MOONSHOTS

50 YEARS OF NASA SPACE EXPLORATION SEEN THROUGH HASSELBLAD CAMERAS

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VOYAGEUR PRESS

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Project Manager: **Jordan Wiklund**
Art Director: **James Kegley**
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“WE CHOOSE TO GO TO THE MOON IN THIS DECADE AND DO THE OTHER THINGS, NOT BECAUSE THEY ARE EASY, BUT BECAUSE THEY ARE HARD, BECAUSE THAT GOAL WILL SERVE TO ORGANIZE AND MEASURE THE BEST OF OUR ENERGIES AND SKILLS . . .

BUT IF I WERE TO SAY, MY FELLOW CITIZENS, THAT WE SHALL SEND TO THE MOON, 240,000 MILES AWAY FROM THE CONTROL STATION IN HOUSTON, A GIANT ROCKET MORE THAN 300 FEET TALL, THE LENGTH OF THIS FOOTBALL FIELD, MADE OF NEW METAL ALLOYS, SOME OF WHICH HAVE NOT YET BEEN INVENTED, CAPABLE OF STANDING HEAT AND STRESSES SEVERAL TIMES MORE THAN HAVE EVER BEEN EXPERIENCED, FITTED TOGETHER WITH A PRECISION BETTER THAN THE FINEST WATCH, CARRYING ALL THE EQUIPMENT NEEDED FOR PROPULSION, GUIDANCE, CONTROL, COMMUNICATIONS, FOOD, AND SURVIVAL, ON AN UNTRIED MISSION, TO AN UNKNOWN CELESTIAL BODY, AND THEN RETURN IT SAFELY TO EARTH, RE-ENTERING THE ATMOSPHERE AT SPEEDS OF OVER 25,000 MILES PER HOUR, CAUSING HEAT ABOUT HALF THAT OF THE TEMPERATURE OF THE SUN–ALMOST AS HOT AS IT IS HERE TODAY–THEN WE MUST BE BOLD.”

President John F. Kennedy, September 12, 1962

INTRODUCTION

The photographs taken on film by American astronauts five decades ago still have the power to amaze us, in our digital age. They are a vivid reminder of past achievements, but also lay down a challenge for the future.

In this age of infinite information, what could be more familiar to us than those famous photos of men walking on the moon? At the same time, what could be less familiar than the hazardous visit to an airless alien landscape a quarter of a million miles away, conducted by just twelve people in all the world? It is not just distance but time that separates us from the achievements of this special dozen. Their bootprints, undisturbed to this day in the lunar soil, were tramped down half a century ago, before most of the seven billion people now alive were born; and of those twelve explorers, who were not precisely young when they reached the moon, only seven (as of early 2017) are still with us to recount their stories firsthand.

Those men, who were in their prime when the world knew each and every one of their names, and who are teasingly, cruelly, still full of youthful vigor in those photos . . . They are old now, and some of their names no longer come so easily to the forefront of popular recollection. Time is doing what it always does: separating us from the tangibility of events, turning the vivid exaltations and terrors of one generation into the vague memories and clinical schoolroom subjects of the next, and reducing the historic achievements of the many people who worked in or around Project Apollo to just two names: Neil Armstrong and Buzz Aldrin, the astronauts who made the first lunar landing in July 1969. This book stands as a tribute to them, their fellow astronauts and NASA colleagues, and the four hundred thousand men and women from all walks of life who contributed to the American space program during the busy decade before Apollo finally reached the moon. *Moonshots* is dedicated also to the people who persevered in the space adventure, up to (and beyond) the moment when the last of the operational winged space shuttle orbiters rolled to a halt at the end of the runway in the early morning of July 21, 2011.

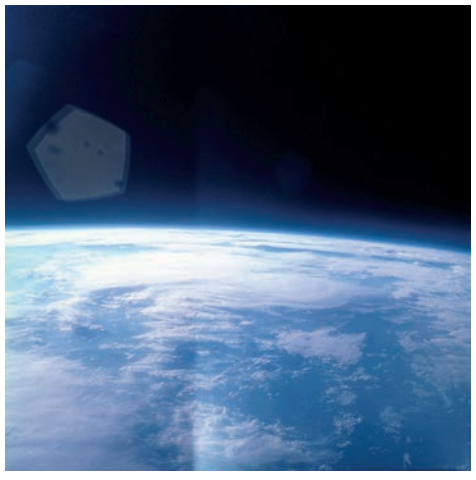
It is normal for us to forget. If asked to identify the men who first conquered the Atlantic on wings, most people would recall Charles Lindbergh, who made his famous solo flight in 1927, but it was a British pair, John Alcock and Arthur Brown, who were the first aviators to cross that daunting ocean in June 1919, by a neat coincidence almost exactly fifty years before Apollo 11's landing craft touched down on the moon. They flew a modified World War I Vickers Vimy

bomber with open cockpits, constructed from wood and canvas, held together by thin wires, and powered by a couple of sputtering Hispano-Suiza gasoline engines. At the time, this creaking biplane represented the pinnacle of technology, just as Apollo's similarly thin-skinned and fragile lunar module showcased the very best that 1960s ingenuity could devise.

