SCIENTIFIC AMERICAN

Was the Race to the Moon Real?

In 1961 President John F. Kennedy made the goal to be first on the moon a matter of national honor. But were the Soviets truly in the running?

by John M. Logsdon and Alain Dupas

Twenty-five years ago, on July 20, 1969, Neil A. Armstrong took the first footsteps on the surface of the moon. That event marked a political and technological victory for the U.S. in its cold war rivalry with the U.S.S.R. In the years that followed, the Soviet government insisted that the Soviet Union had never planned a lunar landing. Hence, it argued, the contest to send humans to the moon was a one-sided exercise. The reality is otherwise; recently declassified information from that era and testimony of key participants in the Soviet space program under Khrushchev and Brezhnev prove that the moon race was indeed real.

New evidence reveals that personal rivalries, shifting political alliances and bureaucratic inefficiencies bred failure and delays within the Soviet lunar-landing program. In contrast, the American effort received consistently strong political and public support. The National Aeronautics and Space Administration and its contractor teams also benefited from a pool of skilled and highly motivated workers and managers. Despite an early Soviet lead in human space exploration, these factors, along with more generous and effective allocation of resources, enabled the U.S. to win the competition to be first to the moon.

GIANT ROCKETS needed to transport humans to the moon were developed in both the U.S.S.R. and the U.S. The Soviet N-1 rocket (*opposite page*) failed in each of its four test launches before its development was canceled. The U.S. Saturn V (*left*), in contrast, proceeded roughly on schedule and successfully carried Americans to the moon in July 1969.

Soviet capability in space became clear to the world in October 1957, when the U.S.S.R. lofted *Sputnik 1,* the first artificial satellite. Two years later the Soviets launched a probe that returned close-up images of the lunar surface. And on April 12, 1961, cosmonaut Yuri A. Gagarin became the first human in space. Soviet officials cited each accomplishment as evidence that communism was a superior form of social and economic organization. The Soviet advantage in space rocketry underlined fears in the U.S. that a missile gap existed between it and its adversary, an issue that Kennedy belabored in the 1960 presidential campaign.

At first, the shape that a U.S.-Soviet space race might take was not clear. Indeed, if President Dwight D. Eisenhower had had his way, there might not have been one at all. Eisenhower rejected the idea that spectacular space achievements had anything to do with the fundamental strength of a country; he consistently refused to approve space programs justified on purely political grounds. In July 1958, however, he created NASA, an agency that brought together the resources to establish a U.S. civilian space program.

It was inevitable, perhaps, that NASA would argue that such a program should be ambitious.

Eisenhower's successor, President John F. Kennedy, perceived a much more direct link between space exploration and global leadership. Stimulated by the worldwide excitement generated by the Gagarin flight, Kennedy decided that the U.S. had to surpass the Soviets in human spaceflight.

On April 20, 1961, just eight days after the Gagarin flight, Kennedy asked Vice President Lyndon B. Johnson, "Is there any…space program that promises dramatic results in which we could win?" In particular, Kennedy inquired, "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?" Johnson, whom Kennedy had named his primary adviser on space policy, promptly organized an intense two-week assessment of the feasibility of these and other alternatives. A series of memoranda trace the evolving response to Kennedy's questions.

One of the many people Johnson consulted was Wernher von Braun, leader of a team of rocket engineers whom the U.S. Army had spirited out of Germany during the last days of the Third Reich. In a memorandum dated April 29, von Braun told the vice president that "we do not have a good chance of beating the Soviets to a manned laboratory in space," but "we have a sporting chance of sending a three-man crew around the moon ahead of the Soviets," and "we have an excellent chance of beating the Soviets to the first landing of a crew on the moon."

