curves represent pure estimate and have only reasonableness to recommend them.

3. The "Saturn" and "Nova" curves have been added year by year to produce the composite curves of Figure 2. These are taken to represent rough bounds on the cost of the NASA man-in-space program.

4. The integrated areas under the curves represent the total expenditures for the period 1961 through 1975. As indicated on the figures, the total Saturn program costs 8 billion (1961) dollars up to 1975. The Nova program over the same time period comes to 25.5 billion on the lower estimate and 38 billion on the higher estimate. (It will be noted that these totals are not four and six times, respectively, the total Saturn cost. This is because the Nova costs were integrated only out to 1975, when the first manned lunar landing might be achieved. The Saturn costs, on the other hand, were integrated over the entire estimated program.) Figure 2 gives the total composite expenditure to 1975 as 33.5 billion for the lower estimate and 46 billion for the higher.

The cut-off at 1975 is arbitrary and might be misleading. During the five or ten year period preceding this date new developments will be under way to implement new programs for the post 1975 era. It does not seem possible at this time to estimate the incremental costs associated with these programs.

Present indications suggest that alternative methods, described elsewhere in this report, of accomplishing the manned lunar landing mission, could not be expected to alter substantially the over-all cost of mission as analyzed here on the basis of Nova.

In the event that additional flight testing is required to achieve adequate reliability in these programs, it seems likely that the program would be stretched out in time. Thus probably the annual expenditures would not change appreciably, although the integrated expenditure would increase accordingly.

6. Conclusions

1. The first major goal of the man-in-space program is to orbit a man about the earth. It will cost about 350 million dollars.

[9] 2. The next goal, of an intermediate nature, is the manned circum-navigation of the moon. It will cost about 8 billion dollars.

3. The second major goal, landing on the moon, can only be achieved about 1975 after an additional national expenditure in the vicinity of 26 to 38 billion dollars.

4. The Saturn program is a necessary intermediate step toward manned lunar landing but must be followed by a much bigger development before manned lunar landing is possible.

5. The unmanned program is a necessary prerequisite to a manned program. Even if there were no manned program, the unmanned program might yield as much scientific knowledge and on this basis would be justified in its own right.

6. Even if there were no man-in-space program, Saturn C-2 is still a minimum vehicle for close-up instrumented study of Venus and Mars, for unmanned trips to more distant planets, and for putting roving vehicles on the surface of the moon.

7. Manned trips to the vicinity of Venus or Mars are not yet foreseeable....

Document III-4

Document title: Richard E. Neustadt, "Problems of Space Programs," December 20, 1960, attached to Memorandum for Senator Kennedy, "Memo on Space Problems for you to use with Lyndon Johnson," December 23, 1960.

Source: Pre-Presidential Papers, John F. Kennedy Presidential Library, Boston, Massachusetts.

Eisenhower made several recommendations concerning space before leaving office. Some of these, such as the elimination of the Civilian-Military Liaison Committee, were followed by the Kennedy administration. Others, such as the elimination of the National Aeronautics and Space Council (NASC), were not. Eisenhower recommended that the council be abolished, but Richard E. Neustadt, who had worked on the Democratic Party Platform Committee and was serving as consultant to the president-elect, recommended that the vice president be named chairman of the NASC in a memo to Kennedy on December 20, 1960. Neustadt also was the first to bring the Saturn rocket program to Kennedy's attention and to note that it was needed only if the United States intended "to put a man on the moon and get him back before or soon after the Russians do."

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[1] December 20, 1960

Problems of Space Programs

The "space" programs both civil and military, raise problems of great difficulty. Superficially these are problems of budget and organization. Essentially they are problems of policy direction.

The following approximate figures include the growth and projected magnitude of the space programs:

New Obligational Authority in millions

	1957 & prior	1958	1959	1960	1961 Approx	1962 Approx	1965 Projected
NASA	--	117	305	524	965	1,110	2,000
AEC (nuclear power for space use)	--	20	33	52	45	53	100
Defense (identifiable space programs)	95	92	511	543	740	825	2,000
Total	95	229	849	1,119	1,750	1,988	4,100

Organizationally, there are two Government space programs: (1) a civilian space program which is the responsibility of NASA (and of AEC with respect to reactor development), and (2) a military space program consisting of activities considered by the Pentagon to be specifically required for defense; these are the responsibility of the Department of Defense.

The existence of two programs has resulted in a certain amount of actual duplication on communications satellites, manned space flight programs, and supporting research and development. The tendency toward duplication has to be watched carefully; there is always danger that it will get out of hand. The Civilian-Military Liaison Committee, established by law, has become inoperative, as a result of experience which showed it to [2] be ineffective in coordination operations. At present there is an administrative established "Aeronautics and Space Coordinating Board" consisting of representatives of NASA and Defense through which operational coordination is being sought.

