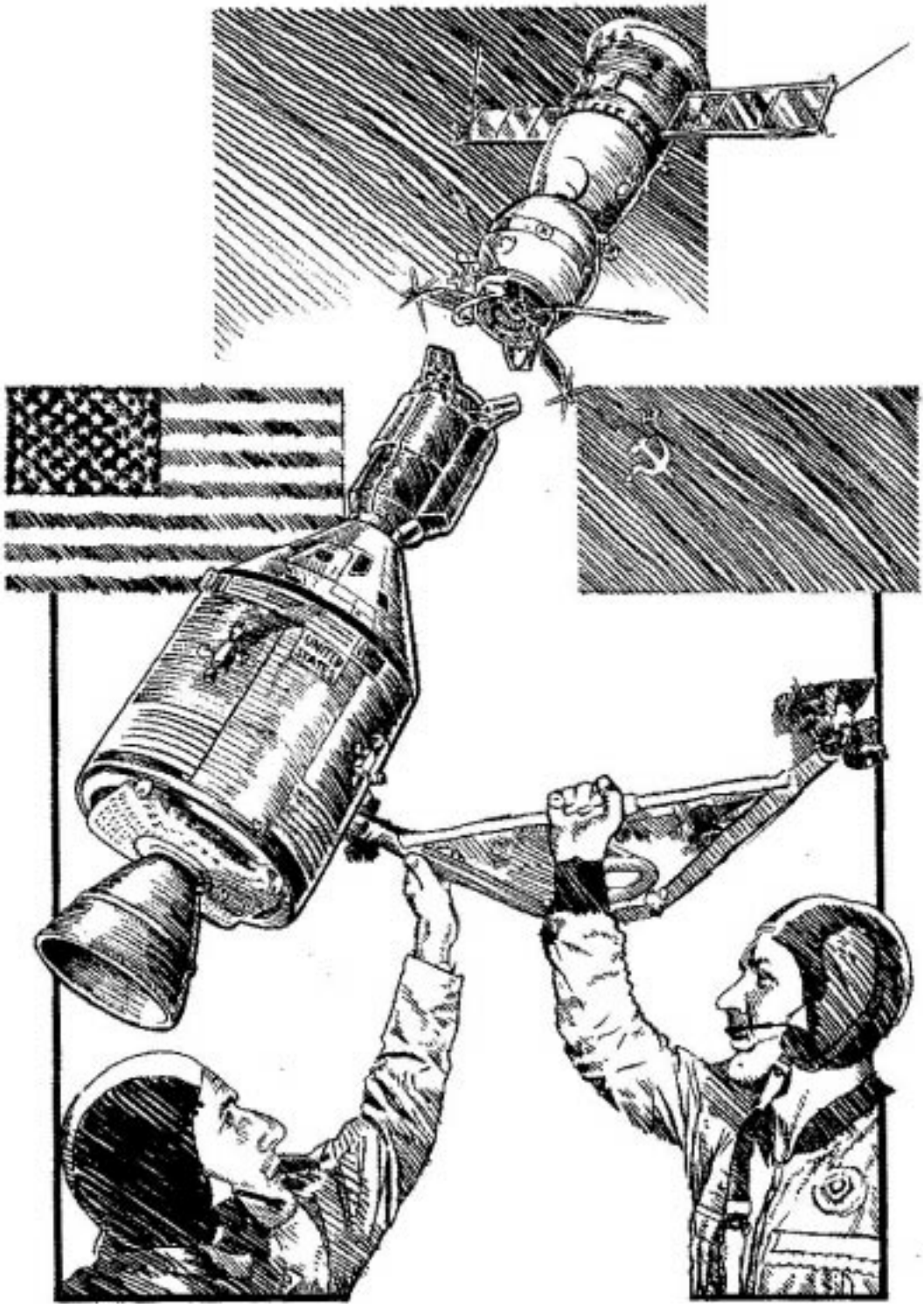


CHAPTER 10: "After Apollo, What Next?"

At the height of the successes of the Apollo program the Nation entered a period of great malaise about space. Even as the astronauts spent almost 3 days on the lunar surface during each of the last three Apollo missions pursuing scientific objectives and research that might broaden human knowledge, NASA and its space programs were on the defensive. While Americans walked and drove a lunar vehicle on the surface of the dusty, rock-strewn surface of the Moon, the earthly ground from which these operations were conceived, constructed and flown became shifting sands of public opinion.

"What are the causes of this phenomenon?" asked Congressman Olin E. Teague, Chairman of the House Subcommittee on Manned Space Flight and a vigorous proponent of American space programs. That "continuing, strong sense of public pride in our space program," that "exhilaration that culminated magnificently" with the Apollo landing on the Moon has passed, Teague noted in 1971. Apathy had set in, "or worse," the space program came under abuse and attack. Why, in the restructuring of national priorities, a restructuring that began well before the flight of Apollo 11, had space slipped close to last, Teague wondered?[1]

In the time between the flight of Apollo 14 in February 1971 and Apollo 17 in December 1972, NASA, American space programs, and the Manned Spacecraft Center met some of their most formidable challenges. NASA's post-Apollo future became entangled in the web of politics, budget cuts, and Apollo program prerogatives. Apollo had its nemeses from the beginning. Its costs were one. Its seemingly single, goal-oriented lunar landing objective was another. War and welfare, and specifically the cold war and the War on Poverty, were others. The close of the Saturn-Apollo program and the confusion and indecision that finally brought NASA into the post-Apollo world of spaceflight is somewhat complex and convoluted.

Although President John Kennedy's memorable charge to the Nation in 1961 to send a man to the Moon and return him safely to Earth helped galvanize the Nation's energies, it was so singly goal-oriented that having been achieved there was nothing further to do. For example, American political parties with single goals, such as free silver or prohibition, rarely survived the accomplishment of their goal. Even in the early years of Kennedy's administration and certainly during Johnson's administration, America's space programs and the focus on space began to be diluted by many new and growing concerns.

The cold war helped define America's goals in space, but it also erected a host of countervailing social and economic forces or conditions. Cuba and the Bay of Pigs diverted American energies. Construction of the Berlin Wall, begun in August 1961, deflected public attention to Europe for much of the decade. The Cuban missile crisis in October 1962 brought the United States to the very brink of war with Russia. President Kennedy was assassinated in Dallas on November 22, 1963. In the 1960's hundreds of thousands of refugees fled to the United States from Cuba, Hungary, and East Germany. Lyndon Johnson declared war on poverty in 1964, and American military forces began bombing North

Vietnam in an undeclared war in southeast Asia. Racial confrontations and violence erupted in the cities—Los Angeles, Chicago, Atlanta, among others—and Martin Luther King died from an assassin's bullet in Memphis in 1968. Gross national product almost doubled during the decade of the 1960's and so did federal expenditures. The rate of inflation more than doubled. The decade in which the plan to put an American on the Moon and return him safely to Earth was one of America's best of times and one of its worst. In retrospect, it is perhaps remarkable that America's manned spaceflight program occupied so great a part of the Nation's energies and interests. It was one thing, despite problems such as the AS-204 fire, that seemed to be going right.