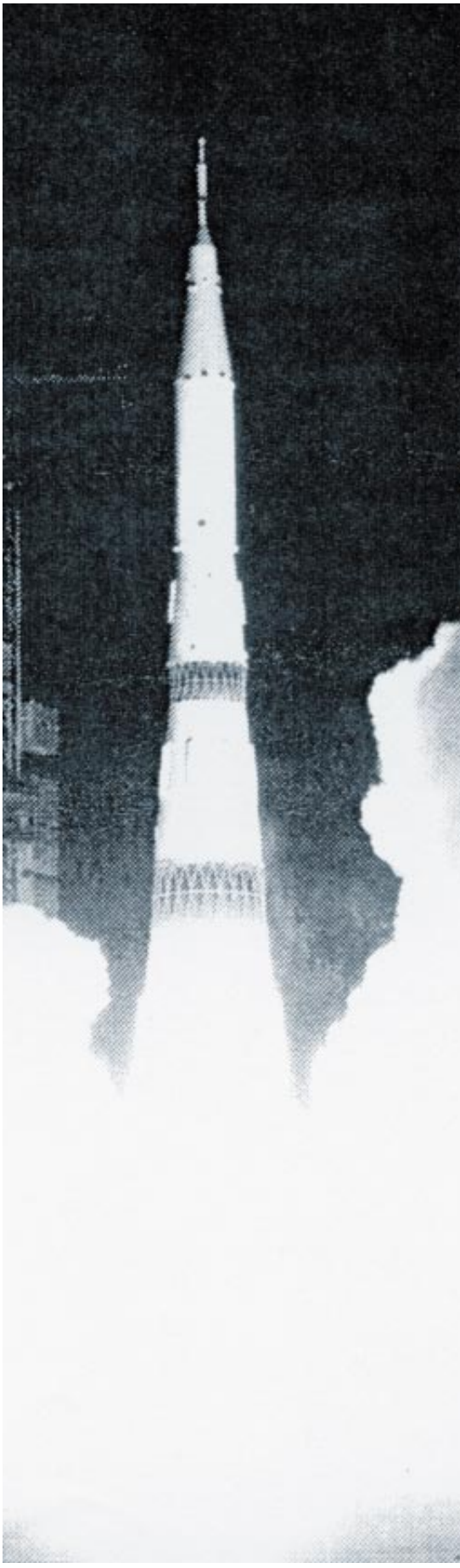
Von Braun judged that a lunar landing offered the U.S. the best opportunity to surpass the Soviets because "a performance jump by a factor 10 over their present rockets is necessary to accomplish this feat. While today we do not have such a rocket, it is unlikely that the Soviets have it." He suggested that "with an all-out crash effort, I think we could accomplish this objective in 1967/1968."

On May 8, 1961, Johnson presented Kennedy with a memorandum that reflected the results of his investigation. It was signed by James Webb, the NASA administrator, and Robert S. McNamara, the secretary of defense. Webb and McNamara recommended that the U.S. should set the objective of manned lunar exploration "before the end of this decade." They argued that "this nation needs to make a positive decision to pursue projects aimed at enhancing national prestige. Our attainments are a major element in the international competition between the Soviet system and our own." The two men cited lunar and planetary exploration as "part of the battle along the fluid front of the cold war."

Kennedy accepted these recommendations and presented them to a joint session of Congress on May 25. The president said, "I believe we should go to the moon…. No single space project in this period will be more exciting, or more impressive to mankind…. While we cannot guarantee that we shall one day be first, we can guarantee that any failure to make this effort will find us last." Kennedy vowed that Americans would set foot on the moon "before this decade is out."

The president's call to action struck a responsive chord in the U.S. populace. There was little public or political debate over the wisdom of the lunar commitment in the weeks following Kennedy's speech. Within months Congress increased NASA's budget by 89 percent; another 101 percent increase came the next year. Between 1961 and 1963 NASA's payroll swelled from 16,500 people to more than 28,000, and the number of contractors working on the space program grew from less than 60,000 to more than 200,000.

During the first year after Kennedy's announcement, a fierce technical debate erupted that threatened to delay progress in getting to the moon. The dispute centered on the most efficient strategy for sending people to the lunar surface and back to the earth. One possibility was to use several rockets to launch pieces of a lunar spacecraft separately into earth orbit, where they would be assembled and directed on to the moon. Jerome Weisner, the president's science adviser, and some elements within NASA initially inclined toward this "earth orbit rendezvous" plan.



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The Space Race between the U.S. and the U.S.S.R.

The competition between the U.S. and the Soviet Union in space grew out of the cold war conflict between the two nations. Early Soviet space achievements included the first satellite and the first human to orbit the earth. An aggressive, well-funded U.S. effort to place a human on the moon attempted to negate the propaganda value of these Soviet successes. By the mid-1960s the Soviets had initiated a secret, parallel program, setting the stage for a race to the moon.

