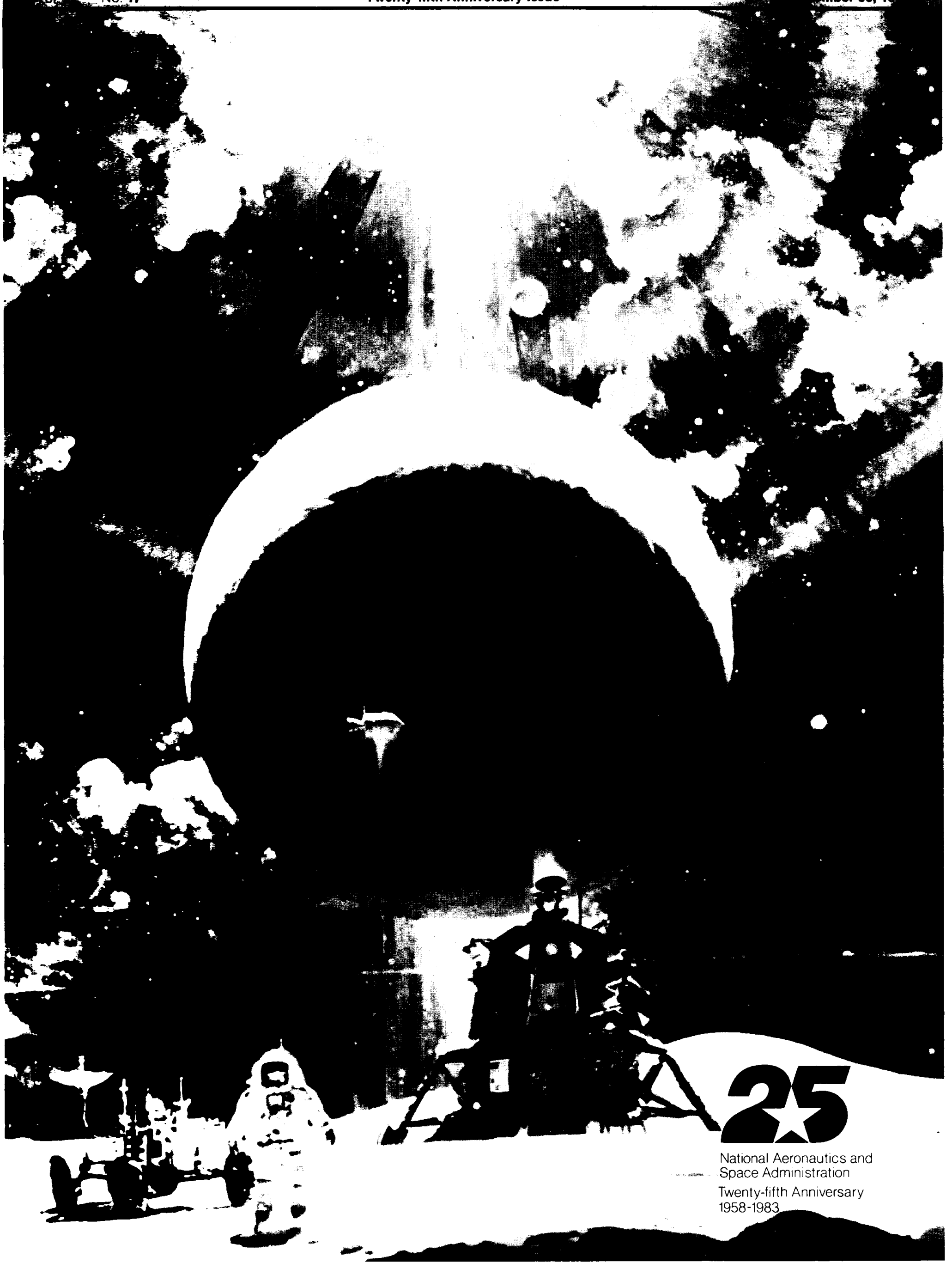
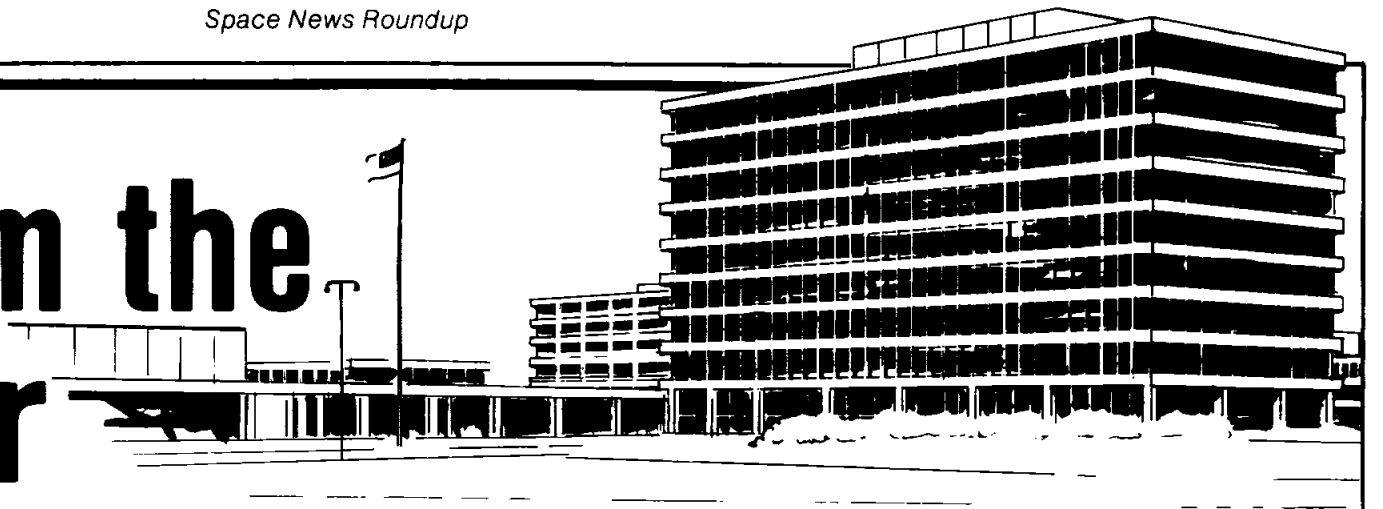
...Johnson Space Center

Space News Roundup

Vol. 22 No. 17 Twenty-fifth Anniversary Issue September 30, 1983



Letter from the Director



Looking back on it now, one cannot help but marvel at how far we have traveled in 25 short years. Although the Manned Spacecraft Center — now the Johnson Space Center — is, as a facility, only 22 years old, our roots go back all the way to the first week of NASA, when Project Mercury was approved and the Space Task Group was activated. It was the beginning of an effort which has few equals in American or even world history. As with all such beginnings, the list of things we knew for sure back then is very short; the list of fundamental questions which still had to be answered in 1958 is very long indeed. As Mike Collins has said so well, we were all, in a sense, "adolescent(s) in an army which has received its marching orders."

Those marching orders called for some incredible achievements, and produced challenges unprecedented in technology. Over the years, this Center has played a pivotal role in many areas of NASA's space program, but in manned spaceflight the people of JSC came through with critical inputs in three particular areas: engineering, flight control and crew training.

Each of the manned spaceflight programs had its own difficult engineering challenge. In Project Mercury, the biggest problem was the weight of the spacecraft, and the need to protect the astronauts. The crewman had to have all of the equipment necessary to come home by himself in the case of a communications loss. This meant he needed time references for retrofire, a fairly advanced control system and survival gear onboard. But in adding those elements, engineers constantly faced the weight problem. They had to deal with that daily, they had to upgrade the capabilities of the Atlas booster, they had to take the path of least resistance when solving problems and, in what was truly a feat of great engineering skill, they had to come up with designs which were tolerant of things they did not understand.

In Gemini they laid the groundwork for Apollo through the demonstration of orbital rendezvous. They also developed systems which made America's first space walks possible,and they designed a spacecraft which was capable of long duration flight. Apollo built on that, but only after engineers answered the fundamental question of that program: can you build systems reliable enough to leave Earth orbit? Did we have enough confidence in our Gemini experience to commit to a rendezvous in lunar orbit?

Out of the thought processes which answered those questions came our designs for the Mercury, Gemini, Apollo and Space Shuttle vehicles. Max Faget stands out when we look back on those accomplishments, but Max was only the capstone of a broad and deep reservoir of talent which America was fortunate enough to have congregated in one place.

After designing the vehicles came the question of flight control. The science of monitoring and guiding and nurturing spaceships and their crews in flight stands as a major JSC accomplishment. But prior to that first Mercury mission in 1961, it not only had not been invented, it hadn't even been defined. It fell to people like Bob Gilruth and Chris Kraft and Gene Kranz and hundreds of others to solve those problems, and the problems were immense. The logistics of Project Mercury alone, when you began at square one as they did, were staggering. You had to have ground stations and tracking ships, data management and recovery vessels, and for all of that you had to have procedures. They developed mission rules and flight control techniques for something which had never been done before.

The true test of those procedures came during Apollo 13. There had been close calls in manned spaceflight before, but not like Apollo 13. For all of its danger, for all of the regret we feel that a crew was imperiled and mission objectives had to be ignored for the larger question of survival, that flight stands out as one of JSC's finest hours. Flight control procedures developed since the first Mercury mission were put to the most severe test imaginable and in the end the crew came back safely. In the first hours after the spacecraft was crippled by an oxygen tank explosion, a huge and highly trained machine sprang into action. The problem was diagnosed and a successful remedy was uplinked to the crew. Going on to the Moon and using the Lunar Module as a "lifeboat" seemed an incredibly daring move to the rest of the world, but it was the only solution possible, and it was possible because we had prepared for such an eventuality.

Crew training, another JSC contribution, was also an inexact commodity a quarter century ago. How do you best train someone for a journey in space? How do you prepare them for potential problems, emergencies and catastrophies, such as on Apollo 13? The early Apollo vehicles had over 5 million parts and over a million and a half systems, subsystems and assemblies. If they all performed with 99.9 percent reliability, as a NASA safety official pointed out back then, one could still expect 5,600 defects. (We had nowhere near that kind of anomaly record, by the way, yet another tribute to the team of government and industry engineers who designed and built the vehicles.)

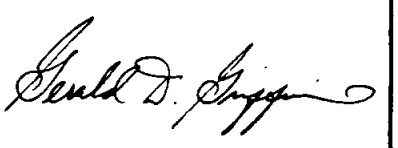
Dealing with such defects in orbit would require split second reflexes, and a thorough knowledge of all the implications of any action taken. So the crew training people developed procedures, checklists and contingency plans, and the crews drilled and drilled and drilled and drilled. We still do it today, and in fact we are in the midst of long duration sims for the next mission, STS-9.

With a clear perception of the challenges NASA faced in the early days, the subsequent achievements are all the more impressive. In all of history, few nations have mustered the type of national will and talent which were required of America to go to the Moon, to make use of space, and to set up a routine Space Transportation System. That is a legacy we all have reason to be proud of.