The Problem of "National Prestige"

Since Sputnik we have been in a race to be "first" in physical achievements of a dramatic sort–the sort which has high visibility and thus makes an impression on mass opinion, especially abroad. This has got us into the business of pressing achievements for the sake of their psychological effect, regardless of concrete scientific or military utility. The dollar costs are high and are bound to grow much higher. The big booster program (see below) is a classic case and demonstrates NASA's expenditures into the future. The dollar costs represent diversion of resources–money, manpower, facilities, scientific skills–from other parts of our national effort.

This is the heart of the problem.

The problem is that we need more funds for research and development of new weapon systems, more funds for science generally, more funds for economic development abroad, more funds for welfare purposes at home. Money spent to serve no concrete purpose save the psychological effect of being "first" is money we could well use for these other needs.

The problem is made sharper by the fact that on the kind of "firsts" which have had most dramatic mass appeal, the Russians may be well ahead of us. We have reason to think that, taken as a whole, our scientific programs of inquiry and exploration in space are more advanced [3] than Moscow's and have yielded more real scientific returns. But we have not yet found means of making our progress drastically apparent to the man-in-the-street around the world.

Two questions arise:

1. If we are behind and are likely to stay behind in the race for "Sputnik-type firsts" should we get out of the race and divert the resources now tied up in it to other uses which have tangible military, scientific or welfare value?

2. By what means, if any, can we make our underlying scientific "firsts" dramatic and appealing, especially aboard? How can we render visible a different sort of "race" which we are more likely to "win"?

Virtually every aspect of the NASA budget now and in the next several fiscal years will be affected by answers to these questions. Admittedly they are very hard questions to answer with anything like a simple yes or no, but reasonably clear answers are needed for the sake of budgetary guidelines in fiscal 1962 and after.

The Big Booster Program

Close to half the NASA budget for 1962 is bound up, in one way or another with this program.

The program has two parts:

First is the so-called Saturn, which, with luck, might become operational in about two years. This is a "bailing wire" devise intended to give us big booster capability for the short-run by combining and adapting devices designed for other purposes. The Saturn is a forced draft operation and an expensive one. Booster capability is needed in this form only in order to put a man on the moon and get him back before or soon after the Russians do. [4] Saturn, in short, is a prestige item. It will *not* affect and is distinct from getting a man in space, *per se.*

Second is the single-engine big booster which is under development for eventual use in a space vehicle designed to transport men and heavy equipment. This is the progenitor of the engines which eventually will be necessary for the "space ship" of the future. Regardless of the Russians, the United States may have reason to go forward with this development. It is a development which stimulates the imagination of young Americans who will be voting before too long. It is a development which *may*, in time, have military and economic uses not foreseeable. Finally, it is part of the whole forward push in technology. We have certainly learned from earlier experience that these forward steps cannot be stopped. But we have also learned that under present circumstances only Government support will get them taken.

The single-engine development is proceeding slowly, in second place for funds and other resources behind the Saturn project. It is necessary to consider: (1) "Prestige" apart, can Government afford, *in the next years*, the diversion of resources needed to bring either or both these boosters to fruition? (2) In the longer run, what proportion of Government resources, for what span of years, should go into developing the technology of space travel?

Civil, Military Duplications of Effort

The decision was made in 1958 to organize governmental space efforts as a civilian enterprise except for programs integrally related to the missions of the military services. The exception, of course, is very significant. Both NASA and the Defense Department will, inevitably, conduct research, development and operations in the space field. The [5] two sets of programs are not always easy to distinguish. For reasons of practicality and economy, NASA uses military facilities for much of its experimentation and testing. Defense, in turn, relies on NASA for some research and development.

The operating relationships between NASA and Defense are bound to be complex, but it does not necessarily follow that they need be inefficient. Nor does it follow that the two programs should be duplicative except where duplication serves a constructive purpose.

Unfortunately, there are many signs of inefficiency in the relationship and many indications of duplicative effort which may not meet the test of useful duplication. There are dual programs in communications, in manned space flight, in vehicles development and in applied research. The relative utility and need for these programs, both on the side of NASA and on the side of Defense, calls not so much for technical as for policy evaluation.

The National Aeronautical and Space Council was originally envisaged as a Cabinet-type advisory committee to help the President with policy evaluation, and to help him also in securing effective coordination of operative relationships. But the Council has not functioned in the past year. Meanwhile, a NASA-Defense committee has been established. Experience to date suggests that this may be a promising development in securing coordination at the working level. It is unlikely to resolve the problems of securing policy advice.

An opportunity now exists to revitalize the National Aeronautical and Space Council under the Chairmanship of the Vice President. Legislation will be required to put him in the chair. It might be timely to simplify the Council's title and to reconsider its statutory membership. If the council is to function effectively in the future, as it has not done in the past, it might be well to keep its membership relatively small and to have it operate selectively on high priority policy issues of the sort mentioned above.

R.E.N.

Document III-5

Document title: "Report to the President-Elect of the Ad Hoc Committee on Space," January 10, 1961.