1961–1962, UNITED STATES

Just four months after his inauguration, President John F. Kennedy vowed to land Americans on the moon by the end of the decade. That goal had been suggested by, among others, Wernher von Braun, the German-born rocket engineer. At the same time, the U.S. raced to catch up with the Soviets. Alan B. Shepard became the first American in space; nine months later John H. Glenn matched Gagarin's feat.

1957–1962, SOVIET UNION

The launch of *Sputnik 1,* the first artificial satellite, captured the world's attention. Subsequent flights lofted dogs into space, paving the way for humans to follow. On April 12, 1961, Yuri A. Gagarin circled the globe in the *Vostok 1* spacecraft, solidifying the Soviet lead in space. "Let the capitalist countries catch up with our country!" boasted Soviet premier Nikita S. Khrushchev.

Engineer readies Sputnik 1 *for flight (1957)*

Malyshka during preflight testing (1958)

McNamara was also intrigued by the potential military applications of earth-orbiting missions.

As they examined how best to meet Kennedy's goal of getting to the moon before the end of 1969, a growing number of engineers within NASA favored another approach, called lunar orbit rendezvous. In this scheme, the entire *Apollo* spacecraft would be sent into space in a single launch and would fly directly into orbit around the moon; a small landing craft would detach from the main spaceship and ferry the astronauts from lunar orbit to the moon's surface and then back to the mother ship, which would then return to earth.

Lunar orbit rendezvous dramatically lowered the overall weight of the *Apollo* spacecraft. Consequently, the Apollo mission could be carried out using a single Saturn V rocket. After fending off Weisner's objections, NASA officials approved lunar orbit rendezvous, realizing that it offered the greatest likelihood of reaching the lunar surface according to Kennedy's schedule. By the end of 1962 the U.S. was well on its way to the moon. Not so the Soviet Union.

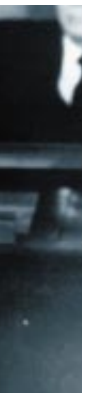
Until a few years ago, the Soviets officially claimed that the U.S. was the sole participant in the race to the moon. The very existence of the Soviet lunar program was a tightly held secret. As a result of *glasnost* and the collapse of the U.S.S.R., that situation has significantly changed. Several crucial players in the space program of the 1960s (most notably Vasily P. Mishin, who headed the Soviet human spaceflight effort from 1966 to 1974) have finally been allowed to place their recollections of the period in the public record. On August 18, 1989, the Soviet newspaper *Izvestia* printed a lengthy and unprecedentedly frank account of the nation's unsuccessful assault on the moon. And an increasing number of photographs and engineering descriptions of Soviet lunar hardware have become available to Western analysts and space observers. A recent study by Christian Lardier, a French space researcher, has been particularly valuable in bringing such information to light. The result is a much clearer picture of just how extensive the Soviet lunar program was.

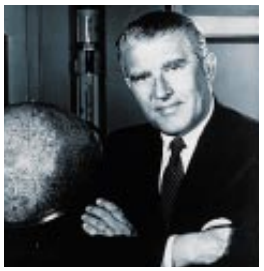
In June 1961, at his first summit meeting with Soviet premier Nikita S. Khrushchev, Kennedy twice raised the possibility that the U.S. and the U.S.S.R. might travel to the moon together. Khrushchev was unresponsive, at least in part because Kennedy's lunar-landing announcement had caught the Soviet Union by surprise. The Soviet leadership was so confident in the country's space prowess that it had not anticipated that the U.S. might actually try to compete in that arena.

More than three years of political debate dragged on before the Kremlin decided, and then only tentatively, that the Soviet Union should also have a lunar-landing program. During that time, powerful and entrenched leaders of the Soviet design bureaus (industrial organizations in which the Soviet technical capabilities for space resided) struggled for priority and for resources related to possible lunar missions. Those conflicts presented a roadblock to establishing a single, coordinated plan of action for reaching the moon.

Sergei P. Korolev, the top space engineer, headed one of the design bureaus. He was, in many ways, the Russian equivalent of Wernher von Braun. Korolev had both designed the rocket used for all Soviet space launches to that point and had managed the programs responsible for developing most of the payloads lofted by those rockets. He was also an energetic and enthusiastic proponent of space travel. Such secrecy surrounded his work that Korolev was identified only as the "Chief Designer"; his name was not publicly revealed until after his death.