We should also especially remember those whose lives were lost in the course of the space program. Nine astronauts are now deceased; eight of them died while on active status with the space program. Gus Grissom, Roger Chaffee, Ed White, Elliott See, Charlie Bassett, Ted Freeman, Ed Givens and C. C. Williams all died while working for a program they believed in. Jack Swigert, who died earlier this year after leaving the program in 1979, exemplified the kind of courage and inspiration we found in all of those who went before him. The loss we feel at their deaths should be tempered by the hope that what we now have in the Space Shuttle, and all it represents for the future, is a living memorial to their lives and careers.

We should all pause for a moment and dedicate our efforts to their memory, and to the hope and belief that what we do here in our daily jobs will continue to have a profoundly beneficial impact on our country and our planet.

Congratulations, and happy anniversary to all of you.



Gerald D. Griffin

Contents

NASA Lyndon B. Johnson Space Center
Space News Roundup

Editor ..... Brian Welch

Editorial Assistants ..... Betty Johnson
Janet Ross

Graphic Artists ..... Joy Shannon
Jerry Elmore
Sid Jones

Typesetting ..... Shantha Elluru
Kim Tucker

Proofing ..... Kitty Linville

Studio Photography ..... Nick Nelms

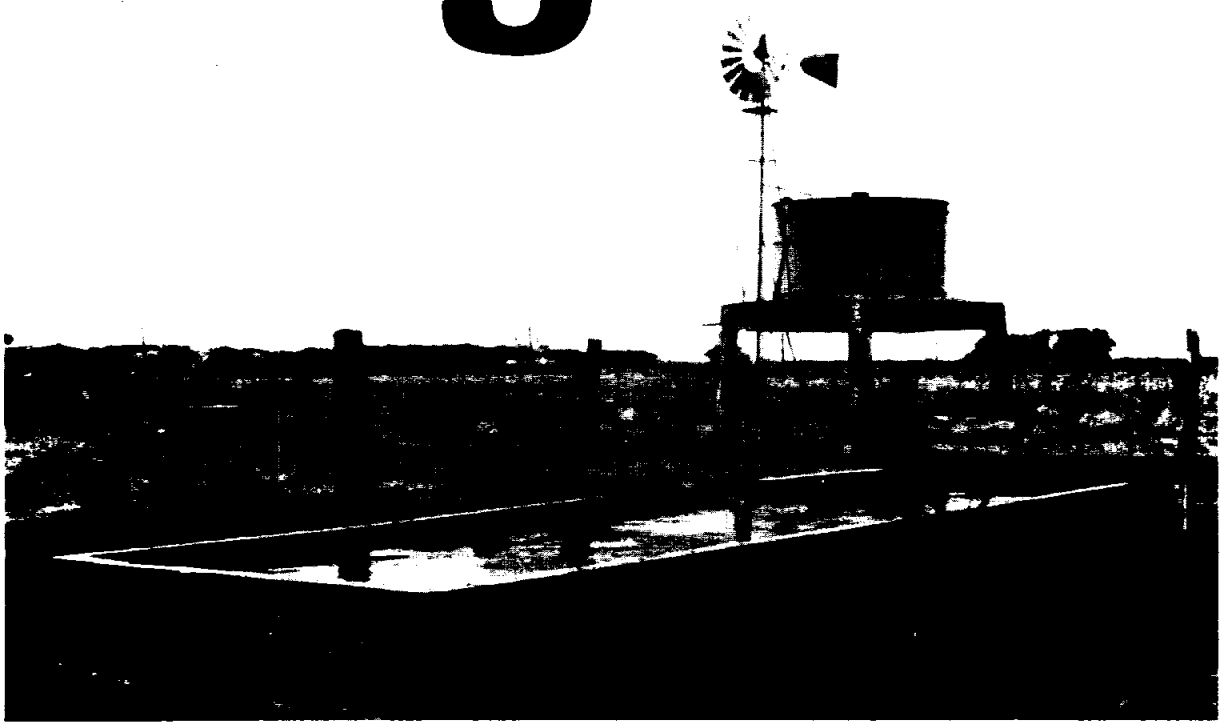
We would like to offer special thanks to the people of the Printing Management Branch, who performed above and beyond the call; to the Public Affairs Still Photo Library, the Photography Branch and the Photographic Processing Branch, all of whom met stiff deadlines with aplomb; the Distribution Operations group and the JSC Mailroom; and to Doug Ward, William Larsen, Laverne Brazil, Virginia Hughes, Bill Palmer, Harry Porter, and Robert McCall, all of whom made this special issue possible.

The *Space News Roundup* is an official publication of the National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Houston, Texas, and is published every other Friday by the Public Affairs Office for all Space Center employees.

Front Cover: "The Space Mural — A Cosmic View." Detail from the master study by Robert T. McCall, National Air and Space Museum, Washington D. C. Acrylics on Belgian linen canvas, 68 feet X 58.5 feet.

Back Cover: "STS-4 at .52 Seconds." From the original by Ren Wicks, NASA Art Program. Oil on canvas, 48 inches X 36 inches.

JSC Origins...



The trees are taller now, more stately, and though battered and thinned by the hurricane of '83, they will in 10 or 20 years stretch out over the grounds of the Johnson Space Center with a lordly, leafy reach reminiscent of Langley, where it all began.

When Robert Gilruth made his first visit to the shores of Clear Lake, however, the area had just been scrubbed clean by Hurricane Carla, and he can be forgiven if a grim sort of feeling welled up in the pit of his stomach as he imagined the vast investment ahead. Out of a flat cow pasture, a space center would rise, and for his people back at the Langley Research Center in Hampton, Virginia, a move was looming which would radically alter their daily lives.

Gilruth had flown to Houston from Langley that September in 1961 to look over the new site. Back at Langley, the time for being built from scratch had come just after World War I, when the lower Virginia peninsula was one big military base from Williamsburg to Norfolk. By the time the National Aeronautics and Space Administration was created in 1958, Langley had been a part of the National Advisory Committee for Aeronautics (NACA) for close to 50 years. It was NACA's prime aeronautical research facility at the time, but in 1958 all of that had been ceded to NASA. Langley had a long and distinguished history. It is said that hardly an airplane flies today that in some way or another has not been influenced by what was done at Langley. It was where the NASA story really began, and the tall hardwoods and Virginia pines which shaded its grounds gave it an air of permanence and stability. Moreover, it was the first home of the Space Task Group.

This new site, however, was different. It was a flat cow pasture scoured by brisk winds off Galveston Bay. A very large effort would be required to turn it into the new flagship facility of a new age of exploration. But then, big plans were being made, and in the tenor of the times a construction project even of this magnitude paled in comparison with striking out for the Moon.

It was altogether clear on May 25, 1961, the day President Kennedy committed the United States to a race for a Moon landing before the decade was out, that a staggering job had been dumped in NASA's lap. "Now how the hell are we going to do *that?*" one NASA engineer asked a colleague as they sat contemplating the speech in a quiet office at Langley.

It was a good question, and the man who ended up answering that and many others was Gilruth. A highly respected technical manager, Gilruth had become head of the Space Task Group, the nucleus of what would eventually become a team of 400,000 people. His job soon took on immense proportions. Hundreds of decisions were needed immediately, if not yesterday, and even as the pace quickened, it also became institutionalized for a period of several years. It never let up, not for a long time.

One of the decisions Gilruth and others in NASA faced was what to do with the Space Task Group. It was growing daily, the job ahead was monumental, and the normal quiet routine of Langley was beginning to groan under the strain. New facilities would be needed, and the construction alone would rival that of many projects America had undertaken in the past. Aside from manufacturing plants, assembly buildings, test stands, shipping facilities and launch pads, the Agency would need new laboratories, office buildings, aircraft hangars and huge warehouses, and the Space Task Group would need a home.

Even before it was built, they called it the Manned Spacecraft Center, and from the beginning it was seen as the crown jewel of the new effort, the lead center for all space journeys involving astronauts. But where to put it? As government decisions go, the answer came quickly.

On July 7, 1961, NASA Administrator James E. Webb directed the establishment of preliminary site criteria and a site selection team. Essential criteria for the new site included the availability of water transport and a first class all-weather airport, proximity to a major telecommunications network, a well established pool of industrial and contractor support, a local utility system capable of delivering 80,000 KVA of reliable power, a readily available supply of water on the order of two million liters per day, a mild climate permitting year-round outdoor work, a culturally attractive community and at least four square kilometers to build on. By August, some 23 sites had been selected as possibilities, including Jacksonville, Miami, Baton Rouge, Corpus Christi, San Diego and San Francisco. Houston was initially included by virtue of the San Jacinto Ordinance Depot, since military rather than commercial facilities were judged best for helping handle NASA's large retinue of jets and specialized equipment. After a visit, however, the selection team agreed that a piece of property owned by Rice University, with its proximity to Ellington Air Force Base, was equally attractive, and on September 19, 1961, that site was chosen. Just the day before, Houston's population had topped the one million mark.

The city was ecstatic. Space fever promptly swept the town. The baseball team was named the Astros, and the basketball team was called the Rockets. The Astrodome, Astroworld and countless businesses with "space city" somewhere in the title blossomed over the years.

It was an enraptured crowd of almost 1,000, then, that greeted Gilruth on his second visit to Houston in December, 1961. Speaking at the Shamrock Hilton (the interior of which once caused the architect Frank Lloyd Wright to murmur, "I always wondered what the inside of a juke box looked like."), Gilruth announced that a second manned space flight program would occupy the staff of the new space center. The new program would bridge the gap between the early Mercury flights and the later missions to the Moon. He described a half-billion dollar program to perfect orbital rendezvous techniques using a two-man capsule launched by a derivative of the Air Force's Titan II booster. The project was called Advanced Mercury, Mercury Mark II or simply Mark II, depending on who was asked. Later, they would call it Gemini.

So it was that in July, 1961, the directive had come to find a home for the Space Task Group. That date is altogether fitting, since by some strange quirk of history, a great many of the central events in the NASA story have occurred in the month of July. There was, for example, the signing in July, 1958 of Public Law 85-568, the National Air and Space Act, by which President Eisenhower approved the creation of NASA. Eleven years later, in 1969, Apollo 11 landed two men on the Moon in July and the name Houston became the first word uttered from the surface of another planetary body. In July, 1972, as NASA turned its attention toward pumping new technology into the private sector, the first of the highly important Landsat Earth observation satellites was launched. Three years later, in July, 1975, Americans and Soviets met in space during the Apollo-Soyuz Test Project. One July later, in 1976, the Viking 1 lander became the first probe to touch down on the surface of Mars. In July, 1979, during the troubled months when NASA and the Johnson Space Center were dealing with widespread criticism of the Space Shuttle Program, Skylab reentered the atmosphere to a crescendo of bad publicity. NASA took a drubbing in the media during that July, but things got brighter in July of 1982, when the Shuttle *Columbia* completed her fourth test flight and officially opened a new era of space transportation. That July Fourth will probably always stand out in the minds of many who work at JSC. It was a proud day. Flags festooned Mission Control, and that afternoon the new orbiter, *Challenger,* visited the Clear Lake area with a stopover at Ellington Air Force Base. But it was a July Fourth exactly 20 years earlier which probably made the biggest impression on the Houston area. That was the day the astronauts came to town.