Today the line for the restroom is on our minds as we hurtle across that same vast expanse of sea in air-conditioned jetliners flying ten times faster, and twenty times higher, than that old Vimy. We are headed toward important business meetings, family reunions, and wonderful vacations. We tend not to think of our own flights as epic. They are simply the fastest, most convenient, and least expensive means to our ends. Perhaps we pass the few hours that our crossings take by watching movies about men and women from long ago who did think in epic terms, and who were willing to risk their lives in terrifyingly fragile machines to pioneer a future that so many millions of us now take for granted.

So it is with the voyages of the first American astronauts. All of them believed that the hazards of rocket flight were worth taking for the benefit of future generations. The immediacy of their drama, and of the world's reaction to it, has faded over the last half a century because we remain unsure what kind of a future those astronauts were pioneering. Are we destined to go back to the moon? Are we supposed to set up camp on Mars? Such a goal may lie beyond this generation's capabilities, no matter what the Red Planet's fans try to tell us. We could get to Mars, but surviving there (and coming home again afterward) is another story. Are we supposed to hunt down asteroids? Not according to those who say that robotic probes are better suited to gather simple rock samples. Is the orbital realm where our spacefaring energies should be directed? We don't know any of the answers right now. Nevertheless, instinct impels us to believe that human space flight should continue, somehow, some way, for reasons as yet unclear.

All we do know is that if humans stopped venturing into space, we would mourn the loss of that capability and feel ourselves lessened as a species. Cash is not the problem. There is always enough money in the world to accomplish pretty much anything we want to, and still keep everyone fed. We could solve all the technical problems about life support and radiation too. The apparent holdup in our bid to become a spacefaring species is political, not mechanical.



Astronaut Wally Schirra tries out a Hasselblad camera, and (at left) one of the views of the earth that he captured during his orbital Mercury mission in October 1962.

It is not (and never has been) NASA's job to tell us where we should go next in space. The role of this government agency is to carry out national space policy, not to determine it. Essentially, that choice belongs to the American people, and to their international allies. It belongs, dear reader, to you.

NASA's Photographic Legacy

To see our way forward, it always helps to have a clear view of the past. To this end, space enthusiasts hunt down rare and faded artifacts: NASA press releases with foxed corners, their paper as stiff and dry as leaves in the fall, or Apollo-themed magazines unearthed in thrift shops, usually with torn covers and crumpled pages. Even the copies preserved in libraries lack the freshness they would have had when first printed, because paper and ink change over time. Yes, time is doing what it always does: separating us from the vividness and intensity of events. And yet, in the vaults of NASA's Johnson Space Flight Center in Houston, Texas, a precious set of resources is held in cold storage in an effort to hold off time's depredations. These are the original film strips extracted from the cameras carried by the astronauts. The strips are not changeless, because nothing is permanent, but they degrade slowly because of the conditions in which they are stored.

What does constantly change is how those film frames are interpreted in other media. The first iterations were released hot in the wake of the astronauts' fiery homecomings. For instance, on August 11, 1969, just two weeks after Neil Armstrong, Buzz Aldrin, and Michael Collins had splashed down, *Life* magazine released a special edition featuring large-format color images from the Apollo 11 mission. The December 1969 issue of *National Geographic* had extensive color coverage. By that point, NASA's press office had sent out thousands of transparencies, prints, and other materials.

So what exactly were we looking at—those of us old enough to have seen those 1960s magazines after they first rolled off the presses? For guidance on this question, we have the wisdom of Ansel Adams (1902–1984), America's greatest landscape photographer, and one of the best photographic craftsmen who ever lived. What came out of his camera was not the final result. "The negative is comparable to the composer's score, and the print to its performance," he asserted. "Each performance differs in subtle ways." It was his total mastery of deriving positive paper prints in the darkroom that established his reputation. It helped that the negatives he pulled from his camera were similarly superb, but sometimes he would explore different ways of interpreting the same negative, adjusting tonal range from soft to high contrast, or perhaps using a more silver-rich paper stock, and so on.