Unfortunately for the Soviet space effort, in the early 1960s Korolev became





Wernher von Braun

John Kennedy announces lunar plans to Congress (May 25, 1961)

Alan Shepard prepares for suborbital flight (May 5, 1961)

John Glenn enters the Mercury *capsule (February 20, 1962)*

Yuri Gagarin about to orbit the earth (April 12, 1961)

Gagarin (center) *celebrates his achievement with Nikita Khrushchev* (left) *and Leonid Brezhnev (May 1, 1961)*

embroiled in a personal and organizational conflict with Valentin P. Glushko, the head of the Gas Dynamics Laboratory and the primary designer of Soviet rocket engines. Disputes between the two dated to the 1930s, when Glushko was one of those whose testimony helped to send Korolev to a forced-labor camp. The two men clashed over the concept of the rocket engines for the next generation of Soviet space launchers. Korolev wanted to use high-energy liquid hydrogen as a fuel (the choice the U.S. made for the upper stages of Saturn V). Glushko was only interested in designing an engine fueled by storable but highly toxic hypergolic compounds, such as hydrazine and nitrogen tetraoxide, that ignited on contact.

The dispute grew so bitter that Glushko refused to work with Korolev in the creation of a new rocket. Instead Glushko allied his laboratory with another design bureau, headed by Vladimir N. Chelomei, to compete for the lunar assignment. Chelomei's group had developed military missiles but had no experience with rockets for outer space. On the other hand, one of Chelomei's deputies was Khrushchev's son, Sergei. That family link offered a great advantage in a system where such personal connections were often all-important. Chelomei had ambitions to expand his bureau's works into what had been Korolev's turf.

On major technical issues such as space exploration, the Soviet leadership relied on recommendations from the Soviet Academy of Sciences. Mstislav V. Keldysh, the president of the academy, was given the task of advising the government on the technical merits of competing proposals for future efforts in space. Keldysh and his associates took the path of least political resistance and did not fully support either Korolev or his competitors until after Khrushchev was removed from power.

From late 1961 on, Chelomei's design bureau devoted most of its attention not to landing on the moon but to sending cosmonauts on a flight around the moon without even going into lunar orbit. This mission was to use a UR-500 rocket (later known as Proton), derived from one of Chelomei's failed designs for an intercontinental ballistic missile (ICBM). Chelomei also promoted an overly ambitious plan for a reusable rocket airplane that could reach the moon and even the other planets.

In August 1964 the Chelomei design bureau received Kremlin approval to build both a spacecraft and the UR-500 rocket to send cosmonauts on a circumlunar mission by October 1967, the 50th anniversary of the Bolshevik Revolution. But Chelomei's apparent victory over Korolev was short-lived. The Politburo removed Khrushchev from power in October 1964.

The post-Khrushchev leadership quickly discovered that little progress had been made by the organization that had been receiving the lion's share of funding related to possible lunar missions. The Chelomei design bureau soon fell from favor, and its contract for the circumlunar program was canceled.

Korolev, meanwhile, had not been entirely shut out of the Soviet space program. After his successful efforts in using a converted ICBM to carry out the initial Soviet forays into space, he had been thinking about the design of a new heavy-lift space launcher, which he had designated N-1. In mid-1962 the Keldysh commission authorized the development of a version of the N-1 that could launch 75 tons into earth orbit, but the commission did not approve Korolev's plan to utilize the N-1 for a lunar mission structured around earth-orbit rendezvous.

The N-1 rocket was supposed to be ready for flight testing by 1965. Because he did not have access to the expertise of Glushko's Gas Dynamics Laboratory, Korolev had to find an alternative source of rocket engines. He turned to the design bureau led by Nikolai D. Kuznetsov, which had previously

1962–1967, UNITED STATES

After an intense dispute between Jerome Weisner, the presidential science adviser, and NASA managers, the agency in 1962 finalized its plan for the Apollo program to the moon. Under the guidance of NASA administrator James Webb, and with the strong backing of President Lyndon B. Johnson, the mission proceeded quickly. Meanwhile NASA continued to lag in feats such as a space walk, which the Soviets had accomplished three months earlier. NASA received a serious blow in 1967, when a cabin fire during a countdown rehearsal killed three *Apollo* astronauts.