During the same few years (between 1958 and 1962) that Mercury, Apollo, and Gemini programs were conceived and initiated, NASA and aerospace industries began giving thought to programs that might go beyond the Apollo lunar landing. What might be logical extensions of the Apollo-Saturn effort? How could the technology, expertise, and capital generated from Apollo be applied to other ventures in space or on Earth? While it concentrated its energies and resources on building machines that could carry humans into space, NASA and MSC did consider tangentially what those people might do once they arrived in space, and how Apollo might be harnessed to other tasks. The final Apollo missions and the almost anticlimactic Apollo-Saturn Skylab and Apollo-Soyuz sequels are critical elements of a NASA search for identity that became very intense throughout the decade of the 1970's.

As early as 1959, a NASA committee headed by Harry J. Goett, which included George Low and Max Faget as members, established a general framework for NASA space missions and established a tentative priority for those missions. The outline included Mercury, unmanned probes, a "manned satellite," a manned spaceflight laboratory, and a Mars or Venus landing. The committee suggested the following NASA missions in order of their priority:[2]

1. Man in space soonest—Project Mercury
2. Ballistic probes of the planets
3. Environmental satellites
4. Maneuverable manned satellite
5. Manned spaceflight laboratory
6. Lunar reconnaissance satellite
7. Lunar landing
8. Mars-Venus reconnaissance
9. Mars-Venus landing

The maneuverable manned satellite would have been a vehicle parked permanently in orbit and used for communications, electronic data gathering, and navigation, but without the capacity to return to Earth. The manned spaceflight laboratory became a prototype for Skylab and provided a conceptual beginning for the later space station. Remarkably, this 1959 study established a basic design for future space programs and instigated considerable thought. Ideas and preliminary designs for spacecraft and space station configurations began to appear from a variety of sources within and without NASA.

By 1962, aerospace engineers and managers were seriously deliberating and studying the feasibility of a permanent space station orbiting Earth as a laboratory and staging platform for manned flights to Mars. McDonnell Aircraft proposed a one-person space station based on a Mercury capsule. Rene A. Berglund at Langley proposed an inflatable laboratory extending from a Mercury spacecraft nucleus. A NASA Headquarters staff study headed by Bernard Maggin recommended development of a manned orbital facility. The Space Task Group at Langley (before its designation as MSC) considered using an Apollo spacecraft and a Saturn second stage for an orbiting laboratory, and asked assistance from Ames Research Center. Canada's AVCO Corporation proposed a Gemini-Titan configuration for a space station in 1962.[3]

The Langley Research Center (within Langley's Spacecraft Research Division) created a Space Station Program Office headed by Edward H. Olling, which initiated preliminary studies of structures and configurations, life systems, operations and logistics, docking and rendezvous mechanisms, and associated engineering studies. In July and August 1962, Langley held a formal debriefing, attended by Robert Gilruth, Max Faget, Aleck Bond, Charles W. Mathews, Walter Williams, Paul Purser and others, effectually transferring the information and part of the responsibility for manned space station work to the MSC being established in Houston.[4]

Concurrently, Lewis Research Center, the newly established Marshall Space Flight Center, and other aerospace industries, including North American Aviation, were examining space station configurations. Goodyear Aircraft Corporation developed models and prototypes of an inflatable 150-foot diameter space station which were submitted for review and consideration to teams at Langley Research Center (in 1961) and Lewis Research Center (in 1962). Gene McClard, with Marshall Space Flight Center's Saturn Systems Office, formally presented Marshall's proposal for an inflatable-type space station (which it referred to as an inflatable-structures experiment) to NASA's Management Council in October 1962. Douglas Aircraft also developed, at Wernher von Braun's request, an unsolicited proposal to adapt a Saturn-IVB stage as an Earth-orbiting, manned space laboratory. As early as 1952, before Sputnik and NASA, Von Braun had proposed an "artificial moon" space station concept employing a fixed hub and an inflated, rotating doughnut-shaped outer chamber. Later, MSC and Langley researchers rejected inflatable structures as being unsuitable, undesirable, or not feasible for a man-occupied space station given the emerging likelihood that a space shuttle system could deliver the materials for a large, permanent station into orbit at a reasonable cost. It is interesting, however, that Grumman designed a Mars mission on the hypothesis that a space station would be an intrinsic part of such a mission because not only would a mission require an orbiting station as a staging base, but any interplanetary vehicle would necessarily resemble a space station as a long-duration habitat for humans.[5]

The Air Force canceled its X-20 Dyna-Soar project in 1963 and began work on a manned orbiting laboratory. NASA continued studies of a manned orbital research laboratory at Langley, while MSC pursued designs for an Apollo "X" two-person orbiting laboratory using an Apollo LM. MSC also worked on the preliminary design of an Apollo orbital research laboratory and a large orbital research laboratory. At Headquarters in December 1964, Joseph F. Shea began discussing with Samuel C. Phillips the Apollo missions that might follow a successful Moon landing. Senator Clinton P. Anderson,

Chairman of the Senate Committee on Aeronautical and Space Sciences, recommended to President Johnson that the Air Force manned orbiting laboratory program be merged with NASA's Apollo X program. NASA and the Department of Defense promised to collaborate but to preserve the integrity of each program. During the spring of 1965, the Office of Manned Space Flight and MSC, with contractor support from North American, Boeing Company, and Grumman Aircraft Engineering, conducted an intensive study of Apollo Extension Systems—that is, a study of missions or programs that might logically follow the completion of a lunar landing using Apollo systems and knowledge. Max Faget chaired the briefing before a large NASA audience at MSC in May.[6] Although no firm proposals developed from the conference, serious thought began to be applied to post-Apollo possibilities within and without NASA.