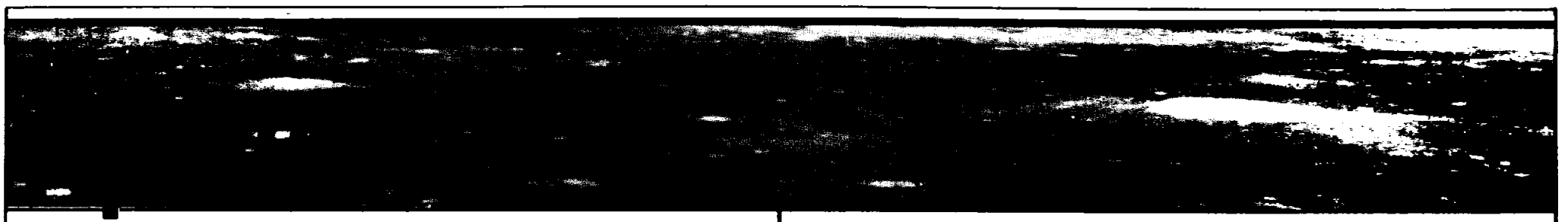
They were the Original Seven, the chosen, the first of a new breed of explorers, and in the early 1960s there were few celebrities on the planet who could compare with them. When they made their first trip to Houston on July 4, 1962, all the stops were pulled out. They were given a motorcade along a route lined with cheering admirers. Speeches were made, the welcoming ceremony was pure Texan, and a vast barbeque was thrown in their honor at the Houston Coliseum.

Today there are almost 80 active astronauts living in the Clear Lake area. They still command a lot of attention, but the tours which used to bring citizens out to tramp about on their lawns and ask to pose with their wives and children have long since stopped.

These days, after 20 years of becoming accustomed to astronauts, Houston takes less notice of them. The new generation of space explorers marry, raise children, go to movies and restaurants, shop in the malls, go to baseball games and every once in awhile they take a trip into orbit. Most people don't even recognize the vast majority of them anymore, much less ask for autographs. And there is a certain significance to this, satisfying to the people at NASA — it means they've done their jobs well. Space flight has matured, it has become a routine — if still spectacular —

(Continued on page 10)

...and the future



James A. Michener
Space

James Michener's long-awaited book about the space program uses the vehicle of fiction to present a long and detailed story, from 1944 to the landing of STS-2. In this excerpt, Michener describes the assembly of a Saturn V and its rollout in preparation for a fictional mission, Apollo 18. Had that mission taken place, the rocket which now lies on its side in JSC's Rocket Park would have been the vehicle. The fictional characters quoted here are Col. Randy Claggett, USMC, and Capt. John Pope, USN, members of the prime crew for Apollo 18.

When it was decided, back in 1961, to launch the predicted Apollos from Canaveral, the engineers and scientists of America faced a tantalizing problem. The vehicle would be so massive, 363 feet high, which was longer than a football field, that if it were assembled in one place, say Denver, it would be so big and weigh so much—3,150 tons—that it could not possibly be transported across the country. It would have to be built at six separate locations and brought to Canaveral for final assembly.

The first problem was solved majestically. Beside a canal into which barges could come bringing the components, a stupendous white cube was built, rising from the Canaveral swamps like some modern-version pyramid, preposterously big. Silent, isolated in the landscape, an abiding symbol of the space age, it became the mammoth barnlike building in which the Apollo complex would be assembled, and square though it was, it rose in the air almost as high as the needlelike spire of the Washington Monument. The face of the cube to the east contained doors half again as high as a football field is long; the covered interior provided a work space of 130,000,000 cubic feet. In many respects it was the largest building in the world, and it had been completed at breakneck speed.

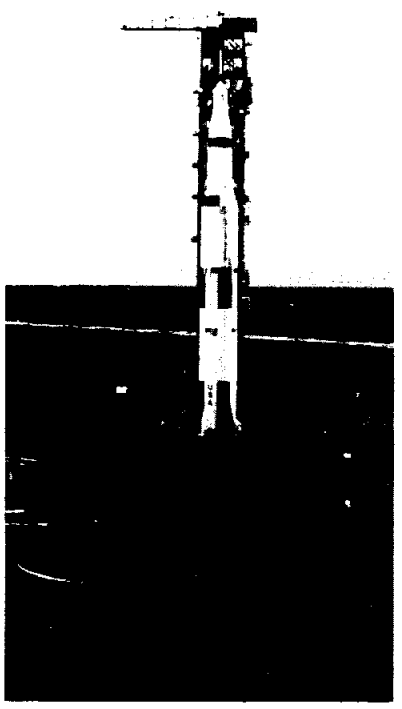
In it, six extremely complicated machines would meet for the first time; none would ever have been in proximity to any other, and not until they were intricately fitted together, with each bolt and wire in one component interfacing with its mate in another, could the spacecraft be said to be in existence. One workman had calculated that some 22,000 joinings had to be completed, tested and approved before Apollo 18 became a whole.

The constructors of this giant machine, working in six widely separated sections of the nation, required 30,000 different complex documents to ensure congruent fittings from one manufacturer to the next. The massive Stage I was put together in Louisiana by Boeing; the powerful Stage II was built in California by North American; Stage III, containing the crucial single engine which would send the spacecraft toward the Moon, once it got aloft, was built in a different part of California by Douglas. And the instrument unit, built by IBM in Alabama, was so huge and complicated that one traditional engineer said, 'That had to be built by some kid with an Erector set.'

Those four basic parts comprised only the rocket, but the process was the same for the two craft in which the astronauts would actually fly. Their command and service module was built in Downey, California, by an independent branch of North American and was broken down into two intricately related parts: the command module in which the men lived, and the service module which kept most of the gear out of the way. The astronauts considered this a single unit, the CSM, and spent days in its simulator, for upon it they must depend. The lunar module in which two of the men would drop down to the Moon and fly back to the orbiting CSM was built on Long Island by Grumman.

It was a preposterous way to construct one of the most intricate machines ever devised by man, for no one could predict whether the system would work until the six pieces—seven, really—were assembled in the waiting cube on the Florida swamplands. As Randy Claggett said irreverently, while orbiting his first Apollo when his companions were walking on the Moon, 'Here I am tooling along in a machine with four million different parts, each one supplied by the lowest bidder.'

The Preparations



And how did NASA bring these widely separated items together at the Cape? The instrument unit was placed on a barge on the Tennessee River, sent north to the Ohio River, then floated down the Mississippi, and around the southern tip of Florida to Canaveral. Stage I followed the same route, starting at New Orleans. California forwarded its segments two ways: by ship through the Panama Canal and by a huge Boeing Stratocruiser converted into what NASA people called our 'Pregnant Guppy'; its belly could accommodate a completed Stage III.

In mid-February the experts in the vast assembly building reported: 'All okay'—and this became the signal to initiate an operation of ponderous elegance, one which always caused gasps of approval from the hordes of visitors allowed to watch from a safe distance. The gigantic doors of the building drew aside, 456 feet tall, to reveal, standing erect inside in the darkness, a gleaming white masterpiece, heavy at the bottom but tapering to a delicate point 363 feet in the air. The simplicity of the streamlined exterior, each surface honed smooth, belied the extreme complexity within, and often at this moment of revelation watchers applauded.

Through the vast doors they could see that the Apollo had been assembled attached to a massive gantry, both structures resting on a heavy metal base supported by pillars which kept them well above the floor, and now the tremendous supertractor—each of its four sets of what

(Continued on page 10)

Michael Collins
Carrying The Fire

There are few who would argue that the best book written by an insider about the space program is this one by former astronaut Michael Collins. Witty, literate and informative, the book is subtitled, "An Astronaut's Journey." In this excerpt, Collins relates those feelings we all wonder about as we watch astronauts board large, dangerous ships for outbound journeys. The time is 6 a.m. Central, July 16, 1969. The place is the Kennedy Space Center, and the reason is the first manned landing on the Moon.

It's a clear day, we can see that, and we are told that it's hot already with little breeze—a scorcher in the making. Last night the Saturn V looked very graceful, suspended by a cross fire of searchlights which made it sparkle like a delicate opal and silver necklace against the black sky. Today it is a machine again, solid and businesslike, and *big.* Over three times as tall as a Gemini-Titan, taller than a football field set on end, as tall as the largest redwood, it is truly a monster. It is parked next to a huge steel scaffold known as the launch umbilical tower, which is designed to hold the rocket and nuture it until the final second. The two partners make quite a contrast, the rocket, sleek and poised and full of promise, the tower old, gnarled, ungainly, and going nowhere. We park at the base of the tower and clamber out. The first elevator is waiting for us with its doors already open. Something seems wrong, and suddenly I realize what it is. The place is deserted! Every other time I have been to the launch pad it has been a beehive of activity, with workmen shouting at each other, equipment being hoisted by crane, and all the other vital signs common to a big construction site. Now it seems as if some dread epidemic has killed all but those protected by pressure suits, except there are no corpses and Joe Schmitt still looks healthy. Perhaps it is simply a case of the air-raid siren having sounded and left the city deserted. As the four of us ascend, I feel that more than the elevator door has clanged shut behind me. I recall that there are one million visitors here to watch the launch, but I feel closer to the moon than to them. This elevator ride, this first vertical nudge, has marked the beginning of Apollo 11, for we cannot touch the earth any longer. I am treated to one more view, however, one last bit of schizophrenia as I stand on a narrow walkway 320 feet up, ready to board *Columbia*. On my left is an unimpeded view of the beach below, unmarred by human totems; on my right the most colossal pile of machinery ever assembled. If I cover my right eye, I see the Florida of Ponce de Leon, and beyond it the sea which is mother to us all. I am the original man. If I cover my left eye, I see civilization and technology and the United States of America and a frightening array of wires and metal. I am but one adolescent in an army which has received its marching orders. Neil has entered the spacecraft, and I am next.

I kick off my yellow galoshes, grab the bar inside the center hatch, and swing my legs as far as I can over to the right. After a couple of grunts and shoves, I finally manage to get my backside into the seat, with my head on a narrow rest and my legs up above me, my feet locked into titanium clamps. It's not very comfortable, especially in this suit, which is tight in the crotch, but I can put up with anything for two and a half hours—all we have left before launch. Joe is leaning over me busily, giving oxygen hoses, communications plugs, and restraining straps one last check; then he is gone. I barely have time to grab his hand before he leaves. Fred Haise is still with us. As a good back-up crewman, he was inside the CM when we got there, running some preliminary checks and certifying switch positions, and now he is down in the lower equipment bay, where we cannot reach, helping with last-minute preparations. Finally, Fred scrambles out and closes the hatch behind him. Now, hopefully, we will see no more people for eight days.

