A GREAT NEW ENTERPRISE

After the twin shocks of Sputnik and Gagarin, Americans' confidence needed a boost. Politicians gave them the moon.

by Wayne Biddle *Illustrations by Paul Salmon*

The day man reached the moon has receded enough in time that the explorers and their machines have begun to seem a bit remote. They do not look as quaint as the Wright brothers, but the drift is already noticeable. Once the quintessence of the future, Project Apollo has become another archetype of the American past.

Something greater than a simple 20-year expanse separates the Apollo era from today. The fabric of American life has changed since then, along with the institutions that color it. Tracing the history of Apollo thus means examining the unique set of political and economic forces that shaped the United States and its institutions in the 1960s and made the moon the place to be.

Visiting the moon became a top government priority eight years before the first landing, when President Kennedy told Congress on May 25, 1961, that achievement in space was part of "the battle that is going on around the world between freedom and tyranny." He did not sell the "great new American enterprise" as a scientific mission but as a way of influencing "the minds of men everywhere who are attempting to make a determination of which road they should take"—namely, capitalism or communism. From the start, Apollo was a spectacular gambit in the Cold War, an essential test of the American way of life.

"Kennedy wasn't terribly excited about doing it—something not generally understood today," recalls Jerome Wiesner, J.F.K.'s chief science advisor. "But he was faced with a dilemma. You could do nothing new, and remain behind the Russians indefinitely. Or you could quit the space race, which wasn't a real option. From a purely political point of view, the United States had to do something that would ultimately put the relative technological capabilities back in perspective. The pressure on him was enormous from the public. He used to press me, saying, 'Can't you find something to do here on Earth that would use the money more effectively?' And I said, 'Not with the same political effect.' "

The young president and his charismatic approach to politics stood in exhilarating contrast to the Eisenhower style, but Kennedy's decision would have sounded foolish in the absence of any prior planning. Although Eisenhower had never accepted the necessity

of a big-ticket space program for national prestige, the 1957 launch of Sputnik, the world's first artificial satellite, and the subsequent waves of fear and shock it set off in the American public had forced his hand. The following year Eisenhower created a civilian space agency, the National Aeronautics and Space Administration, and opened the highest levels of federal policymaking to scientists and engineers. Project Mercury, America's first manned spaceflight program, was soon under way in a wave of patriotic fervor.

But with only minimal support from Eisenhower, nothing as exotic as a trip to the moon could emerge from backstage dreaming. "At that time, a lunar mission looked pretty wild—it was far down on the list of ordered accomplishments," recalls Edward Purcell, a Nobel laureate physicist who served on various space advisory panels during the Eisenhower and Kennedy administrations. "In the early days, one problem was that people needed to have even something as simple as satellites explained to them. No matter how high the bureaucrat might be in Washington, he didn't understand what kept them up."

"Eisenhower was just not interested" in a lunar mission, remembers Robert Gilruth, director of Project Mercury and of the Manned Spacecraft Center in Houston from 1961 to 1972. "He was an old man, and he didn't want any part of it. So there wasn't any real money spent on it. But there were a few people who were off by themselves thinking about what it would really take."

Indeed, Gilruth was one of the principal thinkers. By the time Kennedy moved into the White House, NASA had already picked landing on the moon as its long-range goal and determined that such a mission would at least require no fundamental breakthroughs. Kennedy himself had little knowledge of space, but he had campaigned on the supposed existence of a "space gap" and a "missile gap" and had chosen a powerful advocate of big space projects, Texan Lyndon Johnson, as his vice president.

During his first few months in office, sobered by foreign policy difficulties in Laos and Cuba and the 1960-61 economic recession, Kennedy was as cautious as Eisenhower had been about a sharp acceleration of the nation's space program. The most he would commit was a $125 million increase over Eisenhower's last NASA budget recommendation of $1.11 billion, mostly for development of heavy-lift booster technology that might also be of use to the military. Yet the pieces were in place for a major space initiative—what was needed now was a real push to give it momentum.