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

John F. Kennedy was the first president-elect to set up high-level "transition teams" to advise him on issues that he would face upon assuming the presidency. His transition team on space was chaired by Massachusetts Institute of Technology professor Jerome B. Wiesner, a member of President Eisenhower's President's Science Advisory Committee (and thus familiar with discussions inside the Eisenhower administration on space policy and programs). Wiesner had advised Kennedy on science and technology issues during the Presidential campaign and would become the new president's science adviser. The report reflected the widespread skepticism within the scientific elite of the country over the value, and even the feasibility, of human spaceflight.

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[1]

I. Introduction

Activities in space now comprise six major categories:

1. Ballistic missiles.
2. Scientific observations from satellites.
3. The exploration of the solar system with instruments carried in deep space probes.
4. Military space systems.
5. Man in orbit and in space.
6. Non-military applications of space technology.

We rely on the first member of the list, ballistic missiles, for a large part of the retaliatory response to the Russian missile threat.

It is generally assumed by the American citizen that our vast expenditures of money and technical talent in the national space program are primarily designed to meet the overriding needs of our military security. The fact is, however, that the sense of excitement and creativity has moved away from the missile field to the other components of the list, and that missiles, long before they are in condition for us to depend upon them, are slowly being delegated to the category of routine management. Before we proceed in this report to discuss and support the important activities in the other five categories we wish to emphasize the hazard of failing to complete and deploy on time our intercontinental deterrent missiles.

[2] In addition to the need to develop ballistic missiles to provide for our military security, there are five principal motivations for desiring a vital, effective space program. It is important to distinguish among them when attempting to evaluate our national space effort.

First, there is the factor of national prestige. Space exploration and exploits have captured the imagination of the peoples of the world. During the next few years the prestige of the United States will in part be determined by the leadership we demonstrate in space activities. It is within this context that we must consider man in space. Given time, a desire, considerable innovation, and sufficient effort and money, man can eventually explore our solar system. Given his enormous curiosity about the universe in which he lives and his compelling urge to go where no one has ever been before, this will be done.

Second, we believe that some space developments, in addition to missiles, can contribute much to our national security—both in terms of military systems and of arms-limitation inspection and control systems.

Third, the development of space vehicles affords new opportunities for scientific observation and experiment—adding to our knowledge and understanding of the earth, the solar system, and the universe. In the three years since serious space exploration was initiated the United States has been the outstanding contributor to space science. We should make every effort to continue and to improve this position.

Fourth, there are a number of important practical non-military applications for space technology—among them, satellite communications and broadcasting; satellite navigation and geodesy; meteorological reconnaissance; and satellite mapping—which can make important contributions to our civilian efforts and to our economy.

Finally, space activities, particularly in the fields of communications and in the exploration of our solar system, offer exciting possibilities for international cooperation with all the nations of the world. The very ambitious [3] and long-range space projects would prosper if they could be carried out in an atmosphere of cooperation as projects of all mankind instead of in the present atmosphere of national competition.

The ad hoc panel has made a hasty review of the national space program, keeping in mind the objective—to provide a survey of the program and to identify personnel, technical, or administrative problems which require the prompt attention of the Kennedy administration. We have identified a number of major problems in each of these categories, and they will be discussed in this report. It is obvious that there has been inadequate time to examine all facets of the program or to permit full consideration of the possible answers to many of the questions raised.

Because of the overriding necessity to provide more efficient and effective leadership for the program, the group has devoted a major portion of its time to this aspect of the space program. We will, however, indicate important scientific and technical problems which should be thoroughly examined as soon as possible. We have concluded that it is important to reassess thoroughly national objectives in the space effort—particularly in regard to man in space; space, science and exploration; and the non-military applications of space, in order to assure a proper division of effort among these activities. Space activities are so unbelievably expensive and people working in this field are so imaginative that the space program could easily grow to cost many more billions of dollars per year.

While we are now compelled to criticize our space program and its management, we must first give adequate recognition to the dedication and talent which brought about very real progress in space during the last few years. Our scientific accomplishments to date are impressive, but unfortunately, against the background of Soviet accomplishments with large boosters, they have not been impressive enough.

Our review of the United States' space program has disclosed a number of organizational and management deficiencies as well as problems of staffing and direction which should receive prompt attention from the new administration. These include serious problems within NASA, within the military establishment, and at the [4] executive and other policy-making levels of government. These matters are discussed in the sections which follow.

II. The Ballistic Missile Program

The nation's ballistic missile program is lagging. The development of the missiles and of the associated control systems, the base construction, and missile procurement must all be accelerated if we are to have the secure missile deterrent force soon that the country has been led to expect.

While additional funds will undoubtedly be required to accomplish this, we believe that re-establishing an effective, efficient, technically competent arrangement for the program is the overriding necessity.

Though the missile program is not ordinarily regarded as part of the space program, it is important to recognize that for the near future the achievement of an adequate deterrent force is much more important for the nation's security than are most of the space objectives, and that at least part of the difficulty in the management and execution of the program stems from the distraction within the Defense Department and in industry caused by vast new space projects. However, we have no alternative but to press forward, with space developments.