Olin E. Teague's NASA Oversight Subcommittee (of the House Committee on Science and Astronautics) began gathering information from NASA center directors about "where you feel your center should be going into the 1970's." His concern, Teague said in a letter to Bob Gilruth at MSC, had to do with future efforts and future center missions. Gilruth promised a full staff analysis of MSC's organization, functions and personnel requirements given several alternative missions. Teague addressed similar letters to Administrator James E. Webb and Secretary of Defense Robert McNamara. He also requested status reports from major Apollo subcontractors (Grumman and North American). James Webb visited MSC twice in August 1965 to discuss Apollo missions after a lunar landing. Webb stressed that such missions should use "off-the-shelf" hardware and be "cheap." In early September, Gilruth invited "serious consideration" by his staff on the next major mission to be undertaken by the manned spaceflight program.[7]

The Senate Committee on Aeronautical and Space Sciences held hearings on "Space Goals for the Post-Apollo Period" in late August 1965. George Mueller advised the committee members that NASA planned Apollo flights with experimental packages, extended orbital missions, and extended lunar surface missions. The post-Apollo period, he explained, included programs emphasizing Earth-orbital missions that would produce direct economic benefits. Communications satellites would be one such benefit. Other program alternatives included extensive lunar exploration and operations; planetary exploration and scientific missions; a combined "maximum effort" program; and finally, a balanced, cost-effective combination of Earth orbit, lunar and planetary exploration, and science. Only a few weeks prior to his testimony, Mueller established a Saturn-Apollo Applications Program Office, headed by Major General David Jones, detailed to NASA by the Air Force, with John Disher as deputy director. As David Compton and Charles Benson commented in their history of Skylab, by 1965, well before the first successful manned flight of Apollo, NASA had given 6 years to space station study and at least 3 years to post-Apollo planning.[8]

It is significant that the inception and development of the Apollo program occurred within a broad conceptual framework that included space stations, unmanned probes, orbiting laboratories, a shuttle transport system, and manned lunar and planetary missions. The lunar landing objective provided a sharp, definitive focus for space initiatives, but possibly also resulted in narrowing and limiting those objectives. The several billions of federal monies being directed annually to NASA also created criticism and dissent from

potential beneficiaries of federal spending. Defense and welfare programs, as well as the traditional local "pork barrel" type funding all had growing appetites. Even those who supported NASA program funding argued over the program distribution of those funds. Scientists became increasingly restive, arguing that unmanned satellite programs would produce greater knowledge and scientific benefits than the far more expensive manned lunar landing program. This dissent, in part, contributed to NASA's decision to use Apollo systems for scientific investigations in space.[9]

By 1965, Congress' funding approach to the space program had changed from "what can we do for you?" to "what can you do without?" It got worse. By 1966, Congress and the administration were no longer asking what NASA could do without, but were deciding for themselves what NASA might do without. The spiraling costs of defense, military commitments in southeast Asia, and Great Society social programs pressed heretofore seemingly unlimited federal resources and fueled fears of inflation. Following a program review by the Bureau of the Budget, in Congress Teague's NASA Oversight Committee began a review of Apollo program costs, progress and program management. While that was going on, Vice President Hubert Humphrey pledged the administration's continued support for space programs in a speech to the Aerospace Industries Association in Williamsburg, Virginia, but he explained that "immediate national security requirements have necessarily limited the funds available" for space. This is regrettable but inevitable, he said. In the future, the space program must accept as its guiding principle "to get the largest possible return on the public funds we have already put into facilities, trained manpower, boosters, spacecraft, and all our other accumulated space assets." It means, he said, that we must exploit to the maximum all that the Apollo program has produced for us, and that we do not start from scratch after the Manned Orbiting Laboratory program, but that we seek out every possible application of that hardware and expertise. Humphrey talked about communications satellites, research in space, environmental benefits that might be derived from space surveillance, international understanding and cooperation in space, and the energizing force derived from space programs that permeates the economy. But he also implied that funding for space programs would be decreasing, not increasing. In direct communication with Administrator Webb, President Lyndon B. Johnson was more explicit. He told Webb, "by God, I have got problems and you fellows are not cooperating with me. You could have reduced your expenditures last year [1965] and helped us out, you didn't do it!"[10]

On the House floor during the appropriations debate in August 1966, Congressman Teague blamed NASA for a lack of advanced planning and warned the Agency that "space does not have the same high priority it once had." As if to illustrate the point, the Senate staved off several attacks on NASA's budget by declining margins. Senator William Proxmire, who led separate moves to reduce space spending by first half a billion dollars and then by $150 million, said that NASA would still be "a fat cat" even if it lost the $150 million. Administrator Webb called for a national debate on where the Nation wanted to go in space, and warned that much of the momentum and investment in space might be lost unless new goals were chosen and funding sustained. Teague supported the call for a national debate, but a comprehensive study by his staff placed the burden for recommending broad objectives on NASA. It asked the Agency to establish specific missions and to identify the costs and benefits associated with each—no later than December 1. Teague's

439-page staff study, headed by James E. Wilson, asked for a reevaluation of space programs in the light of President Johnson's Great Society goals and the budgetary constraints caused by the war in Vietnam.[11]

At a symposium sponsored by the American Institute of Aeronautics and Astronautics (AIAA) in October, panelists responded to the general question, "After Apollo, What Next?" News moderator Peter Hackes said that Congressman Teague had repeatedly posed the question of a post-Apollo program and the need to define it *now*. "Obviously, Vietnam has affected NASA's budget as it has all other governmental agencies," but although budget problems will affect the scheduling of future missions, they do not preclude the establishment of goals. And then he asked Edward C. Welsh, Executive Secretary of the National Aeronautics and Space Council, to describe the administration's position on future space goals. Welsh responded very briefly that there would be future space goals and that the key would be to defining the proper mix. An observer at the hearings later told Teague that everyone present felt that the reply was "completely nonresponsive."[12]

The fact was, according to a private study conducted by Thomas D. Miller (a financial analyst for Arthur D. Little, Inc.), NASA had been too preoccupied with the lunar landing program to give much thought to longer range goals. In truth, although Welsh obviously understated the situation, NASA did have rather well enunciated program goals, but now the problem had become establishing priorities and as Welsh said, "the proper mix." Moreover, although NASA had a coherent plan for the next 20 years of spaceflight, the escalation of the Vietnam War and Great Society programs had reduced the priority of spaceflight in the minds of decision makers. Economies were being forced on NASA and all nondefense government activities. Miller estimated that sustaining NASA flight programs would require a fiscal year 1968 budget level of $5.5 to $5.6 billion, rising to $7 billion by 1976. Although pessimistic on achieving that level of funding, Miller believed that NASA programs would be supported at a lower level because of the continuing competition with the Soviet Union, and because the space program employed a large proportion of the Nation's scientific and technical personnel and contributed significantly to the financial health of the aerospace and electronics industries.[13]

The reality of budgetary constraints and the mismatch of future planning with budgetary projections began to affect and alarm NASA center managers. Gilruth sent George Mueller an analysis of what he believed to be a critical situation, with copies to Wernher von Braun and Kurt Debus. Gilruth said that his concerns stemmed in part from the lack of a definite goal or direction for the future of manned spaceflight. Future program planning, he advised, was employing a launch rate higher than the in-line Apollo launch rate. Apollo Applications Program (AAP) missions proposed to use Apollo hardware for purposes "differing significantly" from those intended. Gilruth feared that economic considerations were driving future plans to use equipment in ways that were inconsistent with its technical capabilities. Moreover, the many changes going on in AAP plans, occasioned by a "steadily shrinking" AAP budget, were causing the diversion of management attention, effort, and funding from the mainline Apollo programs. Gilruth strongly urged support for a large, permanent, manned orbital space station, and strongly advised against using the LM for any operations other than that for which it was specifically designed. He suggested more use of unmanned lunar probes, better and more accelerated mission planning, fewer and

more efficient missions, and improvement in the quality of projected scientific experiments. There was, Gilruth believed, a critical mismatch between AAP planning, the opportunities for manned spaceflight, and the resources available.[14] Effective planning required close cooperation between Headquarters and the technical centers and that was not always evident. Headquarters, in fact, tended to reserve planning as its primary duty, while the centers concentrated on development and operations.