It came on April 12, 1961, when Yuri Gagarin orbited Earth in a five-ton capsule, becoming the first man in space. Americans had taken for granted that one of the seven Mercury astronauts—who had attained nearly god-like status in American mass culture—would make it there first. But once again the Soviets had taken the lead.

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As Sputnik had been four years earlier, the Soviet feat was far more a political jolt than a technical victory. Scientists and government officials knew that Vostok 1 did not represent a serious gap between American and Soviet prowess, though the Soviet boosters' capability to handle greater loads than the United States' was worrisome. But the public and much of Congress were shocked, their fears fanned by Cold War press rhetoric such as the *New York Times'* suggestion that Vostok might cause "Western governments to make concessions on the great world issues of the present day." Kennedy could not tolerate this and soon made his grand move.

Looking back on the times, James Webb, hard-driving NASA administrator from 1961 to 1968, offers a broad context: "Having made the atom bomb and used it in World War II, and having felt that this would be an umbrella over the development of the Earth based on market trade and not communistic government, the senior thinkers in this country were really shocked when they saw the Russians doing space probes before we could .... Anytime you can launch a rocket and have it orbit the Earth, you've got a powerful military weapon, even if you're not building it as such. Kennedy needed Apollo because he was being hammered over the Bay of Pigs, he was being charged by the opposition that he had no real programs to carry out his promises, and that he didn't really understand the complications of international diplomacy."

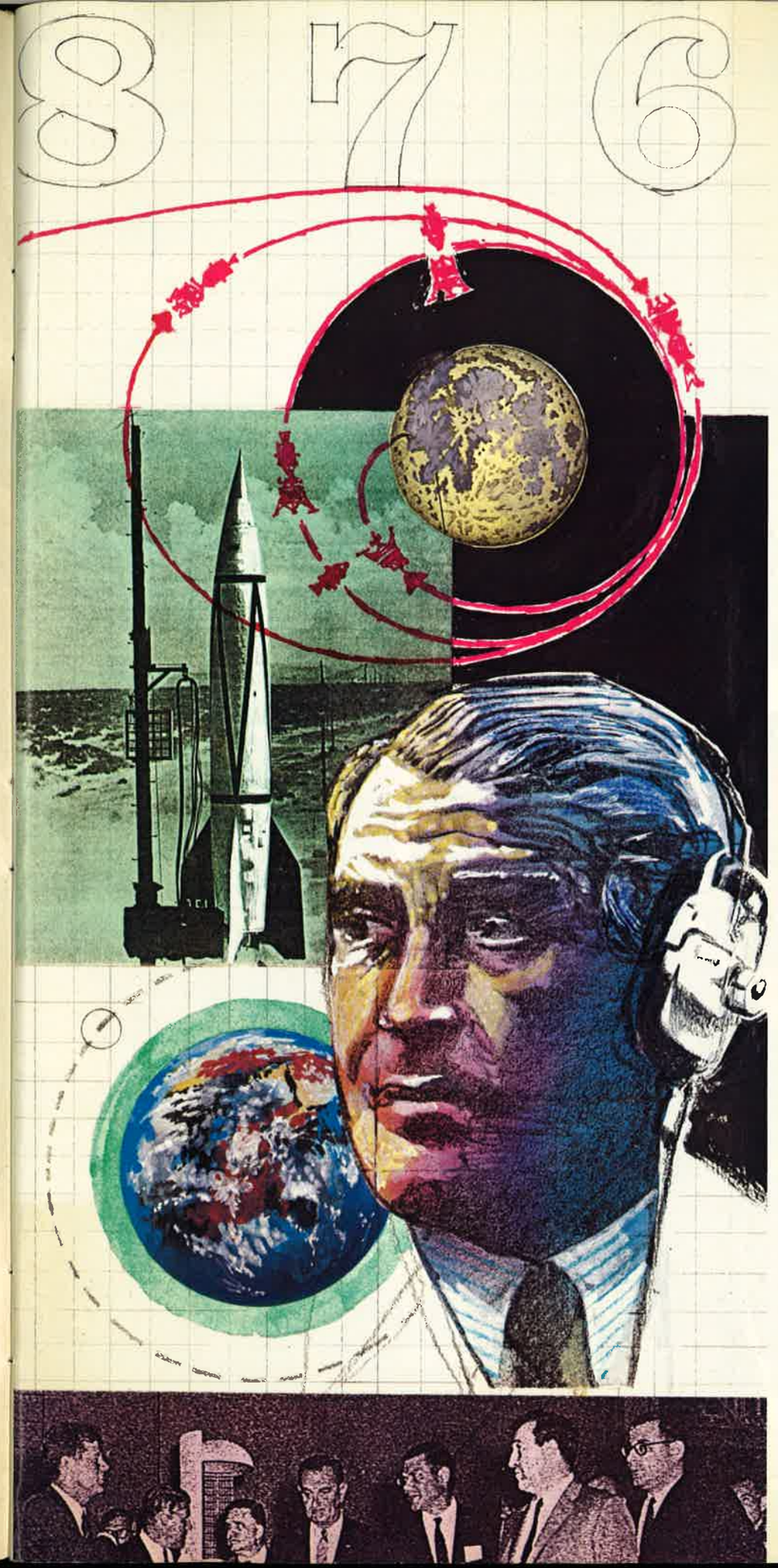
"He wanted the United States to be number one, and it wasn't," Robert Gilruth says. "It was just as simple as that. Of course, he was a young man."