In that same spirit, NASA did a great job creating initial "performances" from their original film frames. Then it was up to the countless magazines, books, and other printed versions to add their own touches, and here is when the serious diversions from what we might think of as the original images really began to kick in. After the editorial selections were made, and the layouts decided (and often, after square images had been cropped to suit rectangular page layouts), then the printing presses put in their ten cents' worth of interference. The choice of paper had an influence on how the ink settled, as did the mood swings of the presses. It was easy for the black to go down a little hazy, or the cyan to come down too hard. By the time the public saw any of NASA's famous images from space, they assuredly were looking at "performances" based on a wide range of variables, some controllable, others down to chance.

On the Christmas Eve of 1968, Apollo 8 astronaut Jim Lovell reported from lunar orbit, "The moon is essentially gray, no color. It looks like plaster of Paris or sort of a grayish beach sand." How was any magazine editor supposed to check the color balance of a gray moon, when even the best print systems of that era had their own biases? Gray is a difficult thing to render in pictures built from cyan, magenta, yellow, and black inks. Furthermore, even the best color film stocks balked at registering colorless grays. Photographers working with film knew this very well and selected their stock for the well-known biases, some great for architecture and landscape, others suited to portraiture, and so on. There

never was a strip of color film that produced an absolutely "true" color rendering of a scene (whatever "true" means).

On top of that little problem, there just wasn't such a huge range of shots for picky editors to select from out of the Apollo haul, and that's why, over the years, we have tended to see the same ones reproduced time and again. A wonderful myth has gotten hold of some conspiracy enthusiasts. How could those lunar photos be real when they are so suspiciously perfect, as if created in a studio? If the doubters took the time to look through more than eight thousand frames retrieved from the handheld cameras of Apollo, and if they would only put themselves in the position of an art director trying to design a salable print product, they would struggle to select more than a few hundred that would pass muster. The sun's glare too often spoiled a shot. The spacesuits were so white and reflective they tended to bleach out, and so on. The astronauts were swamped by NASA's incessant demand for science tasks and had to point and shoot their cameras swiftly, without help from a viewfinder, while getting on with other work. It's amazing that they brought back as many good photos as they did, and much of the credit belongs to the cameras they wielded.

Wally Schirra, one of NASA's first team of astronauts, bought a Hasselblad roll film camera manufactured in Sweden and took it with him on his orbital flight aboard a one-man Mercury capsule in October 1962. His shots of Earth, hastily snapped through his tiny window, convinced NASA that Schirra had discovered a powerful tool, not just for space science but for public relations too. The film frames were large (two and a quarter inches square), yet the camera was surprisingly compact and mechanically rugged. The Carl Zeiss lenses were formidably sharp. Best of all, the Hasselblad was easy to reload. A conventional camera had to be opened up like a heart surgery patient, and its film carefully extracted and replaced. Astronauts could never have done this while wearing their spacesuit gloves. Hasselblad featured self-contained, instantly switchable film magazines. It was almost as if they had been designed with space explorers in mind.

> "THE FLIGHT EXPERIENCE ITSELF IS INCREDIBLE. IT'S ADDICTIVE. IT'S TRANSCENDENT. IT IS A VIEW OF THE GRAND PLAN OF ALL THINGS THAT IS SIMPLY UNFORGETTABLE."
>
> **Mercury-Atlas 7 astronaut Scott Carpenter, June 1962**

Into the Digital Era

A quarter of a century after the first lunar touchdown, the technologies of film were under threat from a new and fast-growing interloper: digital imaging. In the mid-1990s, Michael Light, another American cameraman with an eye for large format precision, was struck by the similarities between some of the desert landscapes of his homeland, and the surface of the moon. He experimented with digital scanning of NASA film materials at a time when this was not so easy as it is now. He wondered if he might gain access to the very first generation of copies made from the precious original Apollo film strips, including many from the suite of automatic mapping cameras carried in the service modules of Apollos 15, 16, and 17. Sensing that a fresh new "performance" was justified, Light took on the daunting task of digitizing some of the materials and readying them for a large-format book, *Full Moon*, first published to worldwide acclaim in 1999.

Light's book certainly featured Apollo hardware and astronaut activities, but mainly he wanted to steer clear of familiar "greatest hits" materials and tell what was, at that time, a less well-known story, where the lunar terrain itself featured as his leading subject. *Full Moon* was a significant achievement, and *Moonshots* aims to serve as a companion piece by focusing precisely on those more famous images that everyone thinks they have already seen.