III. Organization and Management

There is an urgent need to establish more effective management and coordination of the United States space effort. The new administration has promised to move our country into a position of preeminence in the broad range of military, cultural, scientific and civilian applications of satellite and other space vehicles. This cannot be done without major improvements in the planning and direction of the program. Neither NASA as presently operated nor the fractionated military space program nor the long-dormant space council have been adequate to meet the challenge that the Soviet thrust into space has posed to our military security and to our position of leadership in the world.

[5] In addition to the difficulties and delays which the program has endured because of the lack of sufficient planning and direction, it has also been handicapped because too few of the country's outstanding scientists and engineers have been deeply committed to the development and research programs in the space field. In changing the management structure and in selecting the administrators for the effort, the need to make space activities attractive to a larger group of competent scientists and engineers should be a guiding principle.

The new administration has announced that it plans to use the National Aeronautics and Space Council for coordinating government space activities, or advising the President on policy on plans and on the implementation of programs. We believe that the space council can fulfill this role only if it is technically well-informed and, moreover, seriously accepts the responsibility for directing the conduct of a coherent national space effort. Particular care should be taken to insure the selection of a very competent and experienced staff to assist the Council

Not only must we provide more vigor, competence and integration in the space field, but we must also relate our space requirements to other vital programs which support our national policy. We refer particularly to the missile needs, already mentioned, and to the continuing need for development and research in the field of aeronautics.

Each of the military services has begun to create its own independent space program. This presents the problem of overlapping programs and duplication of the work of NASA. If the responsibility of all military space developments were to be assigned to one agency or military service within the Department of Defense, the Secretary of Defense would then be able to maintain control of the scope and direction of the program and the Space Council would have the responsibility for settling conflicts of interest between NASA and the Department of Defense.

With its present organizational structure and with the lack of strong technical and scientific personalities in the top echelons, it is highly unlikely [6] that NASA space activities can be greatly improved by vitalization of the Space Council.

We are also concerned by the NASA preoccupation with the development of an in-house research establishment. We feel that too large a fraction of the NASA program, particularly in the scientific fields, is being channeled into NASA-operated facilities. NASA's staff has had to expand much too rapidly and without adequate selectivity, so that many inexperienced people have been placed in positions of major responsibility. This has, in turn, made NASA less willing than would a more mature and competent organization to solicit and accept the advice of competent non-government scientists. This situation appears to be improving at the present time.

One important responsibility of NASA given little attention now in the organization, is that of providing for basic research and advanced development in the field of aeronautics. There is a general belief in the aviation industry that the national preoccupation with space developments has all but halted any advance in the theory and technology of aerodynamic flight. There is ample evidence to support the contention that the Russians and possibly the British, are surpassing us in this field and consequently in the development of supersonic commercial aircraft. We should make a substantial effort to correct this situation, possibly by getting some of NASA's aeronautical and aerodynamic experts back into the field of advanced aircraft research and development. Possibly, after careful investigation, the Space Council would prefer to stimulate this work by non-governmental arrangements, or by placing it entirely in another agency.

We believe that the work of NASA would be facilitated and the task of recruiting staff made possible if an outstanding expert was placed in charge of the direction and management of each of the following important areas of work:

a. Propulsion and vehicle design and development
b. The space sciences
[7] c. Non-military exploitation of space technology
d. Aeronautical sciences and aircraft development

IV. The Booster Program

The inability of our rockets to lift large payloads into space is the key to the serious limitations of our space program. It is the reason for the current Russian advantage in undertaking manned space flight and a variety of ambitious unmanned missions. As a consequence, the rapid development of boosters with a greater weight-lifting capacity is a matter of national urgency.

Payload weight is currently limited by our dependence on modified military rockets as the primary boosters (THOR, JUPITER, ATLAS). Current plans call for the first substantial increase in payload with the addition of the CENTAUR upper stage to the ATLAS in 1962, followed by a second big step with the SATURN booster in 1965.

It is likely that a variety of new booster programs will be proposed in the near future, particularly for military projects. There are no fundamental differences in civilian and military requirements which are foreseeable now. If the national effort is to be focused and the very large expenditures are not to be distributed among an excessive number of booster programs, it is important that we maintain and strengthen the concept of a National Booster Program.

A number of problems may well arise in the National Booster Program. The present MERCURY program, based on the ATLAS, is marginal and if the ATLAS proves inadequate for the job it may be necessary to push alternatives vigorously. The first possibility appears to be the TITAN, although it has not yet demonstrated the reliability which is required. We should study the desirability of carrying out a TITAN-boosted MERCURY program in the event ATLAS should prove to be inadequate.

The CENTAUR rocket involves an entirely new technology and is still untested. If difficulties develop in this program within the next three or four months we must act promptly to initiate an alternate.

[8] Development of the SATURN-booster—a cluster of eight ATLAS engines—should continue to be prosecuted vigorously. However, it would be dangerous to rely on SATURN alone for the solution to our problems, either in the long or short term, for two reasons:

(a) It is intrinsically so complex that there is a real question whether it can be made to function reliably.