Once the President had staked the nation's reputation on reaching the moon by the end of the decade, NASA officials who had campaigned for years for such a mission were suddenly faced with the boggling problems of actually meeting his all-or-nothing challenge.

"They didn't have the faintest idea how to do it," remarks Willis Shapley, who reviewed NASA's programs for the Bureau of the Budget until 1965 and then served as associate deputy administrator of NASA until 1975. "Webb was very lukewarm when he first came in—he had worked a lot for the government and knew what a billion dollars was."

Congress, for its part, helped ease the pain by opening the Treasury coffers to a degree that had never been seen for a single-purpose, non-military venture. The space agency's budget soared from $523.6 million in 1960 to an Apollo-era high of $5.25 billion in 1965, an increase of more than 1,000 percent. Between 1961 and 1967, Congress cut the administration's NASA funding request by more than 10 percent only once: an across-the-board reduction in 1964 of 10.7 percent that did not eliminate any programs.

"We had a most unusual kind of economic situation, one that is in particular contrast with the situation today," observes recently retired Senator William Proxmire, a longtime watchdog of the NASA budget. "We had a very big increase in government revenues because the economy was doing well. And there was a feeling that we wanted to maintain those revenues and not cut taxes. It was argued that what we should do, in order not to slow the economy by running surpluses, was give a substantial amount back through revenue sharing.



Therefore there was funding available to go ahead with this exciting activity in space."

With a blank check and White House blessings, Webb and his top NASA managers proceeded to forge not just a moonship but an earthbound technological empire to support it. "We were getting a lot of money—to build facilities, to build the biggest machines the human race had ever built, to bring universities into a different relationship with the national government—and that obviously required a lot of things different than had gone on in ordinary procurement," Webb says. "It wasn't possible, in my view, to sit down and say, 'Here's a standard form of organization—personnel department, operations department, supply department, and so forth.' We had to get a development and testing philosophy going in a hurry, based on the latest science in this field. We were building a capability for the entire United States."

By the end of 1961, Webb—who was not an engineer but a lawyer and businessman who had directed the Bureau of the Budget under President Truman—had reorganized NASA so that what had originally been a widely scattered group of semi-independent research fiefdoms all reported directly to headquarters in Washington. Industry contracts were quickly awarded for the Apollo booster, command section, and guidance system (NASA-sponsored feasibility studies had been under way in the aerospace industry since the fall of 1960, with hopeful contractors spending millions of their own above what the space agency paid them). Webb and his closest deputies decided the biggest contracts personally, wielding enormous power in a fashion that would be politically impossible today. Still, the question of just how to get to the moon—whether by direct ascent or some indirect path involving an Earth or lunar orbital rendezvous—went unanswered.