In the two decades since *Full Moon* first appeared, the relationship between film archives and digital interpretation has continued to evolve, and we think that yet another "performance" of historic NASA images is justified. We also believe that printing the results on paper is important. Long after the world's fleeting electronic archives have been lost or deleted, surviving copies of this book will stand (with other similarly respectful volumes) as a testimonial to America's first decades in space. Stored carefully, these pages should stay almost as pristine as the film frames in NASA's vaults. One of the reasons why *Moonshots* comes with a slipcase is to help prevent the fading that often happens when a book is shelved in daylight. This book commemorates (and it seems incredible to say this) the fiftieth anniversary of the first human voyages to the moon, and its publication coincides also with a period of stasis between the shutdown of the space shuttle program and the full emergence of NASA's new crewed launch technologies.

Many of us hope that the Apollo missions will not turn out to be our only experience of walking on another world, and that future space explorers will get the chance to continue where those first explorers left off.

What do you think?

"IN 1969 I PREDICTED THAT THE SATURN V MOON ROCKET WOULD DOMINATE THE 1970s LIKE A COLOSSUS. IN THE EVENT, FAR FROM DOMINATING THE '70S, THE SATURN WAS DOMINATED BY THEM. BUT THE TIME WILL COME WHEN PROJECT APOLLO IS THE ONLY THING BY WHICH WE WILL REMEMBER THE UNITED STATES, OR INDEED THE WORLD OF OUR ANCESTORS, THE DISTANT PLANET EARTH."

Arthur C. Clarke, 1995


REMOVE DARKSLIDE
BEFORE INSTALLING MAGAZINE
HCEX
EVA
1/250
FULL SHADOW-5.6 LM IN SHADOW-5.6
CREW IN SUN-11 LM IN SUN-11
Mag. R
HCEX
ASA 160
Planar 1:2.8
REMOVE DARKSLIDE
P/N SEB 33100082-511 S/N 417
MADE IN SWEDEN

1 THE NEW OCEAN

Our pioneering journeys into space were not propelled by Cold War rivalry alone. Since the dawn of time we had dreamed of flying into the cosmos, and in the mid-twentieth century, we had the tools that could make those dreams come true.

> FIRST, INEVITABLY, COMES THE IDEA, THE FANTASY, THE FAIRY TALE. THEN, SCIENTIFIC CALCULATION. ULTIMATELY, FULFILLMENT CROWNS THE DREAM.

Russian space theorist Konstantin Tsiolkovsky, 1926

The story of space exploration is one of constant evolution. In the early twentieth century, rockets and space vehicles were the speculative visions of brilliant creative minds, such as Konstantin Tsiolkovsky, Robert Goddard, Hermann Oberth, and later, Wernher von Braun. Early science fiction writers such as Jules Verne and H. G. Wells inspired these forward-thinking pioneers. In the late 1950s, space technology emerged from the realm of pure imagination, and it became a major industrial, political, and military business. The world's first artificial satellite, Sputnik, was launched into orbit on October 4, 1957, using a converted ballistic missile. Essentially overnight, an epic rocket competition was unleashed between the United States and the USSR, the two Cold War superpowers. The world was captivated by the pioneering flights of satellites and probes, and then astronauts and cosmonauts, but the glamour of their missions could not entirely mask the fact that space exploration's opening chapters were dominated by political rivalry rather than science and peaceful exploration.

By the spring of 1961, the CIA and other American intelligence agencies had been warning for some time that the Soviets were preparing to launch a manned spacecraft. The rumors rapidly solidified into fact. On April 11, 1961, newly elected Democratic president John F. Kennedy appeared on an NBC early evening television program sponsored by Crest toothpaste. He and his wife, Jacqueline, talked with reporters Sander Vanocur and Ray Scherer about the difficulties of raising their small children and about the president's personal working style. Kennedy happened to remark that political events often appeared more complicated when viewed from inside the Oval Office than they did to the outside world. Even as he smiled for the cameras, he knew that a serious embarrassment awaited him in just a few hours' time. There was little he could do except brace himself.

At 1:07 a.m. Eastern Standard Time, NATO radar stations recorded the launch of a Soviet R-7 rocket, and fifteen minutes later a radio monitoring post in the Aleutian Islands detected unmistakable signs of live dialog with its human

occupant. At 5:30 a.m. Washington time, the Moscow News radio channel announced the latest Soviet triumph in space. An alert journalist called NASA's launch center at Cape Canaveral in Florida to ask, could America catch up? Press officer John "Shorty" Powers was trying to grab a few hours' rest in his cramped office cot. He and many other staffers were working sixteen-hour days in the run-up to the first flight of NASA's one-man Mercury spacecraft. When the phone at his side rang in the predawn silence, he was irritable and unprepared. "Hey, what is this!" he yelled into the phone. "We're all asleep down here!" Later that morning the headlines read: SOVIETS PUT MAN IN SPACE. SPOKESMAN SAYS U.S. ASLEEP.