The budget and future planning crises became more acute as Congress began deliberating the federal budget for 1968 and the war in Vietnam consumed more money and more American lives. Walter G. Hall, a friend of Olin Teague's who lived in Dickinson, Texas, near MSC, reported to Teague in January 1967, that "morale among many of the folks at NASA seems to be deteriorating." Some of them, he said, "feel that there is nothing in 'the mill' after the Apollo program." Hall asked Teague to send him comparative figures for MSC employment over the past 3 years with projections for 1967. Teague answered:

> The truth of the matter is, Walter, I am surprised that the morale of the space people is not lower than it is. We do not have a follow-on program as we should have—all because of money.

Teague predicted a nationwide decline in the number of space program employees in 1967 from 400,000 to 200,000 people. Grumman employment at Bethpage, New York, had peaked and was going down very rapidly. More would be known after the President's budget message (January 24), Teague wrote, and he promised to have some good information when he came to Houston.[15]

J.P. Rogan, Vice President and General Manager for Douglas Aircraft's Missile and Space Systems Division, said that our Nation *must* answer the post-Apollo question and "very soon! Apollo is only a beginning!" We must convert the beginning technology derived from Apollo into building blocks of future space capability. The blocks include a long-duration orbital experience, reusable spacecraft, reusable launch vehicles, nuclear powered rocket stages, and improved secondary power systems. An orbital laboratory would require a reusable spacecraft (but not necessarily a reusable launch vehicle), and he estimated that the evolution of an operational reusable spacecraft would require at least 9 years of development.[16] What would become the Space Transportation System (STS), or Space Shuttle, began to emerge from the exigencies of a national (and NASA) budget crunch.

Budget concerns also reinforced a more conservative or practical approach to space. The President's Science Advisory Committee estimated that total government expenditures on space in 1967, including NASA ($4.9 billion), the Department of Defense ($1.6 billion), the Atomic Energy Commission ($181 million), and a small allocation to the Environment Sciences Service Administration, totaled $6.7 billion. The Science Advisory Committee recommended a limited extension of Apollo programs for the purposes of lunar exploration, upgrading the unmanned program for the exploration of nearby planets, a program to prepare the technology and personnel for long-duration flight, vigorous exploitation of space applications for "national security and the social and economic well-being of the Nation," and exploitation of near-Earth orbit scientific and astronomical experiments and research. The committee recommended construction of a permanent space station in the mid-1970's,

but advised that a decision could await biomedical studies and a decision on the desired pace of effort toward manned planetary travel. The report urged a better mix of manned and unmanned programs and advised that economic benefits from space operations would more likely be derived from *unmanned* rather than manned vehicles.[17] Although industry, scientists, politicians, and NASA administrators all agreed that the United States should clarify the post-Apollo program, by the close of 1967 no firm objectives had developed other than the objectives imposed by budgetary constraints—and those were significant.

NASA's congressional appropriations peaked in 1965 at $5.25 billion and began a steady decline thereafter. Congress, of course, as Arnold Levine explains in his study of NASA management, was not solely to blame for NASA budget reductions. The Bureau of the Budget (later the Office of Management and Budget), responsive primarily to the Executive Office, reviewed NASA's budget requests before they went to Congress. After 1967, the Bureau acted on the premise that the White House would no longer intervene, but would tacitly approve any NASA budget reductions. Thus, prior to congressional action, the Bureau began curtailing budget requests, forcing NASA to choose between programs the agency believed were merely desirable and those deemed essential to the Agency's mission.[18]

Among the very specific results of congressional and Bureau of the Budget fiscal constraints were canceling 2 scheduled Apollo Moon flights (reducing the number to 17), reducing Surveyor unmanned flights from 10 to 7, closing NASA's Electronic Research Center in Boston, freezing the critical NASA "excepted" positions to 425, canceling

TABLE 6. NASA Budget Requests and Appropriations FY 1959 to 1971 (millions of dollars)

Fiscal Year	Administration Request	Amount Appropriated	Percent Cut
1959	$ 280.0	$ 222.8	20.4
1960	508.3	485.1	4.6
1961	964.6	964.0	—
1962	1,940.3	1,825.3	5.9
1963	3,787.3	3,674.1	3.0
1964	5,712.0	5,100.0	10.7
1965	5,445.0	5,250.0	3.6
1966	5,260.0	5,175.0	1.6
1967	5,012.0	4,968.0	0.9
1968	5,100.0	4,588.9	10.0
1969	4,370.4	3,995.3	8.6
1970	3,715.5	3,696.6	0.5
1971	3,333.0	3,268.7	1.9

Source: Thomas P. Murphy, Science, Geopolitics, and Federal Spending (Lexington, Mass.: Health Lexington, 1971), 364.

NASA's NERVA (nuclear) rocket research inherited from the Atomic Energy Commission, and eliminating developmental work on a large solid-fuel rocket engine and a smaller liquid hydrogen engine. Budget office "suggestions" in 1966, reinforced by recommendations of the President's Science Advisory Committee in 1967, led to the closing of the Air Force's manned orbiting laboratory program and the transfer of its hardware and astronauts to MSC in 1969. Future programs, such as the AAP, were particularly vulnerable to budgetary pressures.[19] Thus, even as Congress and the public wondered "After Apollo, What Next?", the answer was: less and less.

AAP funding, that is, the budget for post-Apollo planning and operations, suffered severely. First funded as the Apollo Extension System in 1966, NASA allocated $51.2 million to future planning from its total budget of $5.175 billion. The figure rose to $80 million in 1967. In 1968, under pressure from Congress and the Executive Office, NASA requested $454.7 million for its AAP, received $347.7 million, but then was forced to allocate only $253.2 million in order to cover shortages elsewhere. Webb convened a post-Apollo advisory group, chaired by Dr. Floyd Thompson from Langley Research Center and including center directors, which met variously at Washington, D.C., and each of the three manned spaceflight centers during 1968. That advisory group discovered "unresolved difficulties" with projected post-Apollo programs rather than reaching agreement on future programs.[20]

Paul Purser, special assistant to the director, and others at MSC were of the opinion that, while the center should take the lead in developing future manned spaceflight program options, there would be no real budgetary enabling action until either a successful completion of the lunar landing mission or a sudden and large reduction in Department of Defense spending.[21] Perhaps in part because of this philosophy, and because indeed MSC itself was by no means declining or experiencing current budgetary difficulties, but rather was operating at its peak and maximum effort during the Apollo flights in order to achieve a lunar landing before the end of the decade, MSC focused on its present, real-time, operating program.