The configuration of the entire rocket—and, of course, the ultimate disposition of billions of dollars—depended upon the choice of a flight scheme. This issue ignited fierce rivalries throughout the space establishment, most of all between NASA and the academic science community. Although the obscure but elegant lunar

orbital rendezvous (LOR) method, in which a spacecraft would orbit the moon while a separate vehicle would travel to and from its surface, was finally accepted by all in late 1962, the principal adversaries still bear battle scars.

"The argument essentially was that the lunar orbit rendezvous approach made sense for going to the moon but didn't make much sense for other kinds of space activity," says Franklin Long, a Cornell chemist who chaired a space vehicle study panel for the President's Science Advisory Committee. "A takeoff from Earth orbit made very good sense for the longer term."

"They were seeking power, they weren't just seeking a particular outcome," Webb says of the presidential committee critics, barely willing to offer an olive branch after two decades. "The scientists really felt that a lot of decisions by the military during World War II were not wise and that the president must find some way to rely on scientists, who knew what they knew better than other parts of our society."

"Some people thought LOR was the craziest idea they'd ever heard," Willis Shapley remembers. "Nobody had come close to doing anything like that before. To bet all the chips on it, wasn't that the wrong idea?"

The struggle came to a peak, at least in the media's eyes, during a presidential tour of Marshall Space Flight Center in Huntsville, Alabama, in September 1962. As Wernher von Braun briefed the entourage about LOR, by then strongly favored by NASA, Kennedy interrupted saying, "I understand Dr. Wiesner doesn't agree with this." Wiesner began reviewing his objections to LOR when Webb jumped in to defend it. Kennedy stopped the confrontation by saying that the subject was still under review. The press played up the fracas angle, suggesting there might be weaknesses in Apollo's technical framework.

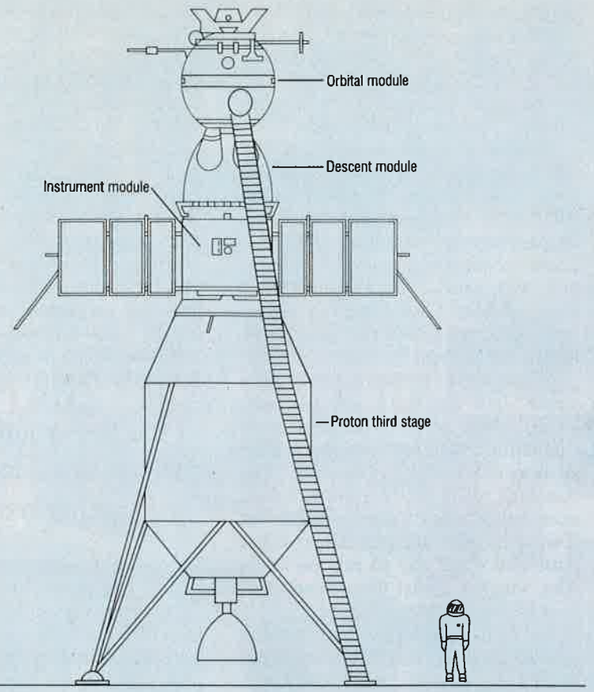
Wiesner maintains today that "von Braun and I were just talking. I remember I asked him some question about the rocket, and he was answering, when Jim Webb—who thought we were arguing—came up and *started* an argument." Wiesner still believes that LOR was more of a "political accommodation" to internal rivalries among NASA's own research centers than a solution based purely on technical merit. With a laugh, he recalls Kennedy's quip to Solly Zuckerman, the British government's scientific advisor, who had wondered which faction would win: "Webb's got all the money, and Wiesner's only got me."