Yuri Alekseyevich Gagarin, a twenty-seven-year-old Soviet Air Force pilot, had just become the first human ever to fly in space, aboard a small capsule named Vostok ("East"). Kennedy held an uncomfortable press conference. Normally a self-confident and eloquent public performer, he seemed distinctly less sure of himself than usual. He was asked, "Mr. President, a member of Congress today said he was tired of seeing the United States coming second to Russia in the space field. What is the prospect that we will catch up?" He replied, "However tired anybody may be—and no one is more tired than I am—it is going to take some time. The news will be worse before it gets better. We are, I hope, going to go into other areas where we can be first, and which will bring perhaps more long-range benefits to mankind. But we are behind."

Gagarin's short journey into space was one of the most important events of the twentieth century—not just for Russia, but for America too, where an industrial shake up of colossal proportions was unleashed in response. Much of the fabric of modern technology was designed with the Space Race (and a potential nuclear missile war) in mind. Microchips were developed because 1950s circuitry was too big, too heavy, and too delicate to fit inside rockets and missiles. The internet emerged from an attack-proof communications network laid down by the Advanced Research Projects Agency (ARPA), a pre-NASA government department that planned for America's future in space, among other things. The global communications industry developed with incredible speed after the invention of satellites. In all likelihood, these technologies would have come along anyway, but probably not as fast as they did. And all because Yuri Gagarin, a good-natured young jet pilot and now the world's first space traveler, had thrown down a challenge to the most powerful nation on earth.

Dr. John Logsdon, former head of the Space Policy Institute in Washington, D.C., has advised a succession of presidents and explains the impact of Gagarin's flight on the American psyche: "It was a sudden rebalancing of our power relationship with the Soviet Union, because of the clear demonstration that, if they wanted to, they could send a nuclear warhead across intercontinental distances, right into the heart of Fortress America. There was an uproar. How did we get beaten by this supposedly backward country?"

Responding to the Challenge

Kennedy was agitated at the global response to Gagarin's flight. He paced his office at the White House, asking his advisors, "What can we do? How can we catch up?" His science advisor Jerome Wiesner opposed any reckless rush, but the president wanted an urgent response. "If somebody can just tell me how to catch up. Let's find somebody. Anybody. I don't care if it's the janitor over there, if he knows how," the president said. He deliberately made these remarks within earshot of Hugh Sidey, a senior journalist from *Life* magazine. All of a sudden the president wanted to be seen as an advocate for space.

Three days later, he suffered another more serious defeat. A 1,300-strong force of exiled Cubans supported by the CIA landed at the Bay of Pigs in Cuba with the aim of destroying Fidel Castro's communist regime. Kennedy had approved the scheme, but Castro's troops learned of the operation ahead of time and were waiting on the beaches. The raid was a disaster. The Kennedy administration seemed to be faltering in its first one hundred days, the traditional honeymoon period during which a new president was supposed to

stamp his particular vision on the country. He immediately turned to space as a means of reviving his political credibility. In a pivotal memo of April 20, he asked his vice president, Lyndon Johnson: "Do we have a chance of beating the Soviets by putting a laboratory in space, or by a trip around the moon, or by a rocket to land on the moon, or by a rocket to go to the moon and back with a man? Is there any other space program which promises dramatic results in which we could win?"

Johnson, a keen supporter of space technology, convened a panel of experts to help decide the matter, but he already knew which option he favored. Wiesner commented afterward, "Johnson went around the room saying, 'We've got a terribly important decision to make. Shall we put a man on the moon?' And everybody said, 'Yes.' And he said, 'Thank you,' and reported to the president that the panel said we should put a man on the moon." Or to put it another way, in the words of Pulitzer Prize–winning historian Walter McDougall, "Johnson sent the president a report so loaded with assumptions that a moon landing was the inescapable conclusion."

As a powerful Democratic senator supporting the Democratic cause throughout the Eisenhower presidency, Johnson had overseen the creation of NASA in 1958, in response to Sputnik. Now he steered it toward the moon because he believed in the value of that goal, not just as a sturdy reply to Soviet domination, but also as a genuine expression of American destiny. His politics had been forged in the 1930s Roosevelt New Deal era. Kennedy was somewhat more pragmatic and went along with the lunar landing idea because it was expedient for him at the time, but when he did decide to push for it, he did so by delivering some of the most eloquent and memorable speeches in all of political history.