The View From Within

I am everlastingly thankful that I have flown once before, and that this period of waiting atop a rocket is nothing new. I am just as tense this time, but the tenseness comes mostly from an appreciation of the enormity of our undertaking rather than from the unfamiliarity of the situation. If the two effects, physical apprehension and the pressure of awesome responsibility, were added together, they might just be too much for me to handle without making some ghastly mistake. As it is, I am far from certain that we will be able to fly the mission as planned. I think we will escape with our skins, or at least I will escape with mine, but I wouldn't give better than even odds on a successful landing and return. There are just too many things that can go wrong. So far, at least, none has, and the monster beneath us is beaming its happiness to rooms full of experts. We fiddle with various switches, checking for circuit continuity, for leaks, and for proper operation of the controls for swiveling the service module engine. There is a tiny leak in the apparatus for loading liquid hydrogen into the Saturn's third stage, but the ground figures out a way to bypass the problem. As the minutes get short, there really isn't much for me to do. Fred Haise has run through a check list 417 steps long, checking every switch and control we have, and I have merely a half dozen minor chores to take care of: I must make sure that the hydrogen and oxygen supply to the three fuel cells are locked open, that the tape recorder is working, that the electrical system is well, and that the batteries are connected in such a way that they will be available to supplement the fuel cells, that we turn off unneeded communications circuits just prior to lift-

(Continued on page 10)

Apollo

Ben Bova

Vision of the Future

The following excerpt from "Vision of the Future, The Art of Robert McCall" pays tribute to a particular type of power and majesty which was last seen on Earth in May, 1973 - the launch of a Saturn V rocket. Bova is the former editor of Omni Magazine and a six-time Hugo Award winner. McCall, whose stunning artwork has celebrated spaceflight since the Mercury days, is the creator of several mission patches and the artwork which graces the front page of this issue.

It is night. The bird sanctuary that comprises a huge tract of the Cape Canaveral area is one vast breathing shadow. The waterfowl and migratory birds that nest among the pines and palmettos are silent in deep darkness. Only the endless peeping of the frogs breaks the moonlit night.

But along the strip of U.S. Highway #1 that borders the mainland side of the Cape, lights are burning, cars are on the move. Towns along the highway, once sleepy little communities, with names such as Melbourne, Cocoa Beach, Titusville, are now bustling boom towns. Not a hotel room is empty; people are sleeping ten to a room. The bars are wide open. Music and revelry from a million visitors ring through the night.

The focus of all this excitement stands bathed in brilliant spotlights out on Launch Complex 39A, rising more than 365 feet into the night air, the second tallest structure in all of Florida. It is a Saturn V rocket booster, bearing an Apollo spacecraft at its lofty tip.

A migration is underway. Along the roads that approach the Kennedy Space Flight Center, along the bridges and causeways that span the Banana River and connect the Cape with the mainland, hundreds of thousands of vehicles are inching along bumper to bumper. All aimed at that Saturn V.

In the air-conditioned Launch Control Center building, facing the launch pad, platoons of engineers are already sitting at their consoles, earphones clamped to their heads, row after row of men and machines monitoring with electrical senses every pulsebeat of the mammoth rocket booster and spacecraft. Nearby, three astronauts struggle into their tailor-made space suits, aided by teams of technicians.

Dawn finds dozens of VIP buses making their way along the special road that NASA has kept clear for them, passing checkpoints guarded by armed men in uniform, heading toward the viewing stands that have been erected a few miles from the launch pad—a safe distance, in the event of catastrophe. The ordinary citizens, the visitors and taxpayers who are financing this spectacle, have pulled their cars and vans and campers and buses up on the shoulders of every road, bridge, causeway, parking area in the Cape's acreage.

The beaches are filled with people, too. Some sit comfortably on folding chairs, most stand or mill around aimlessly, squinting toward the tall Saturn V standing against the brightening morning sky. Radios are everywhere. No one plays music. Or news. Every radio is tuned to the countdown. T minus one hour. Propellant tanks are full and pressurized. The astronauts are in the command module, on their personally fitted acceleration couches, sweating out the final minutes just as everyone else is.

More than 3000 tons of fully fueled rocket stand atop the steel and concrete of Launch Pad 39A. Three astronauts sit buttoned into the command module at the rocket's tip. In the Launch Control Center the engineers hunch over their consoles as the final minutes tick away. Nearly a thousand miles away, at Mission Control near Houston, hundreds more engineers watch their screens and instruments, alert to the slightest flicker of warning that something within the huge complex of intricate machinery might malfunction.

The VIP stands are teeming with people now. The sky is bright and clear. News reporters from around the world listen to the ongoing commentary from Launch Control while they speak sparingly into the microphones of their tape recorders and broadcast transmitters as the final few seconds of countdown click off.

A blossom of flame flares brightly at the base of the rocket. It quickly mushrooms into billows of steam. But in silence. The rocket is too far away for sound waves to reach the watchers. The immense Saturn V stands rock still, as if riveted to the ground. Clouds of white steam begin to engulf it, and still it is unmoving. Seconds stretch to eternities. Millions ask the same question: Will it go? And then the rocket begins to rise. It actually moves. Slowly, as stately as a royal monarch, it rises out of the steaming clouds of its own exhaust until we can see the flames gushing from its engines. It is flying, straight and true, rising as if guided along an invisible wire strung tautly between the launch pad and infinity.

The Launch

And now the sound reaches them—thundering, shattering, overwhelming sound, the roar of dragons and demons and all the unleashed energies that human thought can conceive. Power. Wave after wave of pure power washes over them. "White noise," the engineers call it; the sound bellowing at us contains every frequency the human ear can detect, and far more than that.

The Saturn V is arcing across the blue sky now, carrying its three astronauts farther and faster into the heavens. Sound and sight begin to dwindle. Now it is nothing more than a candle flame burning against the morning Florida sky. Now a bright star winking. Now it is gone and the sky is empty.

People stand and stare into that emptiness, trembling as if they have gone through a religious experience. No one speaks, not for many heartbeats. Then the enormous crowd draws a collective breath as a snowy egret flies across the blue sky. Everyone roars with exuberant joy.

Inside Launch Control they are cheering and slapping one another on the back and breaking out the cigars. Their job is done. Mission Control outside Houston has taken over the flight. For the next half-million miles, for the seven days until the astronauts return, the mission will be directed by them.

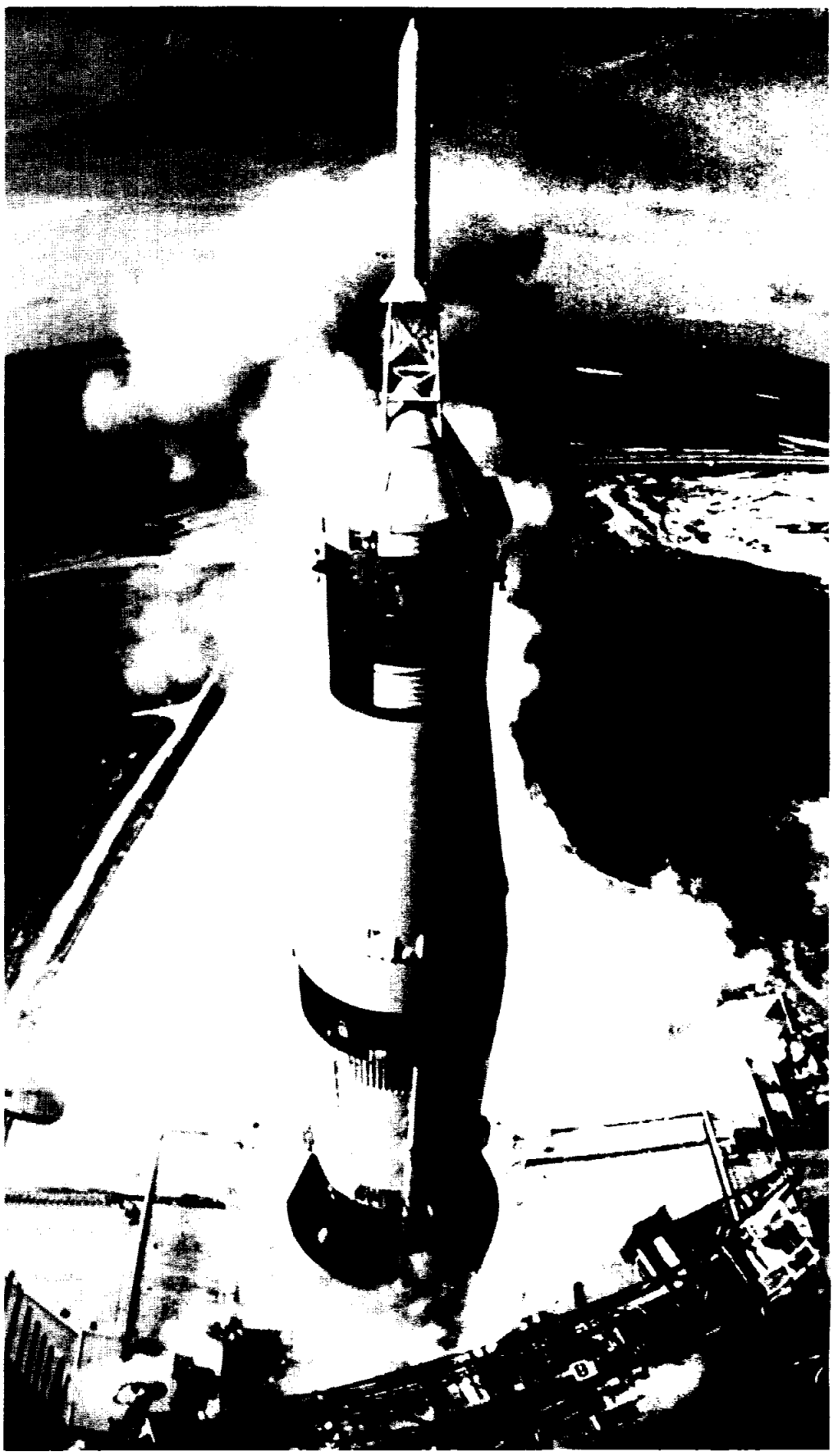
But the mission truly belongs to the astronauts, three human beings who become the focal point of all the eons of evolution, all the long centuries of human history. Billions of people on Earth look skyward. Three men are on their way to the Moon, and the rest of us wait, and listen, and watch.

Then come the exultant words from Armstrong, the first sentence spoken from the surface of the Moon:

"Houston, Tranquility Base here. The *Eagle* has landed!"