The next four years, until the beginning of 1967, were bread-and-butter times for Apollo. The herculean engineering task of getting myriad contractors to produce diverse hardware and funneling the pieces to Cape Canaveral (called Cape Kennedy from 1963 to 1973) according to a lockstep schedule proceeded at a pace that has never been

> "Tell that young guy the facts of life," Johnson said to another participant.

matched. One major management decision of this period was to subject the Saturn boosters to "all-up" flight testing. This risky procedure meant that instead of testing component by component, gradually building confidence in an entire system, the full apparatus would be tested in its ready-to-fly configuration. Supposedly, this would produce a maximum amount of information from a minimum number of flights, but it is not considered orthodox engineering. It is often seized upon when a costly program is under intense schedule pressure. Indeed, NASA made the all-up move after a mid-1963 internal study calculated the chances of landing on the moon by 1970 at only one in 10.

"Working for NASA was, at times, hell," says George Skurla, who directed the Grumman Corporation's work at Cape Canaveral and then went on to become the company's president. "At the Cape, all the hardware was feeding in from all over the United States to make up that 363-foot stack of launch vehicle and payload. NASA had to be awfully demanding and, you might say, arrogant. One of the outstanding accomplishments was putting together this government-industry team and marching the whole parade to a common drumbeat. But it left a lot of human wreckage in its wake in terms of broken families, divorces, and busted profes-



The Other Side of the Race

Could the Soviets have intended to combine a Soyuz vehicle and a Proton booster to create a moon craft?

In the summer of 1969 reports began circulating in the West that a powerful new Soviet booster had exploded at the Tyuratam launch complex. The Soviets had been preparing the gigantic rocket for either a static test or an actual launch when its propellants ignited. The explosion not only destroyed the launch vehicle and its complex, it also put an end to Soviet hopes of winning the race to the moon.

The Soviets never publicly acknowledged the Tyuratam disaster, even though the damage was extensive enough to be photographed by U.S. reconnaissance satellites. And while Westerners believe that there was in fact a space race between the United States and the Soviet Union, with the well-defined goal of placing a man on the moon and returning him safely to Earth, the Soviets have never admitted to participating in such a contest. It has taken careful analysis of the Soviet space program—often with the benefit of hindsight—for Western observers to conclude that until the Tyuratam explosion the Soviet Union certainly did have a program to rival Project Apollo.

Throughout the 1960s Soviet scientists and cosmonauts made comments indicating that they were in competition with Apollo. In 1967-68, however, they became more guarded. Although the Soviets were able to fly unmanned craft to lunar distances and test their lunar vehicles in Earth orbit with men aboard during 1968-69, there was speculation in the West that they were facing technical problems. The Soviets would not comment, however. To understand their reticence it is essential to recall their attitude at that time: in space—as in all high technology—during the 1950s through the 1970s the Soviets *never* came in second.

The first element of their manned lunar effort was the Zond series of spacecraft, an offshoot of the Soyuz vehicle that made its first unmanned flight in 1966. Zond 5 flew around the moon in September 1968. Launched by a four-stage Proton booster, Zond 5 looped behind the moon, then returned to Earth to splash down in the Indian Ocean. Zond 5's mission profile wouldn't have been acceptable for a manned flight, however: its reentry G-loads were much too high. Two months later Zond 6 rectified the problem with a "double skip" reentry that resulted in lower G-loads. According to a statement released after the mission, Zond 6 was intended "to perfect the automatic functioning of a manned spacecraft that will be sent to the moon." This is the most explicit admission the Soviets made about the existence of a manned lunar effort.

NASA officials were concerned that after the Zond flights and the successful Soyuz 3 mission in October 1968, the Soviets would attempt to fly a manned Zond around the moon before Apollo 8 could accomplish the same mission. The Zond launch window came at the end of the first week in December 1968 but no launch took place. Most likely excessive vibration made the first stage of the Proton booster unsafe for manned flight.

Analysis of the Soyuz spacecraft provided more evidence that the Soviets were aiming for the moon. Unveiled to the world on the Soyuz 3 mission, this new generation of spacecraft had three modules: an instrument module, a descent module that carried the crew at launch and recovery, and a spherical orbital module, mounted topmost, which was described as workspace for experiments. (The Zond lacked only this spherical module.) Observers of the Soviet space program were struck by one design anomaly: the orbital module was oriented differently from the descent module, with its "up and down" in different directions. If the spacecraft were sitting on its base with the orbital module on top, crew members in the descent module would be on their backs looking up the craft toward the orbital module, much as Apollo crews were in the command module. When they were in the orbital module on the top, the cosmonauts' would be standing with their feet pointing down along the length of the vehicle. It was as if the orbital module were designed for work in a gravitational field, much like the ascent stage of the Apollo lunar module.