(b) It represents a maximum elaboration of present technology and provides no route to further development.

Therefore, the development of a very large single engine should proceed as fast as possible so that it may be a back-up for the SATURN cluster and a base for future larger vehicle development. The present F-1 (1.5 million lb. thrust) engine development should be studied to be sure it is progressing fast enough and has enough promise of success to fill this role. If the technological step in going from the present 180,000 lb. thrust engines to 1.5 million lbs. is so big as to make success marginal, a parallel development of a somewhat smaller engine should be started.

The nuclear rocket program (ROVER) presents an area in which some major decisions will have to be taken by the new administration. In principle the nuclear rocket can eventually carry heavier payloads much farther than any chemical rocket. Nevertheless, the technology is so new and the extrapolation from reactors developed now to sizes which would be useful in large rockets is so great that it is not clear how soon they will make an important contribution to the space program. The use of nuclear rockets will raise serious international political problems since the possibility that a reactor could reenter and fall on foreign territory cannot be ignored. A major technical and management review of the ROVER program seems urgent.

Above all we must encourage entirely new ideas which might lead to real breakthroughs. One such idea is the ORION proposal to utilize a large number of small nuclear bombs for rocket propulsion. This proposal should receive careful [9] study with a realization of the international problems associated with such a venture.

[Most of page 9, all of pages 10 and 11, and 1/3 of page 12 excised during declassification review]

[12] **VI. Science in Space and Space Exploration**

In the three years since space exploration began, experiments with satellites and deep space probes have provided a wealth of new scientific results of great significance. In spite of the limitations in our capability of lifting heavy payloads, we now hold a position of leadership in space science. American scientists have discovered the great belt of radiation, trapped within the earth's magnetic field. American scientists have revealed the existence of a system of electric currents that circle our planet. Our space vehicles have probed the interplanetary space to distances of tens of millions of miles from the earth. They have shown that the earth is not moving through an empty space but through an exceedingly thin magnetized plasma. They have intercepted streams of fast-moving plasma ejected from the sun which, upon reaching our planet, produce magnetic storms, trigger off auroral displays and disrupt radio communications.

From these and other experiments, there is gradually emerging an entirely novel picture of the conditions of space around our planet and of the sun-earth relations. One of the important tasks of space science in the next few years will be a full exploration of the new field revealed by the early experiments. There is little doubt that such exploration will lead to further important discoveries.

[13] Another scientific field, where space science promises an early and major breakthrough is that of astronomy. Until a few years ago, visible light from celestial objects, reaching our telescopes through the atmospheric planet, had been the only source of astronomical information available to man. The only other portion of the spectrum capable of penetrating the atmosphere and the ionosphere is that corresponding to shortwave radio signals. In recent years, the development of radio telescopes has made it possible to detect these signals. Radio astronomy has enormously advanced our knowledge of the universe. By means of radio telescopes we can now "see" not only the stars, but also the great masses of gas between the stars; we can detect the high-energy electrons produced by cosmic accelerators located thousands of millions of light years away from the earth.

We are entitled to expect a similar and even perhaps a more spectacular advance the day that we shall have telescopes installed aboard satellites circling the earth above the atmosphere and the ionosphere. These instruments will be capable of detecting the whole of the electro-magnetic spectrum—from long-wave radio signals to gamma-rays.

A third major task of space science in the years to come will be the exploration of the moon and the planets. Scientists are planning to fly instruments to the vicinity of these celestial objects, and eventually to land them upon their surface. From the data supplied by these instruments they expect to obtain information of decisive importance concerning the origin and the evolution of the solar system. Moreover, there is the distinct possibility that planetary exploration may lead to the discovery of extra-terrestrial forms of life. This clearly would be one of the greatest human achievements of all times.

Our present leadership in space science is due to a large extent to the early participation of some of our ablest scientists in our space program—primarily as part of the International Geophysical Year—and to the fact that these scientists were in a position to influence this program. Another important [14] factor was our initial advantage in instrumentation, which helped to offset our disadvantage in propulsion.

We must not delude ourselves into thinking that it will be easy for the U.S.A. to maintain in the future a prominent position in space science. The USSR has a number of competent scientists. It will be easier for them to catch up with us in instrument development than for our engineers to catch up with the Russians in the technique of propulsion. Thus we must push forward in space science as effectively and as forcefully as we can.

Our scientific program in space appears to be basically sound. However, to insure its success, the following requirements must be met.

1. In the planning of our space activities, scientific objectives must be assigned a prominent place.

2. Our space agency must insure a wide participation in its program by scientists from universities and industrial laboratories, where our greatest scientific strength lies.

3. It must provide adequate financial support for the development and construction of scientific payloads.

4. It must exert the greatest wisdom and foresight in the selection of the scientific missions and of the scientists assigned to carry them out.

5. It must initiate immediately a research program in advanced instrumentation, so that we may be ready to exploit fully the capability of flying heavier and more complex payloads that we shall possess several years from now. Problems of automation, processing and transmission of information must be tackled by competent and imaginative research teams.