James Webb* (left), *with Lyndon Johnson

Jerome Weisner

1962–1967, SOVIET UNION

Personal conflicts hampered the Soviet lunar-landing program. Sergei P. Korolev conceived of a huge rocket, the N-1, that would transport cosmonauts to the moon. Korolev's plan was delayed by his clash with Valentin P. Glushko. After his death in 1966, Korolev was replaced by Vasily P. Mishin, who kept the beleaguered N-1 program alive. The Soviet space program also experienced technical setbacks, including a 1967 reentry mishap that killed the cosmonaut on the first flight of the new *Soyuz* spacecraft.

Sergei Korolev, "chief designer" of rockets* (right), *with Gagarin

Valentin Glushko, primary designer of Soviet rocket engines

worked on airplane engines. Kuznetsov's group had to begin its work on space propulsion systems basically from scratch. In the limited time available, Kuznetsov was able to develop only a conventionally fueled motor of rather little power. To achieve sufficient lifting power for a lunar mission, the N-1 ultimately needed 30 such engines in its first stage. (The American Saturn V had just five first-stage engines.)

After the fall of Khrushchev, the Soviet space program changed direction. Probably because it no longer feared angering Khrushchev, by December 1964 the Keldysh commission finally gave preliminary approval to a Korolev plan for placing cosmonauts on the moon. Korolev's revised lunar mission utilized a redesigned, more powerful N-1 rocket and the same lunar orbital rendezvous approach adopted for the Apollo mission. In May 1965 the Soviet government created the Ministry of General Machine Building to oversee the nation's space program; the ministry gave Korolev's lunar mission its highest priority. The official plan called for a first landing attempt in 1968, in the hope that the U.S.S.R. could still beat the U.S. to the moon.

Just as the Soviet effort was gaining momentum, disaster struck. In January 1966 Korolev died unexpectedly during simple surgery, robbing the Soviet space effort of its most effective and charismatic leader. Korolev's successor, Vasily Mishin, had neither Korolev's political standing nor his ability to lead. Continuing struggles with various government ministries and other design bureaus slowed progress. Chelomei continued to push an alternative lunar-landing scheme. To make matters worse, the revised N-1 launcher proved insufficiently powerful, so still more time was lost in another redesign.

Not until November 1966 did the Keldysh commission give a final go-ahead to the lunar-landing project. A joint government-party decree supporting the project was issued the following February, but still the Soviet government allocated only limited resources to it. By then the date for an initial lunar-landing attempt had slipped into the second half of 1969.

The U.S. was well aware of the Soviet decision to proceed with the N-1 but for several years remained unsure of the kind of mission for which it would be used. In 1964 U.S. intelligence satellites observed the construction of a launchpad for a large new booster and recorded the building of a second such pad in 1967. In a March 1967 national intelligence estimate (declassified in 1992), the Central Intelligence Agency suggested that "depending upon their view of the Apollo timetable, the Soviets may feel that there is some prospect of their getting to the moon first, and they may press their program in the hopes of being able to do so."

After 10 successful launches of the two-man *Gemini* spacecraft during 1965 and 1966, NASA seemed well prepared to move on to Apollo test flights leading to a lunar landing in 1968. Then, on January 27, 1967, the program received a tragic setback. An electrical fire broke out in the *Apollo 204* spacecraft (later renamed *Apollo 1*) during a countdown rehearsal on the launchpad. All three crewmen perished. Although critics lashed out at NASA, the agency never faltered. With limited congressional and White House intervention, NASA swiftly took the investigation into its own hands and identified and fixed the problems that had caused the fire. By the end of 1967 the space agency had set a new schedule for Apollo that called for an initial attempt at a landing by mid-1969, approximately the same target date as that of the Soviet program.