In retrospect, it is obvious that the Soyuz was designed to carry men to and from the moon. During the landing, cosmonauts would stand upright in the orbital module, looking down at the moon during touchdown. The orbital module hatch would face down toward the lunar surface after the landing, allowing easy exit and return.

The major missing element for a Soviet lunar mission was a giant booster equivalent to the U.S. Saturn V. In 1967 NASA administrator James Webb testified before a Congressional committee that the Soviets were developing such a booster, which was dubbed Webb's Giant in the U.S. press (the defense department used the designations SL-15 and TT-5 for the vehicle, also called a G-type booster). Rumors and satellite photography indicated that the giant booster was being readied for flight, possibly in an attempt to beat Apollo to its lunar goal. The explosion in July 1969 effectively dashed those hopes. The Soviets did fly two more Zond flights around the moon, but two more SL-15 failures ended the Soviet manned lunar program.

It wasn't until 1984, when they started to reveal details about the Proton booster, that the Soviets provided the first clues about the profile for a lunar mission with Soyuz. The second and third stages of the Proton vehicle apparently would have been coupled with the SL-15 booster, just as the upper stage of the U.S. Saturn 1-B would fly on the giant Saturn V.

The Proton's second stage was just the right size to take the Soyuz and third stage out of Earth orbit and into a translunar trajectory, while the Proton third stage had just the right propellant load to place a fully fueled Soyuz into lunar orbit, land it on the moon, and re-launch the landing craft either into a direct return trajectory to Earth or into lunar orbit, where the Soyuz could use its own propellant for a return to Earth. With this mission profile, the Soviets could have flown a mission to the moon with no need for rendezvous and docking and therefore no separate lunar module. It would have been a long descent down a ladder from the Soyuz to the lunar surface, but some early Apollo concepts called for a similar long climb down to the moon.

The SL-15 booster was scrapped after the third launch failure, but other elements of the program have seen regular use since then. The Proton booster is regularly used for unmanned flights, while modifications of Soyuz are still in use for manned flights. In the last 20 years all the elements of the manned lunar complex have been man-rated: only a giant booster has been missing. The introduction of Energia in 1987 could allow the Soviets to reconstruct their 1960s lunar mission profile at short notice (if they want to) and fly men to the moon in the early 1990s. Realistically, though, such a mission would require the introduction of completely new spacecraft.

The Soviets have yet to put men on the moon, but when they do, it is unlikely they will abandon it as the United States did after Apollo 17. We are no longer in an era where the Soviet Union would pull off a major spaceflight stunt simply to beat the United States. Clues to the Soviet philosophy are provided by recent statements indicating that they hope to fly the first men to Mars in about 2007, and they hope to begin a permanently manned base on that planet by 2015.

—Phillip S. Clark

sional careers. The guys were so caught up and driven that they let their families drift, or if they gave NASA a hard time about something, they'd be summarily thrown off."

Doubts about NASA priorities and methods were perhaps freer to surface following Kennedy's assassination, especially among scientists who feared that the gargantuan costs of manned spaceflight would starve "real" space science. Unmanned probes such as Ranger and Surveyor were being subordinated to the lunar landing mission, which was consuming more than two-thirds of the annual space budget. NASA established science planning teams to propose lunar research, but to outside scientists this looked like little more than window dressing. It was to be a perpetual dilemma.

There were other budgetary concerns: the escalating American involvement in Vietnam and costly social programs were putting a strain on the federal coffers. With domestic tensions rising, many Americans began to see the goal of putting a man on the moon as one the country could not afford.