The successful lunar landing by Apollo 11 in July 1969, sparked a wave of optimism throughout NASA regarding the viability of future Apollo applications. George Mueller, Apollo program head at Headquarters, summarized NASA's goals in a teletype message to "all stations" in September. Mueller suggested that while the Apollo program had served the Nation well by providing a clear focus for the development of space technology, a balanced program was needed which would focus on a manned planetary landing in the 1980's. The memorandum identified two directions for manned spaceflight programs. The first involved the further exploration of the Moon with possibly the establishment of a lunar surface base. The second was the continued development of manned flight in Earth orbit leading to a permanent manned space station supported by a low-cost shuttle system. The projected schedule included the operation of two Saturn V-launched Earth-orbital workshops (1972 and 1974), a lunar orbiting station in 1976, and an Earth-orbit space base with a possible Mars landing in 1990.[22]

This rather startlingly clear future programs definition was derived in part from intensive studies during the previous 6-month period by a NASA task group headed by Milton Rosen. Rosen's group reported to Homer Newell, who chaired a NASA Planning

Steering Group. Newell's group in turn coordinated its work with a Special President's Space Task Group created by Richard M. Nixon after his election in 1969. The Space Task Group included the Vice President, Secretary of Defense, NASA Administrator, the President's Science Advisor, and observers from the Department of State, Atomic Energy Commission, and Bureau of the Budget. The Space Task Group presented a strong endorsement for continuing space activities using existing and to-be-developed capabilities. It supported the development of a modular space station and a reusable space transportation system to serve the station. The group noted that schedules and budgetary decisions should be subject to presidential choice and determined in the normal annual budget and review process.[23] It was this report that gave Mueller and NASA a clear signal for future programs. It was in the budgetary processes, however, that future programs again clashed with fiscal realities.

Notably, although 1969 AAP budget requests totaled $439.6 million, emergency action by Congress to reduce federal spending at all levels through the Revenue and Expenditure Control Act of 1968 resulted in only $135.5 million of new money going into post-Apollo planning. In 1970, NASA submitted a request for $345 million for AAP, but Congress and the budget office reduced the operating budget to $288.1 million.[24] Thus, by 1970, the stark reality seemed to be that NASA simply could not truly answer the question, "After Apollo, What Next?"

NASA, however, had reached a consensus on its recommendations to Congress. During the House floor debate on the NASA authorization bill in 1970, Olin Teague asked Dale D. Myers (Associate Administrator for Manned Space Flight), Kurt Debus (Director of Kennedy Space Center), Bob Gilruth (Director of MSC), Eberhard Rees (Director of Marshall Space Flight Center) and Wernher von Braun (now Deputy Associate Administrator for NASA) to send him a personal letter explaining why it was important to "move forward" with the manned spaceflight program. Myers explained that post-lunar landing objectives were different from the "clearly defined national goal of the last decade." But the new multiple programs emphasizing economy and direct space technology benefits were no less challenging and important. Debus and Rees stressed the importance of developing a reusable shuttle. Von Braun said that "with the space shuttle and the space station we will have the space age equivalent of the jet liner." Gilruth, referring to the Apollo 13 mission, told Teague that "we cannot expect to push back the space frontier without some difficulty," and he stressed the reusable Earth-to-orbit shuttle as the key to post-Apollo activities.[25] Within NASA the 4- or 5-year search for its future identity had begun to bear fruit. The aura of success and at least temporary resurgence of national support and interest in space helped produce that united front. But the answer to the question, "After Apollo, What Next?" lay outside the NASA community.

NASA historian E.M. Emme, assisted by Acting Administrator Thomas O. Paine, summarized the critical transition between the outgoing administration of Lyndon B. Johnson and the incoming administration of Richard M. Nixon. Management after 1969, Paine explained, was trying to get the "greatest possible space program returns within severe dollar constraints imposed by the FY 1969 austerity budget of President Johnson and Congress." NASA was giving a lot of consideration to long- and short-term planning to help the 91st Congress in deciding NASA's future direction and level of effort. The moment was

critical. Given declining public support and lower budgets for the past 3 straight years, even after the achievement of the manned lunar landing, "NASA's future fate . . . remained far from assured." Administrator James E. Webb, who left NASA in 1968, had been replaced by an interim administrator. A Republican administration was entering the White House, but Congress was controlled by the Democratic party. Space vied for public attention in 1968 as the crew of the U.S.S. *Pueblo* was being released from an ignominious North Korean captivity. Thousands were starving in Biafra. Armed combat interrupted a truce in South Vietnam. Arabs and Israelis were on the brink of war, and Communist China exploded a fourth nuclear device.[26] It was an untimely time to decide, "After Apollo, What Next?"

Since at least 1967, NASA's budgetary and political stance had been increasingly defensive. The tone of agency-congressional relations had been to prevent budget cuts rather than to seek new funding tied to new programs. Olin Teague, among others, argued that NASA (and MSC) were remiss by failing to formulate earlier and more definite post-Apollo answers. Now, in 1970, the answer rested in Congress and the White House.

For personnel at MSC it was perhaps just as well. All hands focused intensely on the work at hand, which had to do with successfully completing the flights of Apollo. Gerald D. Griffin, who joined MSC in 1964 as a navigation and control officer on Gemini flight operations teams and began work as a Flight Director on Apollo 7, described the Apollo work as having to do with transportation research. Once we had the capability to fly, only then could we begin to think science or post-Apollo operations. From the time of MSC's creation, its engineers and personnel had their hands full with the present and gave relatively little thought to the past or the future. There was, from the inception of Mercury through the last flight of Apollo and the Skylab and Apollo-Soyuz flights, no repose or pause.[27]

Aleck C. Bond, assistant director for Chemical and Mechanical Systems under Max Faget's Engineering and Development Directorate at MSC, remembered that, at least through 1970, personnel at MSC sensed no problems or cutbacks in space program activities. At that time, personnel layoffs had occurred only among contractor support groups. Center managing engineers were all civil service employees and were secure and generally insulated from NASA budget reductions. Only in later years, Bond recalled, did the impact of the budget reductions of the 1967-1970 era become clear.[28] Center employees, caught up in the intensity and exhilaration of Apollo flights and somewhat protected from the externalities of politics and budgeting, were for the most part oblivious to problems on the horizon.

"I never saw any change in attitude or morale," Griffin commented, "especially in the operations end." Personnel had no time to worry about the world; in fact, MSC people were somewhat insulated from the world by virtue of their intense focus on their work. Houston, Griffin said, might as well have been 100 or 500 miles away. Washington, D.C., in a sense was even farther. The space center comprised a very close community. Discipline was very much like the military, but wholly voluntary. There was a close camaraderie and a sense of purpose and mission. "We had a strong government, industry, academic team. We all worked very closely to get the job done. We dealt one to one, not at arms length with our contractors. Throughout the center, and especially in Mission Control, we had a sense of arrogance—we thought we were pretty good!"[29] Although Griffin did not use the term which later became popularized, center personnel, including the astronauts, had the "right

stuff" to get the job done. Center personnel at every level became gripped by a restless energy and excitement. They were one with the astronauts, doing things they had never done before, seeing things they had never seen before.