It had taken nine years of immense effort by a team of thousands of dedicated men and women. The President who began

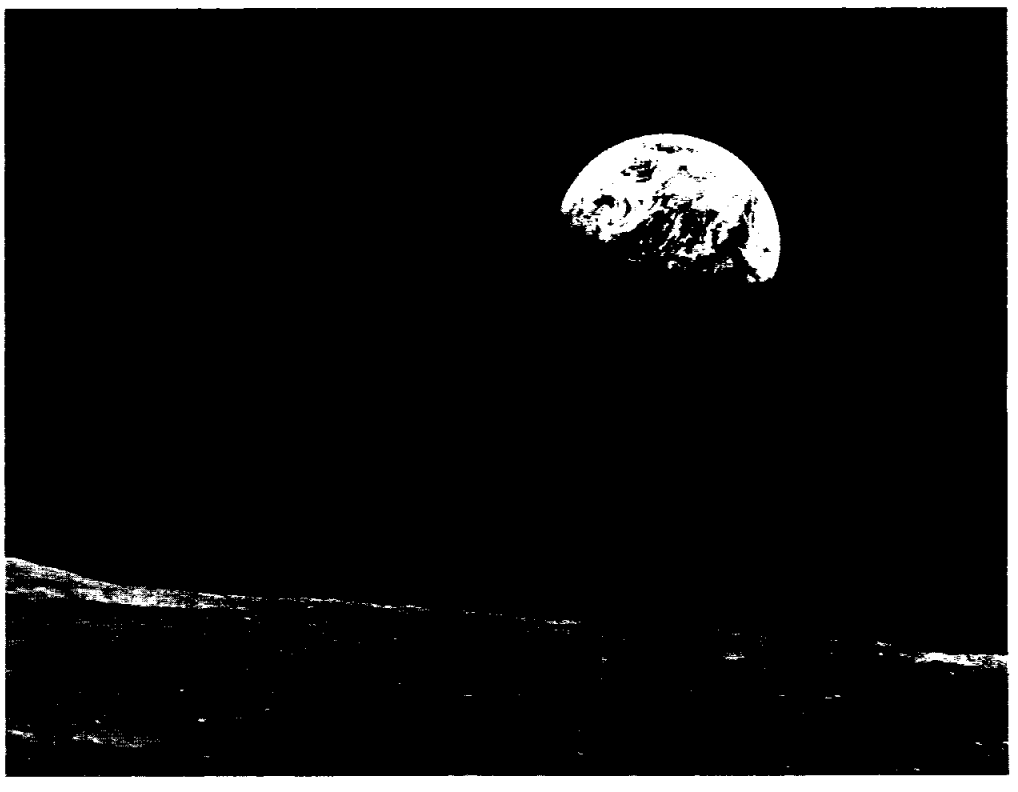
(Continued on page 10)



"Now is the time to take longer strides — time for a great new American enterprise — time for this nation to take a clearly leading role in space achievement, which in many ways may hold the key to our future on Earth...

I believe 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."

President John F. Kennedy, before Congress, May 25, 1961



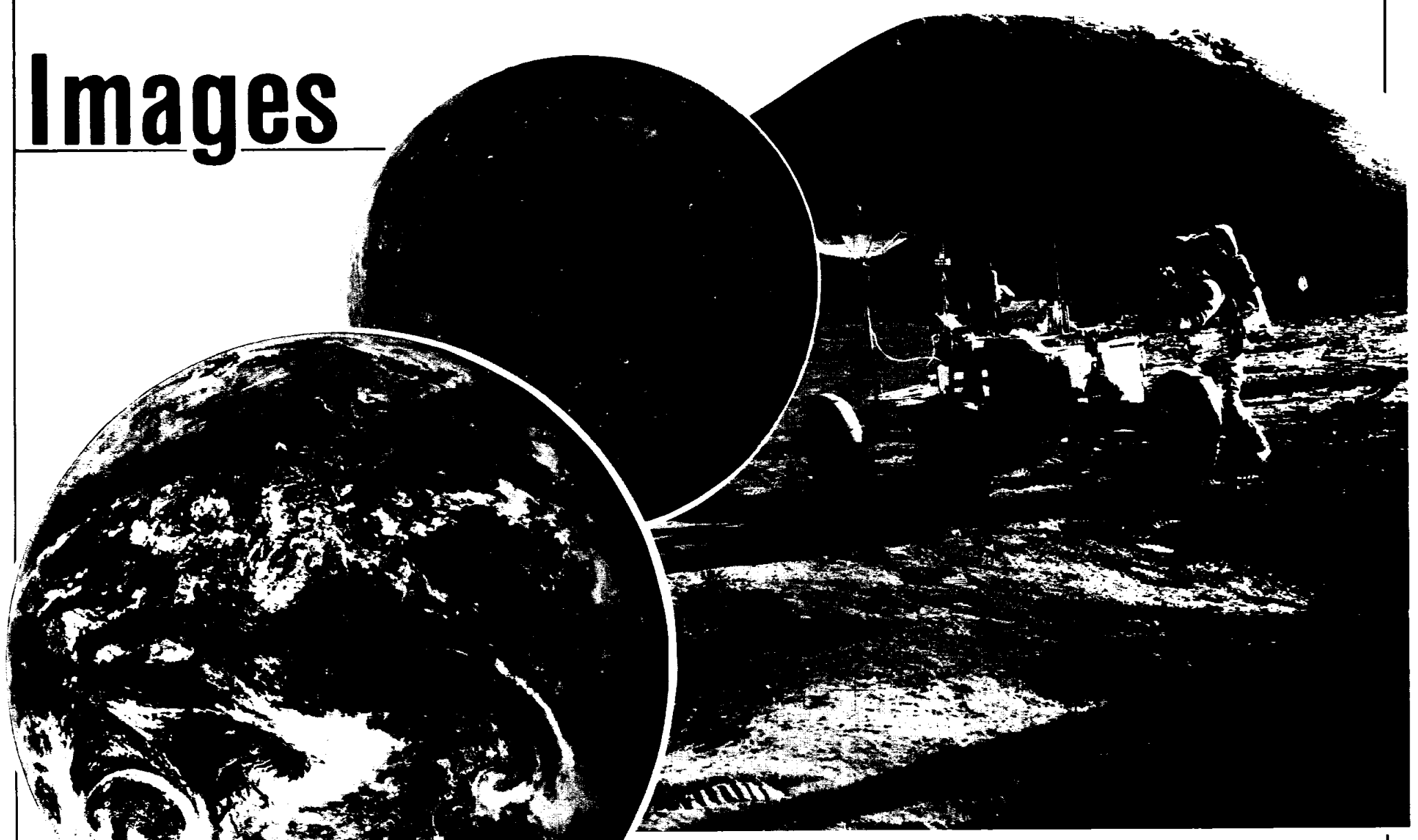
Images

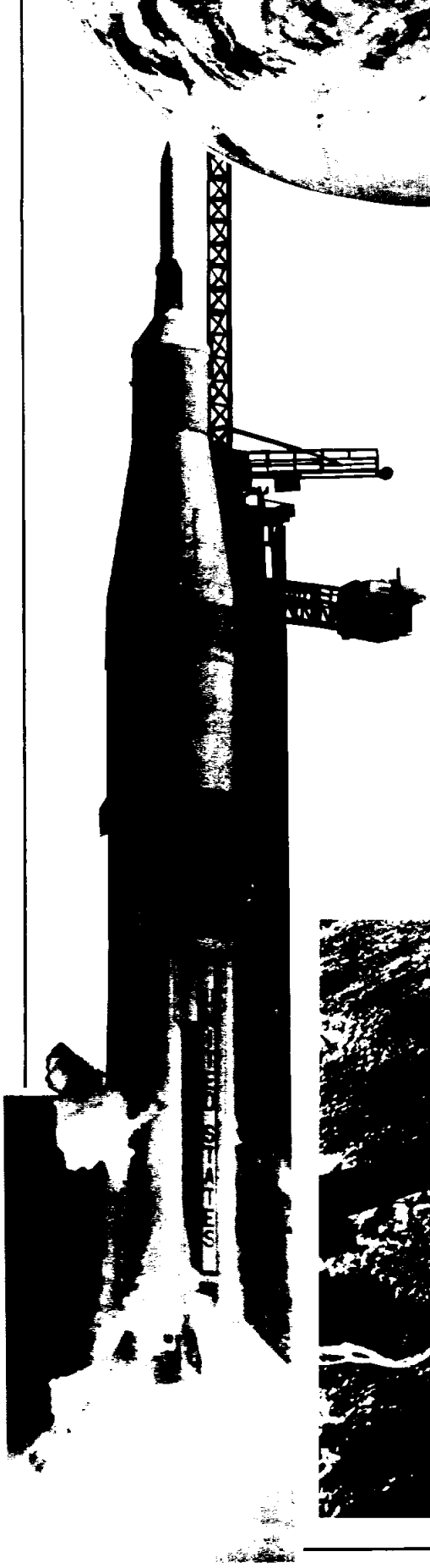

NASA
25
NASA
APOLLO SOYUZ
NASA
Return of the
STS-5 crew
WELCOME HOME
USA

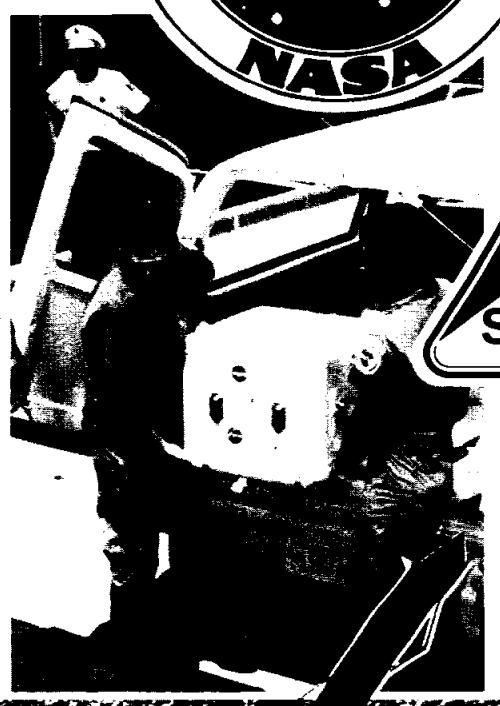
Images

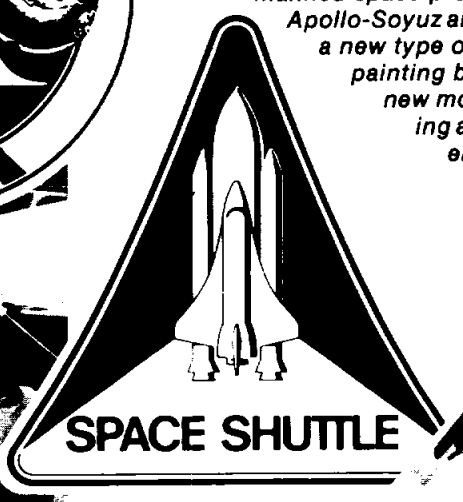
One of the first acronyms to hit Houston with the coming of the space program in the early 1960's was "MSC" - the Manned Spacecraft Center. The city turned out in July, 1962 to welcome the people of MSC to Texas, and that included a down-home barbeque at the Houston Coliseum with the Original Seven astronauts as the featured guests (above). By this time, America had already begun to fly men in space, the first being Alan Shepard, shown suiting up for his 1961 flight in the photo at left. Later, as the sight of space capsules being hoisted out of the water and gingerly placed on the decks of aircraft carriers became more and more common (below, Wally Schirra's MA-8 being recovered by the crew of the USS Kearsarge), the nation's space program was embarking on a new phase — Project Gemini. Efforts branched out to the exploration of orbital rendezvous and the activities of man in space. Above, Ed White on the first American spacewalk during Gemini 4.