NASA has not fulfilled all of the above requirements satisfactorily. We believe, as previously stated, that the main obstacle here has been the lack of a strong scientific personality in the top echelons of its organization.

[15]

VII. Man in Space

We are rapidly approaching the time when the state of technology will make it possible for man to go out into space. It is sure that, as soon as this possibility exists, man will be compelled to make use of it, by the same motives that have compelled him to travel to the poles and to climb the highest mountains of the earth. There are also dimly perceived military and scientific missions in space which may prove to be very important.

Thus, manned exploration of space will certainly come to pass and we believe that the United States must play a vigorous role in this venture. However, in order to achieve an effective and sound program in this field, a number of facts must be clearly understood.

1. Because of our lag in the development of large boosters, it is very unlikely that we shall be first in placing a man into orbit around the earth.

2. While the successful orbiting of a man about the earth is not an end unto itself, it will provide a necessary stepping stone toward the establishment of a space station and for the eventual manned exploration of the moon and the planets. The ultimate goal of this kind of endeavor would, of course, be an actual landing of man on the moon or a planet, followed by his return to the earth. It is not possible to accomplish such a mission with any vehicles that are presently under development.

3. Some day, it may be possible for men in space to accomplish important scientific or technical tasks. For the time being, however, it appears that space exploration must rely on unmanned vehicles. Therefore, a crash program aimed at placing a man into an orbit at the earliest possible time cannot be justified solely on scientific or technical grounds. Indeed, it may hinder the development of our scientific and technical program, even the

[16] future manned space program by diverting manpower, vehicles and funds.

4. The acquisition of new knowledge and the enrichment of human life through technological advances are solid, durable, and worthwhile goals of space activities. There is general lack of appreciation of this simple truism, both at home and abroad. Indeed, by having placed highest national priority on the MERCURY program we have strengthened the popular belief that man in space is the most important aim of our non-military space effort. The manner in which this program has been publicized in our press has further crystallized such belief. It exaggerates the value of that aspect of space activity where we are less likely to achieve success, and discounts those aspects in which we have already achieved great success and will probably reap further successes in the future.

5. A failure in our first attempt to place a man into orbit, resulting in the death of an astronaut, would create a situation of serious national embarrassment. An even more serious situation would result if we fail to safely recover a man from orbit.

On the basis of these facts we would like to submit the following recommendations:

1. By allowing the present MERCURY program to continue unchanged for more than a very few months, the new Administration would effectively endorse this program and take the blame for its possible failures. A thorough and impartial appraisal of the MERCURY program should be urgently made. The objectives of the various phases of this program (including the proposed physiological tests) should be critically examined. The margins of safety should be realistically estimated. If our present man-in-space program [17] appears unsound, we must be prepared to modify it drastically or even to cancel it. It is important that a decision on these matters be reached at the earliest possible date.

2. Whatever we decide to actually do about the man-in-space program, we should stop advertising MERCURY as our major objective in space activities. Indeed, we should make an effort to diminish the significance of this program to its proper proportion before the public, both at home and abroad. We should find effective means to make people appreciate the cultural, public service and military importance of space activities other than space travel.

VIII. Non-military Applications of Space Technology— An Industry-Government Space Program

As the technical feasibility and reliability of man-made satellites was demonstrated, many possible civilian uses for satellites emerged. With no government support, various groups in private industry have examined the field for areas of study and development and a few substantial projects are already under way.

Industrial and governmental communications satellites appear practical and economically sound. Communication satellites will provide high quality and inexpensive telephone and general communication service between most parts of the earth. A by-product of a communication satellite will almost surely be an international television relay system linking all the nations of the world. On a longer time scale it should be feasible to provide radio and television broadcasting service via satellite-mounted transmitters. Such systems would give the quality broadcast reception now only available in and near urban areas to most of the inhabitants of the earth.

Satellites containing reliable beacons can be used to provide improved means of navigation for aircraft and ships at sea and can greatly advance the field of geodetics.

[18] Proper use of the information gathered by meteorological satellites should greatly increase our understanding of meteorology. With more knowledge of meteorology and with world-wide data frequently available from the satellites, longer-range and more reliable weather predictions should be possible. These projects, dreams a decade ago, bridge areas of technical specialty in which this nation is unexcelled. The United States has the most advanced communication system in the world, with a vast scientific and technological base supporting the communications industry. We are preeminent in the development of our electronic skills in radio, television, telephone and telegraphy. This entire industrial-scientific base is available to apply its art through satellite systems to the civilian needs of the world.

The exploitation of a new area of industrial opportunity for civilian use is normally left by our government to private enterprise. However, in the case of these important space systems, the development investment required is so large that it is beyond the financial resources of even our largest private industry. Furthermore, the use of commercial space satellites will require physical support of government installations as well as financial support.

All of the civilian satellite projects listed here will have direct or indirect military usefulness as well. Furthermore, communication and navigation systems of the type envisaged would be extremely useful in implementing an inspection system which might accompany a disarmament agreement. For these reasons projects of the type proposed might well be undertaken in cooperation with the military services.