The successful lunar landings Apollo 11 and 12, and even the harrowing flight of Apollo 13, proved the ability to fly. With the flight of Apollo 14 on January 31, 1971, NASA began to move beyond the goal enunciated by President Kennedy a decade earlier. Griffin first noticed a difference in flight operations beginning with Apollo 14. Subsequently, the installation of scientific experimental packages (the J-capsule) on Apollo 15 through 17 gave the Apollo missions a distinct scientific tilt. Those flights represented a consolidation of efforts after AS-18, 19, and 20 were canceled. Training was correspondingly more diverse and intensified. Griffin, who served as the lead flight director of the Apollo 15 and 17 missions, remembered that mission planning changed from the emphasis on flight operations to scientific experiments. As a flight director, for example, Griffin went on the geologic training missions with the crews. He learned more about geology than he had learned all his past life, he recalled. There was a big change in us, "from the scarf-over-the-neck space era, down to hard rock science."[30]

There was, after Apollo, a rather large change in Griffin's career as well. He went to Headquarters as Assistant Administrator for Legislative Affairs in 1973, then to Dryden Research Center and from there to Kennedy Space Center as Deputy Director, and from Kennedy back to Headquarters to head the Office of External Relations. In 1982 Griffin returned to the (now) Johnson Space Center to replace Chris Kraft as Center Director. Griffin retired from NASA in 1986 to head the Houston Chamber of Commerce and spearhead an effort to reinvigorate the local economy (in part through promoting space technology related industries) which was then suffering severely from the collapse of the oil boom of the seventies. Subsequently, he joined a Houston firm specializing in executive officer searches.[31] Griffin reflected, in part, the restless energy and excitement of so many of the MSC personnel who were determined to continue to do things they had never done before and see things they had never seen before. Few ever truly seemed to retire.

There was simply too much to do and it was exciting work. Changes in top management personnel at MSC after 1969 reflected the center's Apollo operations orientation. Chris Kraft left the Flight Operations Division in 1969 to become Deputy Director, and then Director of the Center in 1972 when Robert Gilruth retired. Sigurd A. Sjoberg succeeded Kraft as Director of Flight Operations, and in January 1972 became Kraft's Deputy Director. When Griffin became Center Director, he named C.E. Charlesworth (also from Flight Operations) as his deputy (1982-1983). In July 1983, Charlesworth moved to become Director of Space Operations, and Griffin appointed Robert C. Goetz, from Langley, as his new Deputy Director. Thus, many of the center's post-Apollo top managers emerged from Apollo flight operations and were in a sense one aspect of Apollo "extensions."

Apollo was a totally preoccupying "present" experience. Following some design changes resulting from the Apollo 13 cryogenic oxygen tank failure, it was time to fly again. Although the lunar objective of Apollo 14 was similar to that of its crippled predecessor, its mission and apparatus were extended to enable the astronauts to gather more information and lunar specimens. The crew of Apollo 14 were rather unique and distinctive human specimens in themselves.

Mission Commander Alan B. Shepard was one of the original seven NASA astronauts and America's first man in space. In 1969 he was grounded with an inner ear problem. Taking a desk job in the Astronauts Office, Shepard used his new "spare time" to organize a bank (which grew rapidly) in Baytown, Texas, and purchase a small bank in Houston. "The banker," as his colleagues at MSC called him, also began raising quarter horses, drilling for oil, and investing in land. But what he really wanted to do was fly. So under an assumed name (Victor Paulis), Shepard entered a hospital in California where a doctor performed a then pioneering type surgery which resolved his ear problem and got him restored to flight status.[32]

Stuart Allen Roosa, the command module pilot, joined the astronaut corps in 1966. Roosa, who was to be the backup command module pilot for Apollo 16 and 17, left NASA in 1976 to enter private business. Edgar Dean Mitchell, a native of Hereford, Texas, with a doctorate in aeronautics and astronautics from Massachusetts Institute of Technology (1964), piloted the LM. Mitchell left NASA in 1972, and founded the Institute of Noetic Sciences (having to do with the working of the mind), organized several private companies, and authored a book entitled *Psychic Exploration: A Challenge for Science*.[33] Apollo 14 left the pad at Kennedy Space Center before dawn on January 31, 1971.

Shepard and Mitchell flew the LM to the Moon's surface in the Fra Mauro highlands (that was to have been the landing site for Apollo 13) and walked, with their two-wheeled cart and equipment transporter, near the rim of Cone Crater where (during two EVAs totaling 9.5 hours) they gathered 43 kilograms (about 95 pounds) of lunar rock samples. The command module returned the crew to a Pacific splashdown almost exactly 9 days after launch. It had been a good mission, with all objectives accomplished, and returned a veritable treasure of geologic knowledge. Apollo 14 also satisfied medical officers and scientists that the elaborate quarantine procedures used to avoid Earth contamination from lunar microorganisms were no longer needed.[34] Lunar soil and space was dead. Scientific inquiry was excited and alive.

A gathering of Apollo 14 flight directors at Mission Control Center: Glynn S. Lunney (seated on the console), M.P. Frank, Milton L. Windler, and Gerald D. Griffin. Griffin, standing next to Lunney, became Director of JSC in 1982, replacing Dr. Chris Kraft.

Apollo 15, scheduled to fly on July 26, was the first of the "J" missions, containing special scientific experiments aboard

The LM "Falcon" is photographed against the barren landscape during Apollo 15 lunar surface EVA at the Hadley-Apennine landing site. Note tracks of the lunar roving vehicle in the foreground. Astronauts David R. Scott and James B. Irwin were on the lunar surface while Alfred M. Worden piloted the command module in lunar orbit.

David R. Scott photographed James B. Irwin as he worked on the lunar roving vehicle. St. George Crater is 5 kilometers or 3 statute miles in the distance beyond Irwin.