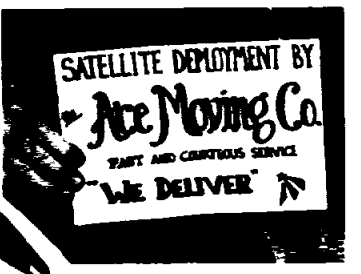
Images

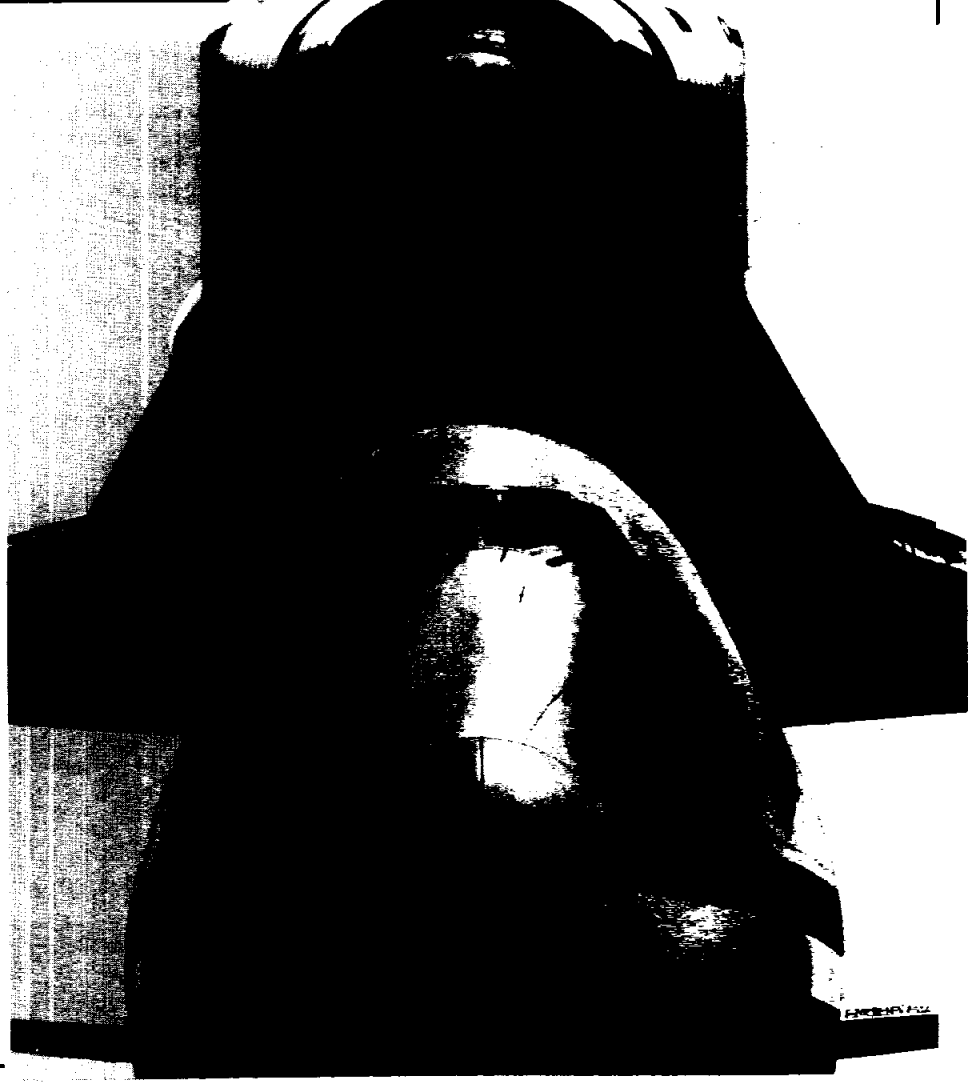












Big things were happening in the Earth-Moon system during the 1960's. In the trek to the Moon, American engineers developed the Apollo spacecraft even as the Gemini program was still underway. Below left, Apollo-Saturn 201 carries the first production command and service module into orbit, and successfully checks out the first Saturn-1B first stage and Saturn-1VB second stage. After we reached the Moon, JSC became the repository for lunar samples; the photo at lower left shows the first batch being unloaded at the Lunar Receiving Laboratory. Later, the early 1970's saw our lunar explorations supplemented by the Lunar Rover - above, Jim Irwin near Mount Hadley during Apollo 15. For the rest of the decade America's manned space program concentrated on Skylab, technology utilization, Apollo-Soyuz and the Space Shuttle. As the 80s dawned, the nation had a new type of fleet (as exemplified by Challenger, seen below in a painting by Ron Cobb of the July, 1982 rollout), and JSC had a new motto - that's the hand of Commander Vance Brand holding a sign in the photo below which proclaimed a successful entrance into a new era of operations during STS-5.

Columbia's Landing Closes a Circle

By Tom Wolfe

The following article is reproduced exactly as it first appeared in the October, 1981 edition of National Geographic.

To me there was a touch of Rip Van Winkle about it all. After 54 1/2 hours in earth orbit an airplane—not a capsule or a command module but an airplane, a ship with wings—descends above the high desert of California. It glides toward a landing at Edwards Air Force Base. As in the old days, the mirages of Rogers Dry Lake envelop it like a hallucination. The ship makes a perfect touchdown and rolls to a stop. At last the commander emerges. He is 50 years old. He has grown old and farsighted waiting for this flight. He had to wear glasses to read the instrument panel. He opens his mouth and out comes a drawl that takes me back 25 years, at least, to the cowboy days of Chuck Yeager.

Not to press John Young into the role of Rip Van Winkle, but his flight with his 43-year-old copilot, Robert Crippen, in the space shuttle *Columbia* resumes a story that was broken off a quarter of a century ago. It returns the American space program to where it started—which was not Cape Canaveral but the throwback landscape of Edwards Air Force Base, a terrain that evolution left behind, a desert decorated with the arthritic limbs of Joshua trees and memories of Chuck Yeager, Scott Crossfield, Joe Walker, Iven Kincheloe, and other pioneers of manned rocket flight.

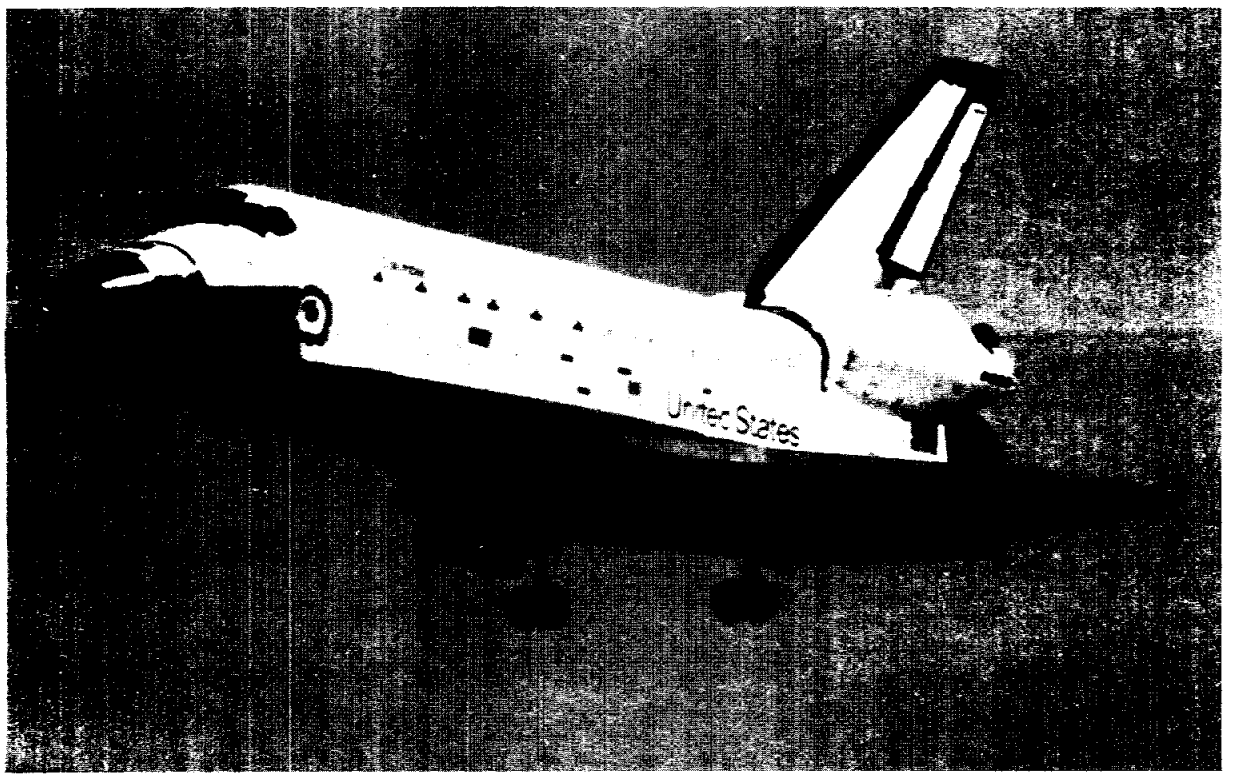
Yeager began the American advance toward space at Edwards—or Muroc as it was then called—on October 14, 1947, when he broke the sound barrier in the X-1. The X-1 was the first in a series of experimental aircraft built solely to test the effects of supersonic speeds and very high altitudes on aerodynamics and structural integrity. The X-1 consisted of a four-chamber rocket with wings (just six inches thick), tail assembly, cockpit, and a set of controls. There were scarcely 30 people on hand who knew what it meant when Yeager's sonic boom hit the desert floor. The Air Force had a security lid on the X-1 project, and no announcement was made of Yeager's triumph. The only celebration was a free steak dinner and all he could drink at Pancho's Fly Inn, a ramshackle dude ranch, saloon, and pilots hangout, just outside the base, run by a female stunt pilot named Pancho Barnes.

Three days before the flight Yeager had taken a terrific fall during a midnight ride through the Joshua trees on one of Pancho's dude-ranch horses. He wound up with two broken ribs, making it impossible for him to use his right arm. But in this, the cowboy phase of manned rocket flight, there were no preflight physicals. Yeager told only one person about his little problem, the flight engineer, a good old boy from Oklahoma named Jack Ridley. So Ridley smuggled a length of broom handle onto the X-1 to give Yeager's one good arm more leverage, and that was the way he went up: with one arm and a piece of a broom handle.

By October of 1957, when the Soviet Union launched Sputnik 1, the first artificial earth satellite, Yeager, Crossfield, Kincheloe, and other pilots at Edwards had gone more than twice the speed of sound in the X-1A, the X-2, and the D-558-2. Crossfield, the prime pilot for the project, was awaiting delivery of the X-15, an airplane North American Aviation had built to fly into the lower reaches of space, 50 miles above earth, although not in earth orbit, and then return through the atmosphere for a landing at Edwards. (This it eventually did, many times, and Joe Engle, scheduled to command the second flight of the space shuttle, was one of the pilots who took it up.)

Assuming that the problem of the heat of reentry could be solved, it was but a short step, in terms of technique, from the X-15 to a ship such as the X-20, which the Air Force started work on within days after the launching of Sputnik 1. Boeing had the contract to build it. The X-20 would be a 35-foot-long black metal version of a paper airplane. It would be launched by a Titan III rocket, which would disengage after lift-off. The ship would orbit the earth and land at Edwards. To pilots like Yeager, this was such familiar and inevitable stuff that they were astounded to see the Soviet Union's little Sputnik, a 184-pound ball with nothing but a little radio transmitter in it, throw the government and the press into such a panic.