The U.S. and U.S.S.R. were also locked into a second contest: to see which country could first reach the vicinity of the moon. After the end of the Khrushchev era, the new

Edward S. White II takes the first American space walk (June 3, 1965)

Apollo 204 *cabin after the fatal fire (January 27, 1967)*

Vasily Mishin, Korolev's successor

UR-500 (Proton) launch

Soyuz *spacecraft*

Soviet leadership of Leonid I. Brezhnev and Alexei N. Kosygin asked Korolev to design a circumlunar mission similar to that of the now canceled Chelomei project. The Soviets still hoped to carry out such a flight in October 1967. After nearly a year of often acrimonious negotiations, Korolev and Chelomei in September 1965 agreed on a plan that would use the Chelomei UR-500 booster, supplemented by a Korolev upper stage being developed for the N-1 rocket and a two-cosmonaut version of the new *Soyuz* spacecraft being designed by the Korolev bureau.

Although the first few test flights of the UR-500 booster in 1966 were successful, there were a series of serious problems with subsequent launches. In addition, the first flight of the *Soyuz* spacecraft in April 1967 had a landing failure that killed the cosmonaut on board. Those setbacks made an October 1967 flight around the moon impossible. Even so, tests during 1967 and 1968 led to the successful Zond 5 mission of September 1968, in which the UR-500 launched a modified *Soyuz* spacecraft carrying living organisms, including several turtles, on a course that took it around the moon and then safely back to the earth. The flight of a Soviet cosmonaut around the moon seemed imminent.

At the time of the Zond 5 mission, the U.S. had no officially scheduled flight to the lunar vicinity until well into 1969. The reality was rather different, however. By mid-1968 development of the redesigned *Apollo* command-and-service module, which would carry astronauts into orbit around the moon and back to the earth, was on schedule for a first orbital test flight in October. But the separate lunar landing module, intended to place astronauts on the moon's surface, was months behind schedule. It seemed unlikely that the lunar module would be ready for an earth orbital test until February or March 1969.

George M. Low, deputy director of NASA's Manned Spacecraft Center in Houston, recognized that the delay in testing the lunar module presented a real possibility that the U.S. might not meet the end-of-the-decade deadline originally set by Kennedy. On August 9, 1968, Low therefore made a bold proposal: he suggested inserting an additional flight into the *Apollo* launch schedule, one in which a Saturn V would send the command-and-service module carrying a three-man crew into orbit around the moon.

Such a mission obviously carried substantial risks. It meant sending astronauts to the vicinity of the moon much earlier than had been planned, and it would be only the second flight of the *Apollo* spacecraft since its redesign after the 1967 fire. Moreover, the Saturn V had been launched only twice, and the second launch had uncovered several major problems. But Low's strategy would allow NASA to gain the experience of managing a mission at lunar distance many months earlier than had been planned. The additional flight would greatly increase the probability of meeting the Apollo schedule. It would also improve the likelihood that the U.S. would reach the vicinity of the moon before the U.S.S.R. did.

Low's plan gained rapid acceptance within NASA, encountering only temporary resistance from NASA administrator Webb and George Mueller, the head of NASA's Manned Spaceflight Program. In a little over a week the agency revised its entire Apollo schedule, creating a new mission just four months before it would lift off. The dramatic nature of that flight remained secret until after the October Apollo 7 mission, in which the command-and-service module performed flawlessly. On November 11, NASA's leaders formally sanctioned the Apollo 8 flight to the moon.

The Soviets, meanwhile, were struggling to keep up. In October 1968 a redesigned *Soyuz* spacecraft carrying one cosmonaut was successfully tested in

1967–1972, UNITED STATES

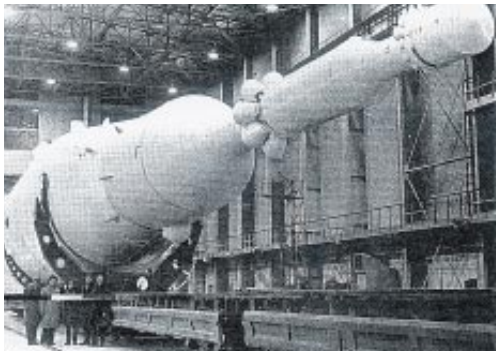
NASA recovered swiftly after the *Apollo* fire. But George M. Low, director of the Apollo program, worried about delays affecting the lunar lander. At his urging, NASA changed its launch schedule so that the first crew-carrying test flight of the Saturn V rocket (*Apollo 8*) went into orbit around the moon on December 24, 1968. Then on July 20, 1969, the *Apollo 11* lunar module made its historic touchdown on the surface, ending the race to the moon. Five more *Apollo* landings followed before the U.S. lunar program tapered off in 1972.