We recommend that a vigorous program to exploit the potentialities of practical space systems. The government, through NASA or the Department of Defense, should make available the required physical facilities as well as any extraordinary financial support required to make the undertakings successful.

Organizational machinery is needed within the executive branch of the government to carry out this civilian space program.

[19] **Summary of Recommendations**

1. Make the Space Council an effective agency for managing the national space program.
2. Establish a single responsibility within the military establishments for managing the military portion of the space program.
3. Provide a vigorous, imaginative, and technically competent top management for NASA, including:
   (a) Administrator and deputy administrator
   (b)
      i. A technical director for propulsion and vehicles
      ii. A technical director for the scientific program
      iii. A technical director for the non-military space applications
      iv. A technical director for aerodynamic and aircraft programs.
4. Review the national space program and redefine the objectives in view of the experience gained during the past two years. Particular attention should be given the booster program, manned space technology, military uses of space to the civilian activities of the country.
5. Establish the organizational machinery within the government to administer an industry-government civilian space program.

Document III-6

Document title: John F. Kennedy, Memorandum for Vice President, April 20, 1961.

Source: Presidential Files, John F. Kennedy Presidential Library, Boston, Massachusetts.

This memorandum led directly to the Apollo program. By posing the question "Is there any...space program which promises dramatic results in which we could win?," President Kennedy set in motion a review that concluded that only an effort to send Americans to the Moon met the criteria Kennedy had laid out. This memorandum followed a week of discussion within the White House on how best to respond to the challenge to U.S. interests posed by the April 12, 1961, orbital flight of Yuri Gagarin.

[1] April 20, 1961

MEMORANDUM FOR
VICE PRESIDENT

In accordance with our conversation I would like for you as Chairman of the Space Council to be in charge of making an overall survey of where we stand in space.

1. Do we have a chance of beating the Soviets by putting a laboratory in space, or by a trip around the moon, or by a rocket to land on the moon, or by a rocket to go to the moon and back with a man. Is there any other space program which promises dramatic results in which we could win?

2. How much additional would it cost?

3. Are we working 24 hours a day on existing programs. If not, why not? If not, will you make recommendations to me as to how work can be speeded up.

4. In building large boosters should we put our emphasis on nuclear, chemical or liquid fuel, or a combination of these three?

5. Are we making maximum effort? Are we achieving necessary results?

I have asked Jim Webb, Dr. Weisner, Secretary McNamara and other responsible officials to cooperate with you fully. I would appreciate a report on this at the earliest possible moment.

John F. Kennedy

Document III-7

Document title: Robert S. McNamara, Secretary of Defense, Memorandum for the Vice President, "Brief Analysis of Department of Defense Space Program Efforts," April 21, 1961, without attachment, "Resume of Existing Programs."

Source: Lyndon Baines Johnson Library, Austin, Texas.

This document was the initial Department of Defense response to the review requested by President Kennedy in his April 20 memorandum. Some of the language in this response also appeared in the May 8 recommendations that formed the basis for Apollo and other elements of an accelerated space effort.

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[1] It is the purpose of the memorandum to outline views with respect to major space programs. This document cannot be adequately supported by detailed analysis at this time. A more complete review is currently under way which will result in a first report on 28 April. That report will include an appraisal in considerable detail of our posture with respect to the Soviets. It will also comment on the Gardner Report and views expressed elsewhere concerning the conduct of our space programs and their proper objectives.

A. General:

1. Programs in space must be undertaken for a variety of reasons. They may be aimed at gaining scientific knowledge. Some, in the future, will be of commercial value. Several current programs are of potential military value for functions such as early warning.

2. All large scale space programs require the mobilization of resources on a national scale. They require the development and successful application of the most advanced technologies. Dramatic achievements in space, therefore, symbolize the technological power and organizing capacity of a nation.

3. It is for reasons such as these that major achievements in space contribute to national prestige. This is true even though the scientific, commercial or military value of the undertaking may, by ordinary standards, be marginal or economically unjustified.

4. What the Soviets do and what they are likely to do are therefore matters of great importance from the viewpoint of national prestige. Our attainments constitute a major element in the international competition between the Soviet system and our own. While the future military value of advanced space capabilities cannot be predicted very well, it, nevertheless, [2] is important to insure that the basic technological building blocks are created in an orderly and timely manner. These building blocks, moreover, must give us capabilities which match the Soviets in all areas of international competition.

5. Because of their national importance and their national scope, it is essential that our space efforts be well planned. It is essential that they be well managed. It is particularly undesirable in this connection to undertake crash programs needed to compensate for inadequate planning. It is likewise undesirable to spread our engineering resources too thinly. It is doubtless necessary to sponsor parallel efforts in the design stage, but it is essential to avoid duplication in the advanced development, procurement and deployment of operational equipment.