The problem with the X-20 program—the political problem—was the Titan III rocket. The Titan III was to consist of a Titan II ballistic missile, ten stories high and 150 tons in weight, capable of 430,000 pounds of thrust at lift-off and boostered by two large solid-



propellant rockets, each ten feet in diameter, attached to either side of the Titan II. Atop the Titan II would be the X-20. But this great brute of a rocket assembly was at least two and perhaps three years away from development. The space race, as it was now called, seemed like such an urgent national priority that the government decided upon a "quick and dirty" approach. Even though the X-20 program would go forward, the emphasis of the space effort would be in a different direction. NASA would use smaller, already fully developed military attack rockets, such as the Redstone. The Redstone had a lift-off thrust of 78,000 pounds, less than one-fifth that of the Titan II, but it was ready to go. The test subject would be placed inside a small shell—a capsule barely six feet across—and the shell would be placed on top of the Redstone. It was the human cannonball approach. All that was required was a test subject who could sit still and stand the strain.

A *test subject;* such a creature could scarcely be called a pilot. He would be a passenger with biosensors attached to his body. He would *splash down* in the ocean at the end of his ride—he wouldn't even land like a man. Because the poor devil couldn't control his own flight, entire fleets of ships and aircraft, plus a world wide network of radio tracking stations, had to mobilized in order to be sure of finding him when he hit the water. Afterward neither the capsule nor its rocket could be used again. It was like buying a new Buick Electra 225 every time you drove over to the Seven-Eleven.

At Edwards the rocket pilots looked with derision upon the astronauts, as the test subjects were called. They spoke of NASA's Project Mercury as "Spam in a can," and added: "A monkey's gonna make the first flight." It was true. Chimpanzees took the first suborbital flight (before Alan Shepard's) and the first orbital flight (before John Glenn's). An ape filled the bill as handily as a human test subject.

What self-respecting pilot would volunteer to become a human chimp? Every hot pilot wanted to do it like Yeager. One of that breed in 1957, when Sputnik went up, was a 27-year-old Navy test pilot named John Young. He was soon to set two world time-to-climb records in a supersonic Navy interceptor, the F4H-1, for the fastest climb from take off to 3,000 meters and the fastest climb from takeoff to 25,000 meters. It went without saying that he had a fully developed Yeager drawl.

But soon an aura of national mission and blazing glamour, complete with *Life* magazine covers, was upon Project Mercury. Not only that, the performance of the Mercury astronauts, whether one regarded them as pilots or guinea pigs, was exemplary. By 1962 the objections and taunts of Edwards' great rocket pilots scarcely even registered any longer. Ambitious pilots like John Young were determined to make it not to the old Olympus, Edwards Air Force Base, but to the new one, NASA's Manned Spacecraft Center in Houston. Even the Air Force attached paramount importance to producing astronauts for NASA.

Young was selected for the second group of astronauts, which included Neil Armstrong, Jim Lovell, Pete Conrad, and Frank Borman. The entire emphasis of American manned spaceflight was now upon the goal of reaching the moon. In 1963 the Air Force's X-20 program was canceled, even though Boeing had begun manufacture of the first ship. As something of a sop, the Air Force was given the Manned Orbiting Laboratory program, which would involve astronauts going back and forth to space stations in two-man capsules of the sort used in Gemini. That scheme was canceled in 1969—the year Young, on his third spaceflight, the Apollo 10 mission, orbited the moon. NASA now somewhat reluctantly absorbed the Manned Orbiting Laboratory trainees as the seventh group of astronauts. One was Robert Crippen, who had come into the program from the Navy.

It was not until 1969, after the success of the Apollo moon project, that NASA returned to the task of developing a rational and affordable system for flight in earth orbit. Which is to say, the X-20 project, reborn as the space shuttle. The shuttle would be launched by a more powerful and sophisticated version of Titan III. Like the X-20 it would have two solid-fuel boosters. The ship itself would be larger than the X-20 and look more like a conventional aircraft. But, in effect, the shuttle would be the X-20, resumed and updated.

Young was the reigning astronaut assigned to the program. He had flown in space four times and, as commander of Apollo 16, had been the ninth man to set foot on the moon. So Young was named commander of the first space shuttle mission, which would presumably take place by 1979. Crippen was named pilot. He would be the first of the Manned Orbiting Laboratory leftovers to get any spaceflight at all.

Politically the times were very different. At NASA it was with a sense of old-oaken-bucket sentimentality that they now talked about the glorious days of "budgetless financing." That had been during the Apollo program, prior to the landing of Apollo 11, when NASA simply spent whatever it needed and Congress was only too happy to take care of the overdrafts.

Those days were gone. Now they could barely pay the light bills down in Houston. Shuttle development dragged on. The ship was referred to as a lemon. In fact, all that was lacking was the money and the sort of national commitment that had made almost anything possible, overnight, for Mercury, Gemini, and Apollo. Years went by, and Young and Crippen grew older, until Young, like many men his age, had presbyopia, literally "old eyes," better known as farsightedness, and had to wear spectacles for close work.

Time had taken its toll on the old notion of pilot's control of the craft too. Ironically, the high speeds that Yeager himself introduced had made automatic guidance systems increasingly important. A computerized inertial guidance platform had been developed to help X-15 pilots bring the ship back through the earth's atmosphere at the proper angle. Neil Armstrong, NASA's backup for Joe Walker in the X-15 project, gave the system its first lower-altitude tests. To the great satisfaction of the rocket aces, the platform had its problems. It was still the brain, the reflexes, and the body of the pilot that controlled the X-15. As the talk of computer-controlled flight grew louder, Scott Crossfield put in a word for the test pilot:

"Where else would you get a nonlinear computer weighing only 160 pounds, having a billion binary decision elements, that can be mass-produced by unskilled labor?"

But by 1980 things like inertial guidance systems were routine in high-performance aircraft. The Navy even had an automated system for landing fighter planes on carriers. The pilot took his hands off the controls and just sat there as his aircraft nosed toward the deck, lurching and shuddering as the computers corrected its course in sync with the motions of the carrier's flight deck.

The space shuttle had five computers in control of most phases of flight. Originally there had been four. During one simulation the computers had arrived at a Mexican standoff, two against two, with no decisions being made. In an actual flight the results would have been disastrous. A fifth computer, an arbiter, a Solomon with a heart of transistors, was added later. In most situations in shuttle flight, the pilot's decisions are not relayed directly to the various movable parts and fuel supplies. They enter the loop of the Computer Solomon along with the other machines' binary decision elements. Technically, none of these computers, not even the Solomon, actually makes a decision. Only the pilot can do that.

One component of classic flight test, Edwards style, had not changed by the time the space shuttle *Columbia* was launched last April with John Young and Robert Crippen in the cockpit. Namely, the danger inherent in the first flight of a completely new aircraft. NASA's other space systems, Mercury, Gemini, and Apollo, involved shells guided by computer from lift-off to recovery, and each was tested first by sending the shells into space without pilots. The space shuttle was like the X-1 or the X-15 in that it would be manned for its first all-out test. The shuttle had never before gone into orbit.

The shuttle, like the X-1 and the X-15, had to come into Edwards without power and make a so-called dead-stick landing at high speed. The ship could make one approach and that was it. Even in an age of computers, to attempt a dead-stick landing without a pilot aboard would mean risking a billion-dollar hole in the ground.

It is this, the unspeakable danger—and the term "danger" is itself taboo among the pilots—that has always given the phrase *the first flight* such a righteous aura among test pilots. And what great first flights remain? It has been 18 years since Milt Thompson, for NASA, and Yeager, for the Air Force, made the first flights of a wingless aircraft (lifting body) at Edwards. It has been 13 years since the X-15 made its final flight. The flight of *Columbia* in April may prove to be the last historic first flight in this century.

So even though it took Young and Crippen almost a decade to reach that moment, and even though they grew very old, in the life span of a pilot, there was no reason to doubt Crippen when he said: "It was worth that wait." Everyone in the flying fraternity, and especially the veterans of those skies above the arthritic Joshua trees, knew exactly what he meant.

As We Were Saying...

The Preparations

(Continued from page 4)

should have been normal cleats being individual tractors of gigantic size—moved from its waiting place outside the building, up a gentle gradient, and right into the heart of the building. There it eased its way under the waiting spacecraft, activated its hydraulic lifts, and tenderly assumed control of the entire mighty structure, Apollo and gantry alike.

At that moment even the workmen cheered, but now a most difficult problem arose. Tractor-plus-Apollo-plus-gantry weighed 18,480,000 pounds—9,240 tons—and how could such a burden be moved three and a half miles across Florida swampland?

'What we did was call in the best roadbuilders in the world, and they said, "Simple. You build a road wider than an eight-lane superhighway. You go down nine feet, line the bottom of your trench with big rocks, then seven feet of aggregate, then eight inches of pebbles. Cost? We can do it for about $20,000,000." '

Gingerly, the massive tractor and its precious cargo edged its way out of the assembly building, down the incline and onto the waiting roadbed, where its four corner tractors, each carrying more than 2,000 tons, ground into the surface and inched its way along.

It required a crew of fifteen to operate it at a speed of not quite a mile an hour, but when it came out into the February sunlight, moving purposefully like some majestic dinosaur, watchers cheered as the great thing went past: 'It moves fast enough to do the job.'

Slow, vast, creaking, grinding its massive cleats into the especially hard pebbles imported from Alabama, it carried on its back the soaring white Apollo nestled into the even taller launching gantry that would keep everything in order until the moment of launching: 'There she goes! Destination Moon!'

As gently as if it were carrying the child Moses along a canal of rushes, the supertractor moved out toward Complex 39, where the launch would be made, and as it passed majestically through the Florida sunshine, three men watched with special interest, for they would ride inside the capsule mounted at the top; they would guide this exquisitely beautiful thing to the other side of the Moon. 'The last and the best,' Claggett said.

John Pope, still amazed by the actual size of this giant, whispered, 'It's a privilege to be associated with it,' and Claggett reminded him, 'You named it, son. There goes your *Altair.*' This would be their home, their responsibility, the last noble bird of its breed, and they watched with love as it crept along. 'It wants to fly,' Randy said. 'Twenty-five thousand miles an hour, not crawl at twenty inches a second.'

After it had traveled three very slow miles, the importance of the top eight inches of pebbled rock and sealer became evident, for now the crawler was required to take a smooth curve to the north, and if the surface had been concrete, or macadam, as originally planned, the twisting of the cleats would have torn the road to pieces. As it was, the tremendous torque pulverized the top pebbles, but the metallic beetle inched ahead.

When it reached the approach to Pad A, from which the rocket would be fired, it faced a five-degree ramp up which it must move to the launch position, and now a score of computers, pumps, hydraulic systems and controls sprang into operation, lowering the front end of the crawler and raising the back so that an absolutely level platform was maintained.

When the climb up the ramp was completed, the crawler delivered the great Apollo with its gantry to the proper point, lowered it onto its stand, then backed slowly away as if it were some fairytale bullfrog who had saved a princess. Job done, it retreated groaningly back across the marshes, never again to bring a gleaming Apollo from its place of birth.

Origins

(Continued from page 3)

business, and it promises to become more routine in the future.