George Low

Earthrise over the moon, seen from* Apollo 8 *(December 24, 1968)

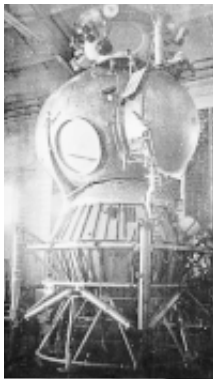
1967–1974, SOVIET UNION

The giant N-1 rocket never performed properly. On its second test launch, the N-1 exploded, wiping out its launch facilities. Glushko assumed control of N-1 development in 1974. He promptly canceled the program and dismantled the existing rockets. Pieces of the N-1 found ignominious duty as storage sheds. Many associated pieces of hardware, including a lunar lander and a semiflexible lunar space suit, were destroyed or placed into museums.



N-1 rocket being readied for testing

Lunar lander, designed to fit atop the N-1



earth orbit. The Zond 6 mission, which one month later sent a similar but unmanned spacecraft around the moon, did not fare so well. The spacecraft depressurized on reentry. If it had carried a crew, they would have died.

Nevertheless, the Soviets made preparations for launching a circumlunar Zond flight carrying two cosmonauts in early December. Both Mishin and the crew agreed to take the substantial risks involved, because by then they knew that the U.S. intended to send humans into orbit around the moon later that month. This launch presented the Soviets with perhaps their final opportunity to beat the Americans to the moon, but they did not take advantage of that chance. Just days before the scheduled takeoff, the Soviet leadership canceled the mission, presumably because they judged it too perilous.

During the final weeks of training for their mission, the *Apollo 8* crew members were well aware of when a Soviet circumlunar mission could be launched. In a conversation with one of us (Logsdon), Mission Commander Frank Borman recalls breathing a sigh of relief as the last possible date passed, and he realized that his own flight to the moon had not been preempted.

Apollo 8 entered lunar orbit on Christmas eve, 1968, all but ending the race to the moon. Furthermore, its accomplishments opened the way for the historic Apollo 11 mission seven months later, when Neil Armstrong planted the American flag in the lunar soil.

After the triumphs of Apollo 8 and Apollo 11, the Soviet lunar program faded into oblivion. But the Soviets did not give up on the moon immediately. Two more, unmanned Zond missions flew around the moon, one in 1969 and one in 1970. Shortly thereafter the Soviet leadership canceled the circumlunar program as it became clear that it had been totally overshadowed by Apollo.

The Soviet lunar-landing program suffered a more ironic fate. The first attempt to launch the N-1, in February 1969, failed one minute into flight. The second launch attempt on July 3, just 13 days before *Apollo 11* lifted off for the moon, ended in an explosion on the pad that destroyed much of the booster's ground facilities and halted the Soviet lunar-landing program for two years. N-1 launches in July 1971 and November 1972 also failed.

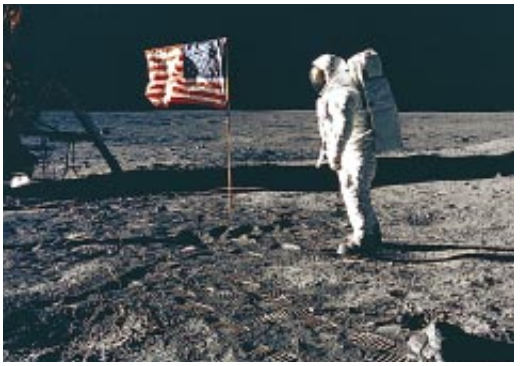
If they could not be first, the Korolev design bureau leaders reasoned, they could still be best. Led by Mishin, they reorganized the program around the concept of extended stays on the moon that would be longer than the brief visits made by the crews of the six Apollo missions. By early 1974 Mishin believed that he and his associates had identified the sources of earlier problems and were on the brink of success. But in May 1974, Mishin was replaced as head of the design bureau by Glushko, the man who more than a decade earlier had fought with Korolev over the choice of the N-1 propulsion system.