The comments in the following paragraphs are based upon these and similar assumptions. They deal with two major areas: launch vehicles and payload recovery.*

B. Launch Vehicles:

It is important from a national standpoint that the launch vehicle "gap" presently separating Soviet and U.S. capabilities be closed in an orderly but timely way. It is also important that our capabilities in the 1965-1970 period continue to grow so that similar important gaps are avoided. There will come a point, of course, at which a superior capability on the part of the Soviets or ourselves will be of little importance since either capability will suffice, but that point will not be reached for many years.

1. **The Current "Gap":**

1.1 The ATLAS-CENTAUR development should continue. If it is successful, it will enable us to boost 8,500 lbs. into a 300-mile orbit which still does not match the Soviet's capability of placing 10,000-14,000 lbs. into a 300-mile orbit.

1.2 CENTAUR like other developments is not assured of success. A substantial delay or major development shortcomings would be serious.

[3] 1.3 It is important, however, that our national launch vehicle program focus on a very small number of devices. A major element in the success of the Soviet program is the orderly, focussed way in which they have placed continued emphasis on the repetitive use of a single booster and a very small family of upper stages.

1.4 It would seem desirable, however, to inaugurate one or two back up programs for ATLAS-CENTAUR. An example would be an advanced upper stage for use with TITAN-II. Another might be a high boost segmented solid rocket booster for use with existing AGENA stages or possibly with an advanced AGENT. There is even the possibility of developing an upper stage using different propellants. It is not possible to decide at this time, but the results of current studies will make it possible to recommend action which fits into an improved over-all plan.

2. **Follow-on Efforts:**

2.1 The SATURN C-1 consisting of a cluster of eight chambers will give a total thrust of about 1.5 million pounds. It is unlikely to become operationally useful for missions such as manned orbital flight until after 1966. Should it prove inadequate or subject to excessive delays, a serious gap in boost capability would develop even if the early undertakings listed above were wholly successful.

2.2 The SATURN, depending as it does upon the clustering of very complex engines, may present very serious reliability problems. It seems almost certain that it will not

*Attachment A summarizes the Department of Defense space projects and shows the budgetary changes that were made as a result of the detailed review of FY-62 budget estimates. No further changes in funding levels for FY-62 are recommended for these programs.

be fully usable in its present form for the DYNASOAR mission. For such reasons it appears likely that a suitable parallel effort should be undertaken to insure that present planning and programming provides adequate insurance against the development of a launch vehicle gap in the 1965-1970 period.

2.3 The F-1 engine capable of developing 1.5 million pounds thrust in a single chamber should be more vigorously pushed. Detailed design studies for a suitable first stage utilizing this engine should be undertaken at once. After assessment and analysis, long lead time procurement and development efforts should be begun which give us the opportunity to accelerate and back this route to a 1 $^1/_2$ million pound booster if SATURN's progress warrants such a decision.

2.4 Other possibilities also present themselves. Upon further investigation it may be desirable to augment the development of large segmented [4] solid rocket boosters capable of 50-70 million pounds/second thrust. Other proposals such as the development of a high pressure hydrogen-oxygen cluster booster should also be investigated.

2.5 It is important to make sure that the number of such programs is adequate but not excessive. It is essential that engineering resources be focused and not spread too thin. It is vital that hard decisions be made at the critical decision points. Such decisions will include the total termination of unprofitable ventures and the deployment of fiscal and human resources on the highest priority and most promising undertakings.

2.6 It is difficult to estimate at this point the magnitude of the efforts which might be initiated to supplement the SATURN development. It is not unlikely, however, that as much as 50-100 million dollars of additional funds might be utilized in FY-62. These funds represent people and facilities. It is mandatory that policies be followed which utilize and strengthen existing organizations. Our national posture may be worsened rather than improved if added expenditures result in the still greater dispersal of scientific engineering and managerial talent among a variety of organizations too small or too over-loaded to do a fully adequate job.

C. Payload Recovery:

The Soviets have developed a recovery system which enable them to recover large payloads with a comparatively high degree of landing accuracy. This capability is essential to the success of manned experiments in space and is important to the success of many other space missions.

The U.S., however, has developed only the DISCOVERER type of recovery system. It is complex and has not proved to be very reliable.

The MERCURY system using parachutes is not very accurate and requires search operations of an enormous sea area.

The DYNASOAR system will not be testable for many years. Hundreds of millions of dollars will be required before maneuverable entry from orbit can be demonstrated.

It seems most desirable, therefore, to undertake the development of a controlled reentry and recovery system emphasizing simplicity, modest accuracy and high reliability. It is not likely that a recovery system per se will prove desirable. Rather, the development of a standardized space vehicle equipped with such a recovery system and incorporating standardized propulsion [5] and control components is likely to be most attractive. If it is large enough, such a vehicle can be used to carry a great variety of payloads with comparatively minor and largely internal modifications. This aspect of our planning for the future has not been addressed in much detail. It is difficult, therefore, to estimate the amount of additional funds which may be required to begin developments in this direction. It would appear, however, that the amounts involved in FY-62 could be comparatively modest.

Robert S. McNamara