A final decision hinged on NASA getting its manned space program off the ground. On May 5, just twenty-three days after Gagarin had flown, astronaut Alan Shepard was launched atop a small Redstone missile. His flight wasn't an orbit, merely a ballistic hop of fifteen minutes' duration. In contrast to Vostok's orbital velocity of 17,500 miles per hour, Shepard's Mercury achieved only 5,000 miles per hour. Vostok girdled the globe while the Mercury splashed down in the Atlantic just 320 miles from its launch site. But this cannonball flight was enough to prove NASA's basic capabilities. Stunned by the potential costs, Kennedy nevertheless decided to support NASA's Apollo lunar project. In a historic speech before Congress on May 25, 1961, he said, "I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon, and returning him safely to the Earth. No single space project in this period will be more impressive to mankind, or more important for the long-range exploration of space, and none will be so difficult or expensive to accomplish."

Not so many months before, Kennedy and his administration had struggled to find anyone willing to lead NASA, because it had seemed, at first, like a small agency engaged on a high-risk, underfunded Buck Rogers experiment. Seventeen highly qualified people turned down the job. Fortunately, an acquaintance of Lyndon Johnson was willing to take on the task. James Edwin Webb took up Kennedy's challenge, and rapidly gathered together the political, financial, real estate, and technological resources that NASA would need. A master of political machination, Webb took care to spread the NASA activities far beyond just the Florida launch site. That choice of seaboard location was dictated by technical considerations to do with the rotation of the Earth, and by the need to keep rockets away from built-up areas. No such justification existed for building NASA's new mission control center far away in a dusty patch of Texas scrubland, but Webb knew that it made excellent political sense. His skillful stewardship gave NASA the momentum it needed.

Throughout the mid-1960s, NASA demonstrated to the world a "can-do" spirit with its two-man Gemini spacecraft, rehearsing most of the techniques we now take for granted in space travel, such as space walks, orbital rendezvous, and dockings. However, on January 27, 1967, the crew of the first Apollo spacecraft, Ed White, Roger Chaffee, and Virgil "Gus"

> “I TRAINED HARD FOR MANY YEARS TO FLY AROUND THE MOON AND TAKE A CLOSE LOOK AT IT, BECAUSE I THOUGHT THAT’S WHAT THE MISSION WAS. WHEN WE GOT HOME, I REALIZED WE HAD DISCOVERED SOMETHING MUCH MORE PRECIOUS OUT THERE: THE EARTH. I BELIEVE THE ENVIRONMENTAL MOVEMENT WAS TREMENDOUSLY INSPIRED BY THOSE MISSIONS. THAT ALONE IS WORTH THE RELATIVELY FEW BILLIONS OF DOLLARS THAT WE SPENT ON APOLLO.”
>
> **Apollo 8 astronaut Bill Anders**

Grissom, died when their capsule caught fire just sitting on the launch pad during what should have been a routine communications test. The subsequent investigation revealed faults in the Apollo’s design, and management errors both within NASA and among the manufacturing contractors were generated in part by everyone’s sense of urgency as they rushed to meet Kennedy’s famous deadline for reaching the moon.

Speeding Up the Race

Apollo 7, the first successful crewed flight in the series, was launched into Earth orbit in October 1968, atop a half-sized variant of the Saturn rocket known as the 1B. Mission commander Wally Schirra, and colleagues Donn Eisele and Walter Cunningham, proved that the spacecraft was ready for action. The huge Saturn V moon rocket had failed badly during an unmanned test flight, so it took some nerve for NASA to put astronauts on the next available one and send them straight to the moon aboard Apollo 8, regardless of the fact that they could not land, because the landing module was also experiencing development problems.

Subsequent Apollo missions were launched in quick succession, one flight following another at a pace that seems incredible in retrospect. Apollo 9 tested NASA’s spidery lunar module (LM) in Earth orbit. The next mission swooped to within a tantalizing few miles of a lunar touchdown, and at last, on July 20, 1969, an ancient dream was fulfilled. Men had walked on the moon. Who could have guessed that in just another three years’ time it would once again slip beyond our reach for at least another generation?

In his celebrated memoir, *Carrying the Fire*, Apollo 11’s command module pilot Michael Collins recalled worrying about what he would say as he concentrated on the switch settings to blast the ship out of Earth orbit and into deep space. “If we’re going to leave the gravitational field of Earth, what are we going to say? We should invoke Christopher Columbus, or a primordial reptile coming up out of the swamps onto dry land for the first time, or go back through the sweep of history and say something meaningful.