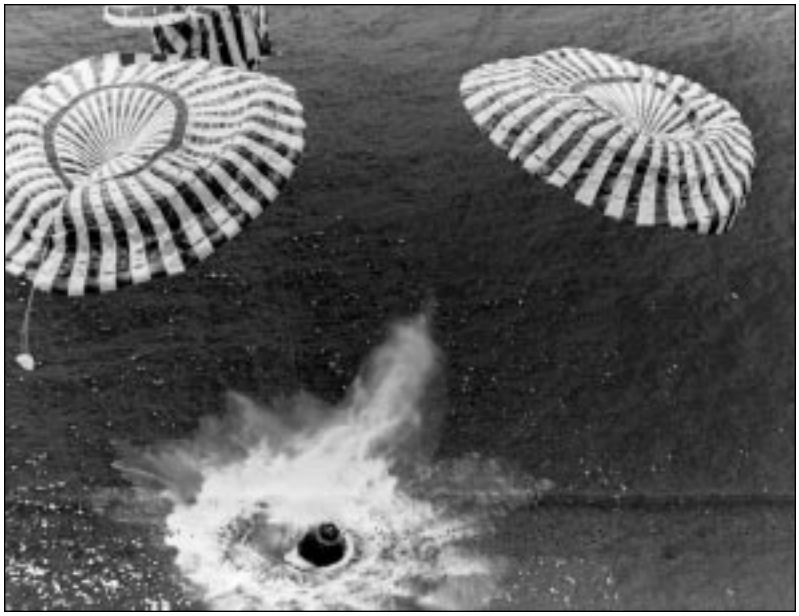
the LM, and in a special compartment of the command module for experimental work during its lunar orbits. Commander David R. Scott and LM pilot James B. Irwin took the LM to the surface of the Moon near the foot of the Apennine Mountains and adjacent to Hadley Rille. One of the most remarkable aspects of Apollo 15 was that the lunar astronauts brought with them an automobile—a battery-operated, four-wheeled lunar roving vehicle. The explorers traversed about 28 kilometers (17 miles) across the lunar surface and collected 77 kilograms (about 169 pounds) of rock and soil samples. Other than for difficulty with core drilling experiments, the scientific and geologic, as well as the photographic, product of the mission exceeded by far anything yet accomplished. Moreover, Earth watched the ascent of the LM from its lunar base on live television. The astronauts returned safely, following the failure of one of the three landing chutes and a somewhat harrowing descent to the recovery point.[35] But public interest, praise, and admiration for the astronauts and the mission accomplishments were short-lived. What Teague had identified first as public apathy had indeed shifted to abuse and attack (that is, if the media provided some measure of the public pulse). Public criticism erupted over what NASA labeled a case of "poor judgment" by the flight crew.

Mission accomplishments were overlooked as the media concentrated on what Congressman Les Aspin (D-Wisconsin) termed a case of immoral, if not illegal, conduct by the astronauts. The astronauts carried with them to the Moon and back 400 specially stamped and canceled first-day covers which were to be sold by a friend who would put the

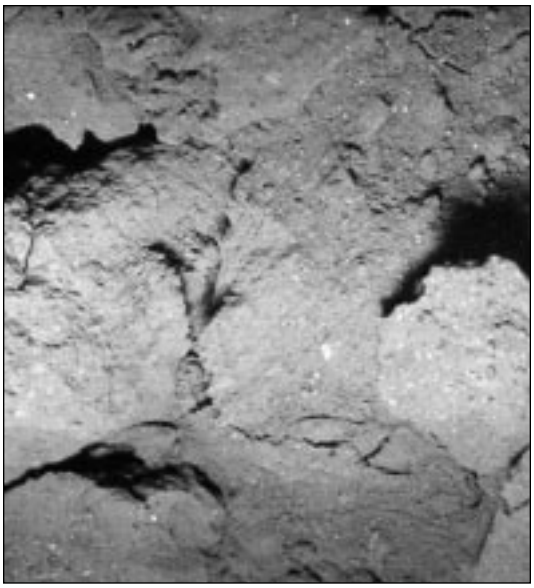
proceeds into a trust fund for their children. About 100 of the covers were sold in Europe for $1,500 each, according to Aspin, but when the story became public they abandoned the scheme and declined to accept any money. Aspin recommended that all should be released from the space program. Although in September the astronauts were welcomed to the Capitol and a visit with the President and selected officials, the controversy continued to brew through the following year.[36]

In October 1972, CBS News with Nelson Benton substituting for newscaster John Hart, posed the proposition that, with the Moon program winding down, ex-spacemen were being touched by the sordid spirit of free enterprise. Understandably so, Commentator Steve Young suggested, inasmuch as the spirit of free enterprise affects most Houstonians. He identified Houston as the "Baghdad of the Bayou, where business is booming everywhere from petrochemical plants to shiny hotels, shimmery office buildings, and complexes." Astronauts were being snapped up for their glamour and name recognition. Scott Carpenter, Buzz Aldrin, Shorty Powers, and Wally Schirra were doing television commercials. Alan Shepard took commemorative medals to the Moon, and the Apollo 15 crew "enhanced astronomically" the value of the covers they took to the Moon, he said.[37] This was, to be sure, a reflection of a distinct mood change in America. These were not, other than perhaps for the remarkable achievements of the Apollo missions, the best of times.

Colonel James Irwin resigned from NASA and from the Air Force in July 1972. He founded a religious organization called High Flight Foundation in Colorado Springs, Colorado, and wrote a book entitled *To Rule the Night* which described his early life, selection into the astronaut corps, and experiences on the flight of Apollo 15. Scott left the astronaut corps in July 1972 to become a special assistant for the Apollo-Soyuz flight, and then served as Director of NASA's Dryden Flight Research Center in Edwards, California, before leaving NASA to organize a private business venture, Scott Science and Technology, Inc., in Los Angeles. Alfred Worden also left MSC in 1972 to serve as Director of Advanced Research and Technology at Ames Research Center, and retired from NASA and the Air Force in 1975 to establish Energy Management Consulting Company



Apollo 15 splashdown.



The lunar surface viewed with a 35 mm stereo close-up camera.

The Lunar Receiving Laboratory. Dr. Elbert King describes procedures for handling lunar materials to Dr. Von Engelhardt, Director of the Mineralogical Institute at the University of Tuebingen, Germany.

and later a helicopter charter and aircraft management company in Florida. He also took time to write a book of space poetry, *Hello Earth: Greetings from Endeavour*, and a children's book, *A Flight to the Moon*.[38]

Apollo 16 flew from Kennedy Space Center on April 16, 1972, carrying commander John W. Young, command module pilot Thomas K. Mattingly, and LM pilot Charles M. Duke, Jr. A number of minor mechanical and computer malfunctions kept the crew and mission control constantly solving problems, but Young and Duke completed a total of 71 hours on the western edge of the Moon's Descartes Mountains. As on the previous mission, the lunar rover enabled the astronauts to cover considerable territory, collect a quantity of diverse geologic specimens, and complete numerous scientific experiments. There were some minor mishaps, such as a broken electronic cable, that prevented completion of some of the experiments, but overall the mission produced new and valuable information. The crew conducted seismic, surface magnetometer, heat flow, cosmic ray, gravimeter, meteorite, atmospheric and ultraviolet experiments among others, in addition to more conventional geologic mapping and sampling.[39]