In one of his first acts, Glushko terminated the N-1 program and destroyed the 10 remaining N-1 boosters. Mishin argued that at least the two N-1s almost ready for launch should be tested, but to no avail. Rather than continue with the lunar program to which it had devoted substantial resources for more than a decade, Glushko and his superiors chose the almost pathological response of destroying most of the evidence of its existence. The Soviet human spaceflight program from the early 1970s on has concentrated entirely on long-duration flights in earth orbit.

Once astronauts had established an American presence on the moon, the U.S. lunar program also soon wound down. The sixth and last Apollo landing mission left the moon in December 1972. By then the lunar effort had clearly met the goals that Kennedy had set out in 1961.

Was the race to the moon worth win-

Apollo 11 *crew (May 1969)*



Neil Armstrong on the moon (July 20, 1969)

1975–PRESENT

In 1975 the U.S. and the U.S.S.R. conducted a rendezvous between a *Soyuz* and an *Apollo* spacecraft. That event set a precedent for the current plan to combine most U.S. and Russian human spaceflight activities, leading to an international space station by 2002. The station could open a new chapter in the collaborative exploration of space.

Soviet lunar space suit

N-1 pieces used as storage sheds

Astronaut and cosmonaut on board **Apollo-Soyuz** *(July 17, 1975)*

ning? In our judgment, that question can be answered only in light of the circumstances under which the competition occurred. The moon race was a cold war undertaking that should be evaluated primarily in foreign policy terms. On those grounds, it was an important victory. The Apollo program undoubtedly aided America's global quest for political and military leadership during the 1960s. The lunar landing constituted a persuasive demonstration of national will and technological capability for the U.S.

Likewise, the failure of the Soviet lunar program was more than a public relations defeat. In 1961, as the race to the moon began, many people in the U.S. (and around the world) thought Soviet centralized planning and management systems would allow the nation to pursue vigorously its long-range goals in space. The dissipation of the Soviet Union's lead in space during the 1960s tarnished the image of socialist competence and diminished Soviet standing in world affairs.

Throughout his brief presidency, Kennedy was ambivalent about the competitive aspects of the space race. In his inaugural address, he suggested to the Soviet Union that "we should explore the stars together." Shortly after being sworn in, he asked NASA and the state department to draw up proposals for enhanced U.S.-U.S.S.R. space cooperation. Those proposals arrived at the White House on the day of Gagarin's initial orbital flight, an event that convinced Kennedy that the U.S. had to assume leadership in space. Yet on September 20, 1963, in an address to the General Assembly of the United Nations, he still asked, "Why should man's first flight to the moon be a matter of national competition?"

Kennedy's dream of cooperation between the two space superpowers is at last on the verge of becoming a reality. On December 15 of last year Vice President Al Gore and NASA administrator Daniel S. Goldin signed agreements with their Russian counterparts for a series of joint space activities. That collaboration will culminate in an international space station, which will be built around U.S. and Russian capabilities but will include contributions from Europe, Japan and Canada. The station will begin operation soon after the turn of the century.

For 30 years, cold war rivalry was the lifeblood of both U.S. and Soviet programs of human spaceflight. If the adventure of space exploration is to continue into the 21st century, it will almost surely depend instead on widespread cooperation. The space station may serve as the harbinger of a new kind of foreign policy, one that brings the nations of the world together in the peaceful conquest of space.

FURTHER READING

THE DECISION TO GO TO THE MOON: PROJECT APOLLO AND THE NATIONAL INTEREST. J. Logsdon. MIT Press, 1970.

THE HEAVENS AND THE EARTH: A POLITICAL HISTORY OF THE SPACE AGE. Walter A. McDougall. Basic Books, 1985.

THE SOVIET MANNED SPACE PROGRAM. Phillip Clark. Orion Books, 1988.

APOLLO: THE RACE TO THE MOON. Charles A. Murray and Catherine Bly Cox. Simon & Schuster, 1989.

L'ASTRONAUTIQUE SOVIETIQUE. Christian Lardier. Armand Colin, Paris, 1992.

POURQUOI NOUS NE SOMMES PAS ALLÉS SUR LA LUNE? V.-P. Michine (with M. Pouliquen). Cépaduès Éditions, Toulouse, 1993.

SPACEFLIGHT. Periodical published by British Interplanetary Society, 27–29 South Lambeth Road, London, England SW8 1SZ.

QUEST. A quarterly magazine on the history of spaceflight. P.O. Box 9331, Grand Rapids, MI 49509.