> IF WE CHOOSE TO TRAVEL INTO SPACE IN THE FUTURE, IT SHOULD NOT JUST BE TO CONQUER NEW WORLDS AND REPLICATE OUR SPRAWLING SHOPPING MALLS ON OTHER PLANETS. WE SHOULD GO OUT THERE TO DISCOVER MORE ABOUT OURSELVES, AND TO LOOK BACK, WITH WISER AND MORE APPRECIATIVE EYES, AT THE WORLD WE LEAVE BEHIND.
>
> **Apollo 8 astronaut Bill Anders**

Instead, all we had was our technical jargon." If an astronaut was dismayed by his own terminology, just imagine its demoralizing effect on the rest of humanity. The famed novelist and journalist Norman Mailer visited NASA's Florida launch complex in that epochal summer of 1969 and saw a technocratic army of white middle-class men sitting at their control panels in neat, obedient rows, most of them dressed alike in white shirts and black ties. Listening to them as they readied Apollo 11 for launch, he thought that "their strength apparently derived from being cogs in a machine. They spoke in a language not fit for a computer of events that might yet dislocate eternity." Neither NASA nor its astronauts were trained for the ambiguities of art, literature, or poetry. The problem turned out to be that poetry was exactly what the rest of the world needed if it was to appreciate Apollo's achievements properly. As Michael Collins remarked after his historic mission, "A future flight should include a poet, a priest, and a philosopher. Then we might get a much better idea of what we saw."

Fifty years later, we can perhaps appreciate—even more than the world did at the time—the incredible achievements of the Gemini and Apollo series. Even after the Apollo 13 scare, NASA's space machinery seemed highly advanced and futuristic for its time. From our perspective, it all looks insanely delicate and dangerous. We, who have been raised on personal tablets and smartphones, can hardly understand the idea of guidance computers with switches and dials, let alone lunar landing vehicles swathed in silver and gold foils that you could have punched a fist through without even scratching yourself. Apollo was the product of a different age, and its success has much to teach our arguably more pampered and risk averse society about stretching the limits of the possible and getting things done.

Anyway, that supposedly antique technology still had some surprises up its sleeve. In April 2007, visitors to a NASA museum exhibit discovered that the apparently lifeless artifacts on display from a long-vanished era of space exploration were not quite so dead after all. As if in some technological version of *Raiders of the Lost Ark*, a team of

awestruck technicians was carefully removing access panels on a spare, unused Apollo spacecraft, revealing pristine mechanisms within.

This was backup hardware for the 1975 Apollo-Soyuz docking mission that signaled the end of the Cold War rivalry in space. All the systems were intact. The investigating team was granted permission to strip down the one small section of the spacecraft that most interested them. They wanted the answer to a problem that had beaten the best minds in modern space engineering. At the end of its mission, and just prior to reentry into the earth's atmosphere, an Apollo capsule had to separate cleanly from the cylindrical service module that had carried most of its air, water, electrical supplies, and propulsion fuels. Many dozens of power wires, fluid cables, and data conduits had to be disconnected in an instant. How was this accomplished reliably, and in a split second, by those cranky old engineers from a bygone age?

The team discovered inside the Apollo a tiny set of explosive guillotines, through which all the cables and lines snaked in a neat bundle. When the time came for the capsule to drop away, the guillotines sliced through metal and plastic as though they were butter. A backup set of guillotines, powered by an entirely separate electrical system, insured against failure. And all in a box the size of a car battery. It seems as if Apollo still has lessons for us, as NASA gears up for new voyages in the coming generation. The upcoming Orion spacecraft looks very much like Apollo's bigger brother.

Today we often hear that the on-board Apollo Guidance Computer (AGC) had less power than a modern digital watch. But it all depends on what we mean by "power." In its way, it was one of the most capable computers ever invented. It absorbed data from a complex gyroscopic inertial navigation system, allied to an optical star telescope and two radar range finders. It also mediated between the astronauts and the thrusters and rocket engines that drove their ship through space.

NASA favored ruggedness over sophistication. Even when Apollo 12 was struck by lightning soon after launch in November 1969, and the interior of the capsule blacked out for a moment, its AGC cycled back to life in less than a second. It was a reliable piece of equipment because it had to be. There is more to great technology than complication for its own sake, and this is another lesson that Apollo can teach us.

Humans or Machines?