And if a sense of the ordinary becomes a part of spaceflight, it will be because an enormous number of people are flying routinely in space. It will be because Shuttle flights take off every week or so, and because scientists and engineers and specialists of all kinds are living and working in space. In the next decade or so, the Johnson Space Center will probably be very heavily involved in the construction of a space station in low Earth orbit. NASA sees this as the next logical step and proposes to have construction underway by the early 1990s. In some ways, that will be analogous to the construction of JSC here some 20 years ago.

As with JSC, one of the items under construction will be a mission control center. With the advent of a space station, more complex orbital operations will begin, requiring some kind of control center in orbit, many believe. This orbital complex probably will also include scientific laboratories, living quarters, and repair and construction facilities. It won't be as large as JSC and it won't house as many people by far. It won't be close to Clear Lake and the salty breezes, but there will be all of the world's oceans to look out on.

And in 20 or 50 years, when the trees at the Johnson Space Center have finally grown to maturity and arc out over the roads and walkways, they may even plant a few more...up there.

The Launch

(Continued from page 5)

the Apollo program had been killed long before it came to fruition. During a groundbased test of the Apollo command module, three astronauts had died in a fire, which nearly stopped the program forever. Through the halls of Congress, in the media, all around the world, people praised or condemned the Apollo project, blessed it as the best thing the human race had ever attempted or cursed it as a waste of time, effort, and money.

But on that moment of July 20, 1969, Armstrong's unplanned, exuberant words rang around the world: "Houston, Tranquility Base here. The *Eagle* has landed!"

And the reply from Mission Control was: "Roger, Tranquility. We copy you on the ground. You got a bunch of guys about to turn blue. We're breathing again. Thanks a lot."

Six hours later Armstrong crawled out of the lunar module, watched by hundreds of millions via television, to plant the first human footprint on the dusty soil of the Moon. He spoke the carefully prepared line, the one intended for the history books: "That's one small step for a man, one giant leap for mankind."

We had reached the Moon. In the words of the President who initiated the Apollo program, "The energy, the faith, the devotion which we bring to this endeavor will light our country and all who serve it—and the glow from that fire can truly light the world."

The View From Within

(Continued from page 4)

off... all nickel-and-dime stuff. In between switch throws, I have plenty of time to think, if not daydream. Here I am, a white male, age thirty-eight, height 5 feet 11 inches, weight 165 pounds, salary $17,000 per annum, resident of a Texas suburb, with black spot on my roses, state of mind unsettled, about to be shot off to the moon. Yes, to the moon.

Inevitably, as the big moment approaches, its arrival is announced by the traditional backward count toward zero. Anesthetists and launch directors share this penchant for scaring people, for increasing the drama surrounding an event which already carries sufficient trauma to command one's entire consciousness. Why don't they just hire a husky-voiced honey to whisper, "Sleep, my sweet" or "It's time to go, baby"? Be that as it may, my adrenalin pump is working fine as the monster springs to life. At nine seconds before lift-off, the five huge first-stage engines leisurely ignite, their thrust level is systematically raised to full power, and the hold-down clamps are released at T-zero. We are off! And do we know it, not just because the world is yelling "Lift-off" in our ears, but because the seats of our pants tell us so! Trust your instruments, not your body, the modern pilot is always told, but this beast is best felt. Shake, rattle, and roll! Noise, yes, lots of it, but mostly motion, as we are thrown left and right against our straps in spasmodic little jerks. It is steering like crazy, like a nervous lady driving a wide car down a narrow alley, and I just hope it knows where it's going, because for the first ten seconds we are perilously close to that umbilical tower. I breathe easier as the ten-second mark passes and the rocket seems to relax a bit also, as both the noise and the motion subside noticeably. All my lights and dials are in good shape, and by stealing a glance to my left, I can tell that the other two thirds of the spacecraft is also behaving itself. All three of us are very quiet—none of us seems to feel any jubilation at having left the earth, only a heightened awareness of what lies ahead. This is true of all phases of space flight: any pilot knows from ready-room fable or bitter experience that the length of the runway behind him is the most useless measurement he can take; it's what's up ahead that matters. We know we cannot dwell on those good things that have already happened, but must keep our minds ever one step ahead, especially now, when we are beginning to pick up speed. There is no sensation of speed, I don't mean that, but from a hundred hours of study and simulation, I know what is happening in the real world outside that boost protective cover, even if I can't see it. We have started slowly, at zero velocity relative to the surface of the earth, or at nine hundred miles per hour if one counts the earth's rotational velocity. But as the monster spews out its exhaust gases, Newton's second law tells us we are reacting in the opposite direction. In the first two and a half minutes of flight, four and a half *million* pounds of propellant will have been expended, causing our velocity relative to the earth to jump from zero to nine thousand feet per second, which is how we measure speed. Not miles per hour, or knots, but feet per second, which makes it even more unreal.

The G load builds slowly past 4, but no higher; unlike the Titan, the Saturn is a gentleman and will not plaster us into our couches. The 4.5 are but a little smooch, letting us know that the first-stage tanks are about empty and ready to be jettisoned. Staging, it is called, and it's always a bit of a shock, as one set of engines shuts down and another five spring into action in their place. We are jerked forward against our straps, then lowered gently again as the second stage begins its journey. This is the stage which whisperers have told us to distrust, the stage of the brittle aluminum, but it seems to be holding together, and besides, it's smooth as glass, as quiet and serene as any rocket ride can be. We are high above the disturbing forces of the atmosphere now, and the second stage is taking us on up to one hundred miles, where the third stage will take over and drive us downrange until we reach the required orbital velocity of 25,500 feet per second. At three minutes and seventeen seconds after lift-off, precisely on schedule, the launch escape rocket fires (no longer being needed). As it pulls away from our nose, it carries with it the protective cover that has been preventing me from seeing out my windows. Now it's much brighter inside the cockpit, but there is nothing to see outside but black sky, as we are already above all weather, at two hundred miles downrange from the Cape and pointed up.

As each minute passes, Houston tells us we are GO (all is well), and we confirm that everything looks good to us. At nine minutes the second stage shuts down, and briefly we are weightless, awaiting the pleasure of the third-stage engine. Due to the heightened awareness that always comes at these important moments, my sense of time is distorted, and it seems to take forever for the third stage to light. Finally! Ignition, and we are on our way again, as the single engine pushes us gently back into our couches. This third stage has a character all its own, not nearly as smooth as the second stage, but crisp and rattly. It vibrates and buzzes slightly, not alarmingly so, but with just enough authority to make me delighted when it finally shuts down on schedule at eleven minutes and forty-two seconds. "Shutdown," Neil says quietly, and we are in orbit, suspended gently in our straps. The world outside my window is breathtaking; in the three short years since Gemini 10, I have forgotten how beautiful it is, as clouds and sea slide majestically and silently by. We are "upside down," in that our heads are pointed down toward the earth and our feet toward the black sky, and this is the position in which we will remain for the next two and a half hours in earth orbit, as we prepare ourselves and our machine for the next big step, the translunar injection burn which will propel us toward the moon. The reason for the heads-down attitude is to allow the sextant, in the belly of the CM, to point up at the stars, for one of the most important things I must do is take a couple of star sightings to make sure that our guidance and navigation equipment is working properly before we decide to take the plunge and leave our safe earth orbit.

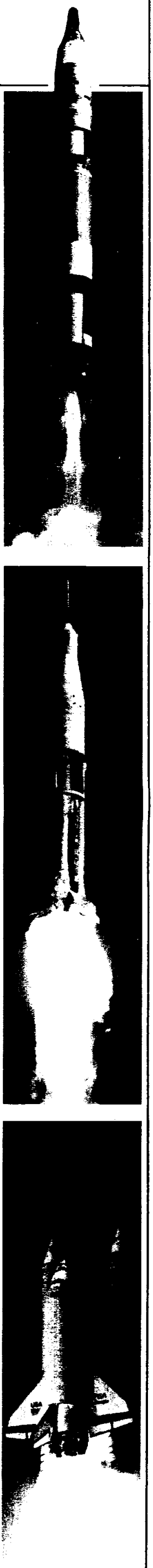
Spacecraft Characteristics

	Mercury	Gemini	Apollo		Skylab		ASTP	Shuttle
			Command Module	*Lunar Module*	*Command Module*	*Orbital Workshop*		
Weight (kg)	1,208	2,165	5,668	5,178	6,088	54,932	5,843	90,249
Volume Pressurized (M^3)	1.43	2.35	7.65	6.65	7.65	351.08	7.65	71.46
Habitable Volume (M^3)	1.02	1.56	5.94	4.53	5.94	344.98	5.94	50.0
Windows	1	2	3	3	3	3	3	10
Number of Compartments/ Items Stowed	0	13/ 196	25/ 1,727		241/ 10,160		32/ 1,965	55/ 2,600
Electrical Busses	4	6	14	5	14	30	14	110
Circuit Breakers	20	107	264	160	256	540	262	1,445
Thermal Control	Cabin Gas Cooling	Cold Plate Water Glycol Radiator	Cold Plate Water Glycol Radiator	Cold Plate Water Glycol Sublimator	Cold Plate Water Glycol Radiator		Cold Plate Water Glycol Radiator	Cabin Gas, Cold Plate Water Glycol Radiator, 3 Ammonia Boilers
Attitude Control (Newton/Sec)	30,967	Entry: 90,478 OMS: 1,077,524	Entry Module: 256,714 Service Module: 1,653,828	782,483	Entry Module: 329,521 Service Module: 3,517,470	3 Control Moment Gyros Cold Gas: 273,766	Entry Module: 329,521 Service Module: 3,517,470	9,236,304
Orbital Maneuver Delta V (M/Sec.)	98.8	99.1	1,951	Descent: 2,135 Ascent: 1,850	533.1	0	271.1	304.8
Maximum Duration (Days)	1.5	13.75	12.5	3	8	84	9	7-30

Program	*Panels*	*Work Stations*	*Control Display Elements*	*Computers Number/Modes*	*Total Measurements*	*Displayed To Crew*	*Displayed To Mission Control*
Mercury	3	1	143	0	100	53	85
Gemini	7	2	354	1/1	225	75	202
Apollo[1]	40	7	1,374	4/50	948	494	615
Skylab[2]	189	20	2,980	4/2	1,720	326	1,669
Shuttle	97	9	2,300	5/140	7,831	2,170	3,826
Space Station[3]	200	40	3,000	8/200	4,000	4,000	4,000

[1]Command Module and Lunar Module; computers include primary and backup in CM and LM.
[2]Orbital Workshop; computers include CM primary and backup, Telescope and Workshop.
[3]Proposed; Assumes real time control on board, data base management from ground.

Sources: Joseph P. Loftus & Maxime A. Faget



High Flight

Oh, I have slipped the surly bonds of earth
And danced the skies on laughter-silvered wings;
Sunward I've climbed, and joined the tumbling mirth
Of sun-split clouds — and done a hundred things
You have not dreamed of — wheeled and soared and swung
High in the sunlit silence. Hov'ring there,
I've chased the shouting wind along, and flung
My eager craft through footless halls of air.
Up, up the long, delirious, burning blue
I've topped the windswept heights with easy grace
Where never lark, or even eagle flew
And, while with silent, lifting mind I've trod
The high untrespassed sanctity of space,
Put out my hand, and touched the face of God.

—John Gillespie Magee, Jr.
Killed in [illegible]

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