The last lunar Apollo mission left Earth on Pearl Harbor day, December 7, 1972. The official mission review noted that Apollo 17 "was the longest mission of the program (301 hours 51 minutes 59 seconds) and brought to a close one of the most ambitious and successful endeavors of man. The Apollo 17 mission, the most productive and trouble-free lunar landing mission, represented the culmination of continual advancements

in hardware, procedures, and operations."[40]

America celebrated. Harrison "Jack" Hagan Schmitt, the first civilian-scientist to fly a lunar mission (Schmitt became U.S. Senator from New Mexico, 1976-1982), with command module pilot Ronald E. Evans and Eugene A. Cernan (the Apollo 17 commander and eleventh man to walk on the moon) kicked off an 11-week "postflight tour" at Super Bowl VII in Los Angeles on Sunday, January 14, 1973. They visited 25 states and the Nation's Capitol. They met 13 governors, a considerable number of mayors, and President Nixon. They visited the major NASA contractors, including North American Rockwell, Grumman, Boeing, Bendix, Teledyne-Ryan, Chrysler, and Martin Marietta. They visited all of the NASA centers except Marshall Space Flight Center, which declined the visit due to the press of other programs.[41] It was well done. The race was over. America had won. By the close of 1972 the United States had launched 27 manned spacecraft into space and returned them safely to Earth; 34 individuals had traveled in space, 17 of them more than once; and 12 had walked on the Moon. Eleven three-man Apollo flights were launched. Two were Earth orbital, two were lunar orbital, and six orbited the Moon and landed there. Unlucky Apollo 13 used a free-return trajectory, meaning it flew around the Moon without assuming orbit.[42]

Where do we go from here? Or why should we go anywhere? Skylab, using Saturn rockets originally scheduled for lunar operations and a product of AAP planning and budget constraints, received President Nixon's

Apollo 16, with astronauts John W. Young, Thomas K. Mattingly II, and Charles M. Duke, Jr., accomplished the fifth lunar landing in the Moon's Descartes area. During three EVAs totaling more than 20 hours, astronauts Young and Duke collected 94.3 kilograms (about 207 pounds) of lunar material.

Scientist-Astronaut Harrison H. Schmitt is photographed on December 13, 1972, next to a huge, split boulder during the final Apollo (17) lunar mission. The photograph was taken by Eugene A. Cernan. Ronald E. Evans flew the support system module in orbit about the Moon.

The Apollo 17 splashdown, marking the end of the Apollo lunar programs, occurred very near the U.S.S. Ticonderoga *on December 19, 1972, about 350 miles southeast of Samoa in the Pacific Ocean.*

support in 1970. It was to be a large orbiting workshop, using systems originally developed for Apollo (Apollos 18 and 19). The orbiting workshop/space station had evolved from that early vision of Von Braun and others to become a "dry" S-IVB capsule with a limited Earth-orbit life that would be manned by three different mission crews: the first for 28 days, and the next two for 59 and 84 days, respectively (originally scheduled for 56 days each). Slippages in scheduling caused largely by budget problems, delayed the Skylab missions to 1973-74. Another project using a Saturn-Apollo system was under consideration, but not yet authorized. For several years, the Nixon administration had been negotiating quietly with the Soviet Union for a combined U.S.S.R.-U.S. spaceflight as yet another means of de-escalating the cold war. That mission would fly in 1975, but it was still being defined and developed in 1972.

In a meeting at the Peaks of Otter Lodge in the Blue Ridge Mountains in September 1972, center directors agreed that the coming decade would be considerably different from the past one. They discussed the future of NASA and the sense of "gloom and doom" that had begun to spread with the end of the lunar program. The consensus was that it was time for those who were weeping to get out so the rest of us could get to work. The work ahead had largely to do with seeing that NASA's future would be bright, innovative, and creative. NASA had to maintain adequate in-house capabilities, provide

technical support to other government agencies, support more nonspace projects including local environmental projects, and stress low costs in terms of payloads, satellite design, and launch vehicles.[43] As did the entire NASA organization, MSC began considering its changing role in the post-Apollo era.

Frank A. Bogart, Associate Director of MSC (1969-1972) and a former Comptroller of the Air Force, during his last year before retiring conducted a careful organizational review of the center and queried each directorate about gaps, overlaps, personnel problems, and the role of the center and how the directorate and its divisions might support that role. The responses were diverse, but usually pointed. Some thought the center's organizational structure was simply out of date—and it was. The directorates did not have clearly defined roles and missions for post-Apollo operations. It had an "organizational interface" problem. There were overlaps in responsibility for the development and delivery of hardware. The center could not hire new people, particularly young engineering graduates fresh out of college. Contractor management responsibilities had become fragmented. The future work of the center would be much more diffuse and, in a sense, more difficult. The center would continue to be a busy place, for a decline in flight missions would be offset by multiple and more diverse programs relating to Earth resources and scientific studies. The old "prime" program system followed under Mercury, Gemini and Apollo had been replaced by a multifaceted group of programs requiring considerably more coordination and interface with other centers, Headquarters, and a multiplicity of contractors, few of whom would equate to the prime contractors of times past.[44]

Following the successful landing on the Moon by Apollo 11 in July 1969, space began to slip from the top rank of American priorities. War in southeast Asia and a war on poverty in America attracted growing concern, human energy, and federal money. Although NASA began considering man-in-space programs that might go beyond Apollo as early as 1959, most of NASA's energies, and especially the work at MSC, concentrated on designing, building and flying the Mercury, Gemini and Apollo spacecraft. A more defined Apollo Extension/Apollo Applications Program focusing on a manned orbital laboratory or space station began to develop in the mid-1960's. Concurrently, funding for ongoing programs and especially financial support for future programs such as AAP became constrained. Financial spending on the Apollo program and space peaked in 1965, 5 years before Apollo enjoyed its greatest operational successes with six lunar landings.

The seemingly sudden retrenchment in America's space programs was in fact the product of devolution over a period of years. Budget constraints and the rise of alternative national priorities resulted in efforts to achieve objectives in space with lower cost, more efficient machines and programs. Skylab became a cost-effective interim substitute for a long-duration space laboratory or station. A space shuttle was intended to provide a low-cost, reusable transportation system from Earth to a destination in Earth orbit. The destination, originally conceived as a large, orbiting space station that would be a very long-term space habitat and perhaps a way station to distant planets, would presumably follow the development of a low-cost space transportation system.

This Apollo 17 view of Earth is one of the most published photographs in the world. In explaining the impact of spaceflight, this one photograph has been worth many thousands of words.

By 1972, when President Nixon authorized development of the Space Shuttle, manned space programs by no means had been abandoned, but rather "slippage" in the broad time frame and other economies were intended to preserve the industrial and technological expertise derived from space, provide time for the absorption and distribution of the new knowledge, and preserve national leadership in space while concentrating national energies and wealth on war and the public welfare. MSC now

concentrated on flying the Skylab and Apollo-Soyuz mission, designing and constructing a space shuttle, and reorganizing for the more complex and multifaceted post-Apollo era.