Discussion about Apollo usually calls to mind the big question about space exploration. Do we need to send people? Robotic missions have already shown us that there are other worlds, far beyond Earth, that are potentially within our reach. Today, the International Space Station is just the first stage in a journey that may take us deeper into the solar system. When we see the canyons of Mars through the sharp digital eyes of robot rovers, who among us does not imagine standing among those same landscapes and seeing them with our own eyes? Fifty years ago, such dreams were science fiction. Then, just for a moment at least, they started coming true. If we are to continue our explorations of space, there will always need to be at least some human involvement, or else it will not be a fully human adventure.

Arthur C. Clarke believed that "one day we will not travel in spaceships. We will be spaceships." In a sense, we already are. Robot probes are extensions of our minds and our physical reach, allowing us to scrabble in the soils of distant worlds with remotely operated claws. Does that mean we no longer have to go to the trouble of turning up in person to clutch handfuls of alien dust in our own (albeit, gloved) hands? Logic suggests that machine probes are the safest and most cost-efficient tools for space exploration. Instinct and emotion cause many of us to think differently; otherwise no astronaut, cosmonaut, taikonaut, or private adventurer would ever leave the ground. Whatever the economic or political arguments may be, it has become almost impossible for us to imagine a world without people in space helmets. Should the day ever arrive when we are incapable of launching anyone into the limitless expanse beyond the thin skin of our atmosphere, surely this will indicate that something has gone dreadfully wrong back on Earth.

About the Cameras

Wherever humans go, they want to record what they see and share their experiences with others. Scientists often need complex data from space missions—temperatures, radiation counts, spectral analyses, mineral ratios, and so on—but almost all the popular awareness of human space exploration comes from the more straightforward visual record. While NASA's first team of seven astronauts was preparing for their Mercury missions, relatively little thought was given to the use of normal film cameras. The priority was to get those men up and beat the Russians. An early design for the Mercury spacecraft even proposed leaving out the window, because it was a structural weakness.

The astronauts were self-motivated aviators, and they rebelled in no uncertain terms about that window. When John Glenn was launched to orbit in February 1962, he carried with him a small Ansco Autoset 35-millimeter camera, manufactured by the Japanese company Minolta. He barely had time to use it. Anyway, in the tense political circumstances at that time, NASA worried that taking snapshots of the Earth from space might come across as an attempt to acquire spy photographs while the astronauts were passing over other countries. Various extremely secret surveillance satellite programs were getting under way at the same time as project Mercury, with budgets and resources that almost matched NASA's, so there was a great deal of sensitivity about the use of cameras in general. It quickly became obvious that astronauts operating in the spotlight of national publicity should be allowed to carry cameras, and when Wally Schirra tried out his personal store-bought Hasselblad 550C during his orbital Mercury flight in October 1962, he fell in love with it, and the obvious scientific and publicity value of recording a space mission photographically was established. Today it seems bizarre that there ever could have been a time when cameras were an afterthought in the astronaut story.

On Apollo 8, Hasselblad EL cameras were used for the first time. They featured battery-powered motors that wound on the film and readied the shutter at the press of a button, greatly speeding up the picture-taking process. Each replaceable magazine could hold sufficient film for 160 color Ektachrome or 200 black and white Panatomic-X frames, captured on specially thin film bases developed for NASA by Kodak. From Apollo 11 onward, a further upgrade to the Hasselblad, the 500EL, was used. A transparent glass Réseau plate, engraved with grid markings, was installed between the film magazine and the camera body. From these markings, it was possible for photo analysts to calibrate the distances and heights of objects in the frames. Those thin black crosses are among the most iconic elements in any Apollo photo.

The Hasselblad Company today has, of course, gone digital. Its latest cameras can deliver images of almost unbelievable sharpness and resolution, but no matter what great new systems it unveils in the future, there is no doubt that this famous brand will always be celebrated for its pivotal role in the exploration of space.

MASTER ALARM

ACCEL G

ATT SET IMU

RATE	ATT DB MIN	ATT DB MAX	MAN RATE
LOW	±.2° ±.2°/sec 5.2 lb/hr	±4.2° ±.2°/sec	±.7°/sec
HIGH	±4° ±2°/sec 1.1 lb/hr	±8° ±2°/sec 1.0 lb/hr	±20°/sec ±7°/sec

NORMAL
STBY
BACKUP
VHF RNG
MODE
OFF
EMS TEST

ΔV/RANGE

ABORT

MIN 1 4 SEC 5 2

LV RATE
S II SEP
LV GUID
LV ENGINES
4
1
5

S II FUEL/S IVB OXID
LV TANK PRESS
S IVB FUEL