"From the time Johnson came in, you could feel the constraints," recalls Robert Seamans, NASA's associate administrator from 1960 to 1965 and deputy administrator until 1968. "I remember going to a meeting of cabinet and agency officials when Johnson was trying to cut the federal budget by five percent. He gave us a big lecture in straightforward, barnyard language about cutbacks. When we left the meeting, he wanted everybody to shake his hand and promise they would cut their expenditures by five percent. When it was my turn to go through, I decided I would say, 'We'll obviously do our best to comply, Mr. President, but I'm sure you wouldn't want us to jeopardize the safety of the astronauts.' He didn't like that. The president then told one of the other participants to 'tell that young guy the facts of life.' "

Through 1965, Apollo managers and engineers were especially plagued with the dual challenges of shaving cost and weight from the program—two factors that have resisted firm estimates since the earliest days of aviation. Construction of the command module by North American Rockwell (now Rockwell International) was haunted by the torturous arguments about LOR, resulting in two different modules in production and continual design changes. The lunar landing module, built by Grumman, was in danger of growing too heavy to lift. With engineering design nearly complete, Grumman was forced to "scrape" (the actual name of one of its weight reduction projects) some 2,400 pounds from the 33,000-pound lander. One result was the distinctive foil wrapping that replaced rigid heat shields, saving about 110 pounds. But the desperate measures also made the lander fragile and difficult to fabricate, requiring even more human attention. Both North American and Grumman saw their cushy cost-plus contracts changed to incentive agreements, whereby the companies faced stiff financial penalties if

> "Working at NASA left a lot of human wreckage in its wake."

technical criteria were not met.

"I don't think NASA paid for more than about 70 percent of the true human effort that went into Apollo," Skurla says. "A lot of people worked day and night. We all were swept up in it. I call the story of my life then 'the agony and the ecstasy.' "

On the evening of January 27, 1967, three Apollo astronauts, including Gus Grissom, one of the original Mercury seven, died grisly deaths when some electrical equipment in the all-oxygen atmosphere of their test command module accidentally ignited. An investigation blamed the Apollo 1 tragedy on "many deficiencies in design and engineering, manufacture, and quality control." Heads rolled at both NASA and North American, direct costs to the Apollo program reached $410 million, and the first manned flight test was delayed for 18 months. At the time of the disaster, schedules had included a possible lunar landing before the end of 1968.

Instead, 1967 and most of 1968 were devoted to unmanned flights of the Saturn rocket and payload. These were successful enough to risk a manned Earth-orbit flight, designated Apollo 7,

by October 1968. Apollo missions 8, 9, and 10 continued the dress rehearsal as a new president took office, the Vietnam War and domestic racial turmoil sapped the nation's enthusiasm for space, and the federal budget suffered its largest deficit since World War II. The sanctity of John Kennedy's challenge was fading fast.

The objectives of the July 1969 Apollo 11 mission were listed by NASA officials in an implementation plan as follows: "1. Perform a manned lunar landing and return. 2. Perform selenological inspection and sampling." In other words, get there, pick up some rocks, come home.

And that's what they did.

Looking back on those heady days 20 years later, key Apollo players share wistful memories interspersed with regrets that the times have changed and that the political and economic circumstances behind them seem unlikely to converge again.

"I remember going up to Montrose Park in Georgetown after telling the House authorization committee that we could do Apollo," Robert Seamans says. "It was a night with a full moon. I looked up and wondered if I was nuts. I think everybody had a little of that feeling."

James Webb recalls a party at his Washington home during the early years, when Vannevar Bush, a science advisor to F.D.R. and one of the nation's most prominent scientists, "grabbed me by the lapels and shook me, saying, 'What are you doing, you're going to kill these men!' "

Webb admits that some of his Apollo methods would be inappropriate today but is not eager to muse about what might be appropriate. Seamans laments that the NASA of the 1980s is "mostly a contract administration agency," with little funding flexibility to maintain a cadre of people developing bold new ideas. As Robert Gilruth cautions, it is hard for any cutting-edge organization to last so long, "especially without anything new on the horizon.

"It was a good thing for us that we had a young president," Gilruth concludes. "And it was fortunate that the task he assigned us was something that could be done. It wouldn't be easy to do again." ☛